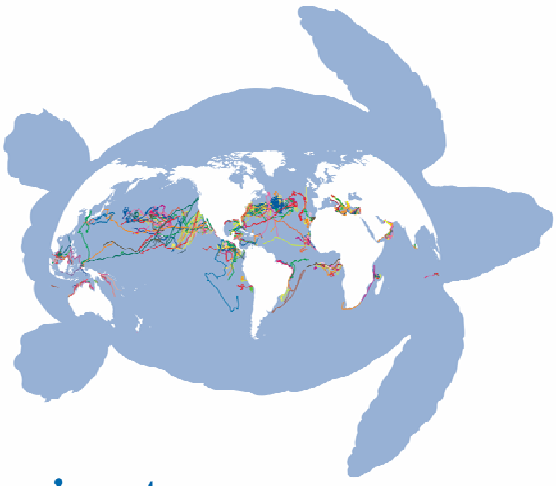
NOAA Technical Memorandum NMFS-SEFSC-569

PROCEEDINGS OF THE TWENTY-SEVENTH ANNUAL SYMPOSIUM ON SEA TURTLE BIOLOGY AND CONSERVATION



Compiled by:
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U.S. DEPARTMENT OF COMMERCE
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National Marine Fisheries Service
Southeast Fisheries Science Center
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Miami, FL 33149 USA

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22-28 February 2007
Myrtle Beach, South Carolina, USA

Compiled by:

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President's Report on the 27th Annual Symposium on Sea Turtle Biology and Conservation

By Michael S. Coyne, President, ISTS

Overview: The 27th Annual Symposium on Sea Turtle Biology and Conservation was a huge success. The Symposium returned to South Carolina, the "business" home of the International Sea Turtle Society, for the first time in 10 years. With about 1000 participants from more than 80 countries, the Symposium's "Migration" theme was clearly evident.

The Kingston Plantation in Myrtle Beach proved to be an excellent location for the meeting. The facilities were such that we were able to keep all Symposium activities within close proximity to one another, and the hotel staff was friendly and extremely helpful. The open bars that we were able to negotiate with the hotel for the nights of the social and auction were huge hits. However, the Symposium would not have been a success without the help and support of all of my turtle friends. Most notably, the Symposium would not have run as smoothly as it did without the tireless effort of Volunteer Chair Wendy Cluse and all of her excellent volunteers!

More than 400 abstracts were submitted, which provided the Program Chairs (Lisa Campbell and Matthew Godfrey), the Program Coordinators (Kartik Shanker and DuBose Griffin) and their 20-member Program Committee with a tremendous amount of work. Over 370 abstracts were accepted for presentation, and were included in the 296-page Book of Abstracts, made available to participants in PDF format in advance of the Symposium. The latter thanks to the fine work of the four compilers: Mike Frick, Aliki Panagopoulou, ALan Rees and Kris Williams. Symposium proceeding will be forthcoming in the very near future, printed and distributed thanks to Sheryan Epperly and the NOAA Southeast Fisheries Science Center.

The Symposium kicked off on 24th February with a special Carolinas Session and an event open to the public entitled "Sea Turtle Discovery Day". The Carolinas Session was co-hosted by Sally Murphy and Matthew Godfrey and included talks by Jean Beasley, Betsy Brabson, and Sally Murphy. The audience divided up into discussion groups to tackle issues such as dredging, beach nourishment, nest relocation and beach driving.

The regular sessions culminated with a special plenary session on Tracking Marine Vertebrates for Conservation, sponsored by Inter-Research (http://www.int-res.com/) and organized by Brendan Godley of the Marine Turtle Research Group (University of Exeter) and Editor in Chief of *Endangered Species Research* - ESR *(http://www.int-res.com/journals/esr/)*. The program for this mini-symposium was excellent, with an introduction on sea turtles by Brendan followed presentations by Mike Fedak, Molly Lutcavage, Bruce Mate and an outstanding finale by Rory Wilson. These reviews will form the core of a future special themed issue of ESR.

Travel Grants: In total, 189 travel grants were distributed by the Regional Travel Chairs, as cash and "free" rooms, through generous donations from Western Pacific Regional Fishery Management Council, US Fish & Wildlife Service, US National Marine Fisheries Service, Florida Power and Light, Disney's Animal Kingdom, Sirtrack Ltd, and the Marine Conservation Society (MCS). There were also several smaller donors and "room sponsors", too many to be mentioned here. Raising funds in advance of the symposium to support student and international travel is always a challenge. We spent about 75,000 USD on travel grants, including housing for 184 people. The delicate job of allocating travel grants was once again expertly handled through the efforts of the Travel Committee Chair, Hoyt Peckham, and the Regional Travel Chairs Alan Bolten, Karen Eckert, Alejandro Fallabrino, Angela Formia, Aliki Panagopoulou, Nicolas Pilcher, and Kartik Shanker.

Media: We had a strong showing in the press thanks primarily to the efforts of Heather Crunchie, of Splash Communication, who donated her time to the cause. In total we had more than a dozen press outputs, including stories in local media outlets, a large full page graphic in a local newspaper, and several on-site interviews.

Local Participation: Approximately 300 members of the public attended the previously mentioned Sea Turtle Discover Day, which featured Jersey and Harley, sea turtle patients at the Karen Beasley Sea Turtle Rescue and Rehabilitation Center in Topsail Beach, N.C. Members of the public were also treated to turtle talks by Jean Beasley, Lucy Hawkes, and Charlotte Hope. The Karen Beasley Sea Turtle Rescue and Rehabilitation Center contributed two turtle mascots to interact with the public, along with Gilly the Sharky from Mote Marine Lab, Sharkee from Ripley's Aquarium, the infamous Mr. Leatherback, and two friends from the South Carolina Aquarium. Finally, visitors and Symposium attendees were treated to nearly 200 works of art as part of a global art project, submitted by students from the Carolinas and as far away as Greece and Gabon.

Vendors: Vendor chair Janet Hochella deserves special thanks for organizing a large number of vendors in a very successful effort. Between the public visitors and very generous attendees, many of the vendors sold out before the Symposium was over.

Entertainment: One of the highlights of each Symposium is the Auction. Attendees contributed a large number of wonderful items. These were well arranged and organized by my lovely wife and Auction Chair Lynette Coyne. The live and silent Auctions were a huge success bringing in a record 25,000 USD. A special thanks to Jen Homcy for her invaluable contributions to the auction, Ed Drane and his team from the Hilton Head Island Sea Turtle Protection Project, auctioneer Rod Mast, and all of the attendees that contributed to the auction. The coffee breaks between sessions provide an excellent opportunity to mingle, compare notes and meet the presenters. The Caribbean Conservation Corporation, CLS America, Inc., Ripley's Aquarium, the South Carolina Aquarium, Turtle Time, Inc., Wildlife Computers, and the Charleston Coffee Roasters, which provided the coffee, generously supported these invaluable events.

I would like to thank all participants, all sponsors and donors, all members of Committees and Task Forces, all of the wonderful volunteers, and all of my friends for helping make this Symposium a great success. Finally, many thanks to Sue Ranger for designing the migration logo and graphics, and Kristy Long for developing the printed program.

COMMITTEES, CHAIRS, AND KEY ORGANIZERS

Symposium Coordinator	Rich Higgins
Website	Michael Coyne
Fund Raising	Michael Coyne, Elena Finkbeiner, J Nichols
Program Chairs	Lisa Campbell, Matthew Godfrey
Program Committee Coordinators	Kartik Shanker, DuBose Griffin
Program Committee	Craig Harms, Jeanette Wyneken, Larisa Avens, Tony Tucker, Peter Richardson, Suzanne Livingstone, Lalith Ekanayake, Mark Hamann, Bryan Wallace, J Nichols, Marydele Donnelly, Johath Laudino-Santillán, Rebecca Lewison, Paolo Casale, Barbara Schroeder, Amanda Southwood, Oguz Turkozan, Blair Witherington, Bethany Haalboom, Sue Ranger
Poster Session Chair	Bill Irwin
Student Awards	Jeanette Wyneken, Lisa Campbell
Auction Chair	Lynette Coyne
Auction Whip	Jennifer Homcy
Auctioneer	Roderic Mast
Travel Committee Chair	Hoyt Peckham
Travel, Regional Chairs	Angela Formia (Africa), Nicolas Pilcher (Asia/Pacific and Middle East), Karen Eckert (Caribbean), Aliki Panagopoulou (Europe), Kartik Shanker (South Asia), Ana R. Barragan (Latin America), Alan Bolten (USA and Canada)
Vendor Chair	Janet Hochella
Volunteer Chair	Wendy Cluse
Resolutions Committee Chairs	Nancy FitzSimmons and Jeffrey Seminoff
Resolutions Committee	Joanna Alfaro, Ana Barragan, Kartik Shanker and Thane Wibbels
Communications	Heather Crunchie
Proceedings Compilers	Mike Frick, Aliki Panagopoulou, ALan F. Rees and Kris Williams
Printed Program Coordinator	Kristy Long
Logo and Graphic Design	Sue Ranger, Marine Conservation Society UK
Latin Reunion	Alejandro Fallabrino
WIDECAST Meeting	Karen Eckert
Mediterranean Meeting	Dimitris Margaritoulis
African Meeting	Jacques Fretey, Angela Formia and Manjula Tiwari
IOSEA Meeting	Douglas Hykle
Marine Turtle Specialist Group	Roderic Mast and Nicolas Pilcher
Historian	Barbara Schroeder
Parliamentarian	Frank Paladino

ARCHIE CARR BEST STUDENT PRESENTATION AWARDS

The 27th Sea Turtle Symposium marked the 10th anniversary of dedicated joint sponsorship of the Archie Carr Best Student Presentation Award by the ISTS and the Chelonian Research Foundation. The contributions made by the Chelonian Research Foundation (CRF) are gratefully acknowledged here. The CRF has significantly enhanced the breadth and impact of these awards. During this 2007 Sea Turtle Symposium, the conservation awards were also co-sponsored The Ocean Conservancy, in honor of Miss Frances Velay, a long time patron of sea turtle conservation efforts.

Ten awards were given for presentations to the best student oral and poster presentations, and runners-up in the categories of Biology and Conservation. The award certificates were accompanied by an honorarium. In total 2,000 USD were awarded to the ten students.

Best Biology Oral Presentation
Shaya Honarvar, Michael P. O'Connor, James R. Spotila. "Density-Dependent Effects on Hatching Success in Olive Ridley Turtles"

Runner-up Biology Oral Presentation
T. Todd Jones, Mervin D. Hastings, David R. Jones. "Rearing Leatherbacks in Captivity: Protocols, Health and Research"

Runner-up Biology Oral Presentation
Sabrina Fossette, Jean-Yves Georges, Hideji Tanaka, Yan Ropert-Coudert, Sandra Ferraroli, Nobuaki Arai, Katsufumi Sato, Yasuhiko Naito, Yvon Le Maho. "Dispersal and Dive Patterns in Gravid Leatherback Turtles During the Nesting Season in French Guiana"

Best Biology Poster Presentation
Caren Barceló, Hoyt Peckham, Baldo Marinovic. "What Do Hitchhikers Eat? The Diet of *Planes cyaneus* and Their Association with Loggerhead and Olive Ridley Turtles Off the Pacific Coast of Baja California Sur, Mexico"

Runner-up Biology Poster Presentation
Paula Sanz, Severine Roques, Adolfo Marco, LuisFelipe López-Jurado. "Fine-Scale Paternity Study of a Loggerhead from Cape Verde: Within and Between Seasons"

Runner-up Biology Poster Presentation
Tomoko Narazaki, Katsufumi, Nobuyuki Miyazaki. "Studies on Diving Behaviour of Sea Turtles Caught by Set Net at Sanriku Coastal Water"

Best Conservation Oral Presentation
Joseph B. Pfaller, Colin J. Limpus, Karen A. Bjorndal. "Doomed Egg Relocation: A Beneficial Conservation Strategy?"

Runner-up Conservation Oral Presentation
Hector Barrios-Garrido, Ma. Gabriela Montiel-Villalobos. "Impacts in the Conservation of the Marine Turtles on the Part of Fishing Communities Wayúu in the Gulf of Venezuela"

Best Conservation Poster Presentation
Marlem Zenteno, Miguel Herrera, Ana R. Barragán, Laura Sarti. “Impact of Different Kinds and Times of Retention in Olive Ridleys (*Lepidochelys olivacea*) Hatchlings in Blood Glucose Levels”

Runner-up Conservation Poster Presentation
Anne M. LeBlanc, Thane Wibbels, Hector J. Martinez-O., Marco Antonio-P., Lila Vega-M., Diana J. Lira-R., Jaime Pena-V., Patrick M. Burchfield, Barbara Schroeder. “Back to the Natural Nesting Beach: A Transition from Egg Corrals to *In Situ* in the Kemp’s Ridley Sea Turtle”

In total, 130 contributions were examined by the Judging Committee divided into 4 categories (Biology Oral Presentations, Biology Posters, Conservation Oral Presentations, and Conservation Posters. Committee members do not judge posters or talks for which they have a conflict of interest. The 20-member Judging Committee generously gave their time to assess the student presentations. The 2007 committee was composed of Karen Arthur, Annette Broderick, Ana Baragan, Marydele Donnelly, Mark Hamann, Kristen Hart, Bill Irwin, Michael James, Jennifer Keller, Cynthia Lagueux, J Nichols, Dave Owens, Nicolas Pilcher, Anders Rhodin, Barbera Schroeder, Melissa Snover, Amanda Southwood, Ed Standora, Roldan Valverde, and Thane Wibbels. It is notable that many of these judges are former Archie Carr Student Award Recipients. Lisa Campbell, Jeanette Wyneken and Anders Rhodin co-chair the Archie Carr student awards committee.

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Anatomy, Physiology and Health

VARIABILITY ON INCUBATION TEMPERATURE AND METABOLIC HEATING AS A FUNCTION OF EMBRYONIC SURVIVAL IN LOGGERHEADS

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The nest thermal environment on endangered species whose sex is determined by temperature could be crucial for their survival. The incubation temperature is also an important ecological parameter in conservation management programs of these species. During the last half of the incubation, embryonic development produce the metabolic heating of the nest. But this endogenous proccess could be affected by the number of alive embryos that develop together inside the nest or external factors such as eventual floodings by high tides or storms may affect the amount of metabolic heating. All these ecological interactions are not fully understood and make it necessary to conduct studies about the thermal biology of the nest environment. We have studied temperature variations within and between nests of 60 loggerhead nests on Boavista Island in Cape Verde. Nests were selected from different microhabitats (dry sand, wet sand and silky substrate), where sea turtles commonly deposit eggs, in order to study possible variations on thermal profiles among microhabitats. Eight nests were controlled with 4 temperature data-loggers in each to know spatial differences in temperature within the nest (bottom, middle-centre and middle-side of nest incubation chamber). In order to understand the vertical thermal gradients of different substrate environments without eggs, to compare substrate temperature at the same depth with and without eggs and to estimate metabolic heating, we excavated a simulated nest 75cm apart from logged nests containing eggs. In these simulated nests we placed 3 thermometers at the same depth of those in real nests. We also put two more temperature loggers at 10cm below the sand surface, one above the nest and the other above the simulated nest. Additionally, we placed one thermometer in the centre of all of the other nests observed during our study in order to calculate the incubation temperature and correlate it with hatching success, hatching duration and hatchling characteristics. During the first third of the incubation there is no evidence of metabolic heating and incubation temperature is affected by external factors. Also during this period, the mean temperature in the middle of nest chamber was not affected by nest depth but varied seasonally during 2005. Nests laid in July had an average temperature of 28.1°C, while nests laid in September had a mean temperature of 29.8°C. Incubation duration was correlated with mean temperature during this first period (r=0.62). However, during the last third of incubation, the nest temperature was correlated with emergence success (r=0.80), offspring size (r=0.54) and mass (r=0.57), but not with incubation time. We found significant spatial variation in nest temperature within the nests.

HEAVY METALS IN THE LIVER OF HATCHLINGS AND ADULT FEMALE GREEN TURTLES, CHELONIA MYDAS, FROM RAS AL-HADD RESERVE OMAN

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In this study, nesting females killed by boats and hatchlings killed by foxes were analyzed for heavy metal contents in their livers. The study was conducted at Ras Al-Hadd Reserve between the 2004-2006 nesting seasons. The Inductive Coupled Plasma (ICP) analytical method was used for the analysis. The results revealed that the metal contents ranged between 0.08 (Se) and 0.476 (Zn) µg/g wet weight in the hatchling livers, and between 0.09 (Ni) to 17.25 (Zn) µg/g wet weight in the adult livers. The results of this study reveal that there is a heavy metal contamination in the feeding areas of the reserve. There is an urgent need for monitoring the heavy metal pollutants and so the sources of these contaminants can be identified and controlled.

AN ANALYSIS OF PLASMA ESTRADIOL IN NESTING GREEN TURTLES (*CHELONIA MYDAS*) AT RAS AL-HADD RESERVE USING HIGH PERFORMANCE LIQUID CHROMATOGRAPHY WITH TANDEM QUADRUPLE MASS SPECTROMETRY

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Recent studies (Al-Habsi *et al*. *in press*) reveal that plasma estradiol levels are undetectable in the nesting green turtles at Ras Al-Hadd using the traditional methods, such as the Coat-A-Count technique. In addition, other studies under natural conditions in other regions show that the estradiol levels in nesting green turtles is also undetectable or present at only very low levels (Wibbles *et al*., '90; '92). Analyses of estradiol using the sensitive technique of liquid chromatography with tandem quadruple mass spectrometry enabled us to detect low levels of estradiol during the nesting process. There was no significant difference in estradiol levels throughout the nesting process. Even though the estradiol concentration is low, it could have some physiological impact during nesting exercises. Estradiol is known to be the main hormone to initiate vitellogenesis in glandular development in the sea turtles. Moreover, estradiol could also trigger migration during the nesting season (Owens and Morris 1985; Ho 1987). The detection of plasma estradiol during nesting using this sensitive technique can be useful in the overall understanding of the hormone dynamics relative to the behavior and physiology of the species.

FLAME RETARDANT CONTAMINANTS IN LOGGERHEAD TURTLE EGGS (CARETTA CARETTA) FROM FLORIDA AND NORTH CAROLINA

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Flame retardants are anthropogenic, emerging persistent organic pollutants, known as polybrominated diphenyl ethers (PBDEs) and broadly used since 1970. PBDEs have been detected in several species of marine mammals and seabirds, but not in marine turtles. The loggerhead sea turtle (*Caretta caretta*) has been recently utilized as a biological compartment in several ecotoxicological studies to conduct biomonitoring of pollutant concentrations (mercury, PCBs, pesticides, perfluorinated compounds) and to assess the potential effects of these contaminants on the health of this threatened species. PBDE congeners were measured in unhatched egg samples from 37 nests collected from beaches in North Carolina (NC) and both eastern and western Florida (FL) coasts in the summer of 2002. Yolk of eggs containing only early and middle stage embryos were pooled per nest. Twelve PBDEs congeners (BDE 17, 28, 47, 66, 71, 85, 99, 100, 138, 153, 154, 183) were measured by gas chromatography and mass spectrometry (GC/MS) in electron impact mode using a 60 m DB-5MS column. The NC nests had significantly higher concentrations of PBDEs (13.5 ng/g lipid) compared to eastern FL (2.23 ng/g lipid) and western FL nests (0.815 ng/g lipid; ANOVA $p < 0.001$). This geographical variation is likely due to different foraging habitat during the seasonal migration and gradient of urbanization and industrialization along the eastern coast. Nesting females from NC are known to migrate to northern Atlantic Ocean waters to forage during the non-nesting season, while the females nesting further south migrate to more southern waters in the Gulf of Mexico, Florida coastal waters, and the Caribbean Sea. These spatial differences may be important because the northern subpopulation (e.g., NC), the one with higher PBDE concentrations, has been declining over the last three decades compared to the stable or increasing south FL subpopulation.

PATHOLOGICAL STUDIES IN GREEN SEA TURTLES (*CHELONIA MYDAS*) AND LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) FROM THE NORTHERN COASTAL AREA OF BUENOS AIRES, ARGENTINA

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Twenty-seven free-ranging green sea turtles (*Chelonia mydas*) and two loggerhead sea turtles (*Caretta caretta*) were systematically necropsied for histologic, parasitologic and stomach content studies. From December 2004 through March 2005, they were accidentally taken as by catch by the San Clemente del Tuyú (36º22'S – 56º44'W) and Mar de Ajó (36º43'S – 56º41'W) artisanal gillnet fisheries, in Buenos Aires Province. The average CCLmin (Minimun Carapace Length over the curve) for *C. mydas* was 38.56 cm and the average weight was 6.49 kg (5 ♂, 16 ♀ and 6 undetermined). For *C. caretta* the LMC were 53.2 cm (♀) and 62 cm (♂) and they weighed 17.1 kg and 28 kg, respectively. The samples were fixed with 10% formalin and were processed following routine histological protocols. We mainly found entanglement-induced lesions 27/27 (100%), parasite-induced lesions 26/27 (96,3%), different levels of hepatic lipidosis 26/27 (96,3%), fibrosis in the renal medulla 18/27 (66,7%), mycotic-associated lesions 2/27 (7,4%) and bacterial lesions 1/27 (3,7%) in *C. mydas*. Furthermore, both *C. caretta* had entanglement-induced lesions 2/2 (100%) and only one had parasite-induced lesions 1/2 (50%). The entanglement-associated changes included different haemodynamic disorders (congestion, edema and hemorrhage) attributed to shock, and were most prominent in lungs, liver, thyroids, coelomic cavity, spleen, brain, kidney and skeletal muscle. Lesions attributed to parasitism included gastroenteritis, systemic lymphonodular hyperplasia, urocystitis, myocarditis, and nematode granulomas in a variety of tissues. They were due to different stages of larval migration (nematodes) along the gastrointestinal tract and viscera. Lesions were observed in esophagus 3/27 (11,1%), stomach 23/27 (85,2%), small intestine 21/27 (77,8%), liver 8/27 (29,6%), lungs 7/27 (25,9%), kidney 4/27 (14,8%) and urinary bladder 4/27 (14,8%). The mycotic and graulomas were occasionally seen and limited to the lungs. We found mild to severe hepatic lipidosis. The significance of these lesions in turtles can be difficult to judge and can be associated with anorexia, obesity, malnutrition, endocrine or metabolic derangements, hepatotoxins, hypoxia, preparation for or emerging from brumation, and active reproductive status. All turtles had some form of underlying disease process detected histologically, but based on nutritional status and severity of the lesions associated with these disease processes, it is considered likely that all other disease processes were incidental and probably did not predispose these turtles to a drowning event. No macroscopic or microscopic lesions of fibropapillomatosis were seen. Nonetheless, we are monitoring for this disease in Argentina. This study represents preliminary data regarding the health status of sea turtles in areas of great anthropogenic impact like Bahía Samborombón and Cabo San Antonio in Argentina. Future studies will focus on continuing the monitoring effort in the region.

SYNOPSIS OF INFECTIONS IN SEA TURTLES CAUSED BY VIRUS, BACTERIA AND PARASITES: AN ECOLOGICAL REVIEW

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During the last centuries sea turtle populations worldwide have been declining or have been driven nearly to extinction due to human activities. According to IUCN, all of the world's seven sea turtle species have become threatened, five of them are endangered and two vulnerable. This precipitous decline in sea turtles numbers has awakened an interest in the use of classical anatomic pathology to describe their infectious diseases their prevalence and to determine cause of death. Lists of parasite species of sea turtles exist and new species are described continually, but few data are available on parasite life histories; how infestation affects an individual turtle's health, growth, and reproductive output; or effects on population structure and dynamics in both the pelagic and terrestrial environments (Zug *et al*., 2001). However, very little is known about sea turtles in their wild environment. Our understanding of sea turtle biology, ecology and pathology is obtained almost entirely through the short phase in their lives when they come to ashore to lay their eggs or by incidental catch at sea. From these periods, pathogens and parasites such as virus, bacteria, protozoa, worms, leeches and insects have been found and described. This paper examines the known infections caused by virus, bacteria and parasites of sea turtles, and groups them using classic systematic taxonomy. Two families of viruses (possibly six), 56 species of bacteria, 15 fungi, 6 protozoa, 87 plathelminthes (mainly trematodes), 6 nematodes, 4 annelids (leeches), 17 arthropods were found to be the cause or related to infections in sea turtles. The roll of epibionts in sea turtles is also mentioned briefly. A taxonomic summary of infectious virus, bacteria and parasites are presented by sea turtle host species at the end of this synopsis. Keywords: sea turtles, infections, diseases, pathogens, parasites, life cycle, epibionts.

DIAMONDBACK TERRAPINS AND MERCURY: THE WHO, WHAT, HOW, WHERE AND WHY OF USING MALACLEMYS TERRAPIN AS AN ESTUARINE SENTINEL SPECIES

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Mercury contamination has become an increasingly important global issue over the past century, especially in susceptible aquatic environments where inorganic mercury is biotransformed to the toxic methylmercury form. We believe the diamondback terrapin, *Malaclemys terrapin*, may be a good sentinel species for mercury-contaminated estuaries along the Atlantic and Gulf Coasts of the United States. *Malaclemys* exhibits several life history characteristics typical of sentinel species: it is widely distributed in estuaries along the Atlantic and Gulf Coasts, exhibits high site fidelity, and is a high trophic-level predator and a long-lived species. Preliminary studies suggest *M. terrapin* may be an effective tool for monitoring mercury contamination at a local level. This study expands such protocols to examine the utility of *M. terrapin* on a regional scale. Mercury levels will be compared in terrapin blood and scutes collected during summer 2006 from estuaries in three distinct airsheds (Chesapeake Bay,

Charleston Harbor, Florida Bay) with differing levels of annual atmospheric mercury deposition in order to evaluate the relationship between atmospheric inputs and terrapin mercury levels. The regional sampling was complemented by microscale sampling that consisted of two reference and two polluted creeks within the Charleston Harbor to further examine the utility *M. terrapin* on a creek-by-creek basis. Mercury will be determined in blood and keratin matrices via isotope-dilution cold-vapor inductively coupled plasma mass spectrometry. A similar method will determine the fraction of bioavailable mercury in sediment samples from each site. An index of recent exposure will compare mercury in a short-term storage compartment (blood) to a long-term storage compartment (keratin) to provide a possibly useful tool for assessing recent uptake of mercury from the aquatic environment. Results of these analyses will determine the sensitivity of *Malaclemys terrapin* to differing mercury levels in the environment, and will point to the scale upon which *M. terrapin* can be used to monitor mercury contamination in estuaries along the Atlantic and Gulf Coasts of the United States.

RECORD NUMBERS OF SEA TURTLE STRANDINGS IN SOUTHWEST FLORIDA DURING 2005 ASSOCIATED WITH A YEARLONG RED TIDE EVENT

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High concentrations of the dinoflagellate *Karenia brevis* (a bloom more commonly known as red tide) were found in the coastal waters of southwest Florida throughout 2005. Red tides with cell counts of >100,000 cells of *Karenia brevis* per liter of water (aka strong red tide) have the potential for debilitation or mortality in large marine animals. A strong red tide was first identified in the area of Pinellas to Sarasota Counties on 7 January 2005 by routine water sample testing conducted by the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWC/FWRI). The number of dead or debilitated sea turtles (i.e. sea turtle strandings) documented during 2005 by the Florida Sea Turtle Stranding and Salvage Network (FLSTSSN) in Pinellas, Hillsborough, Manatee, Sarasota and Charlotte counties was more than double that in any previous year recorded (since 1980). Loggerheads (*Caretta caretta*) and Kemp's Ridleys (*Lepidochelys kempii*) appeared to be the most affected and reached record numbers for the year, while green turtle (*Chelonia mydas*) strandings reached the second-highest numbers ever recorded. Strandings of hawksbills (*Eretmochelys imbricata*) and leatherbacks (*Dermochelys coriacea*), which are usually found in low numbers (< 5) each year along the coast of southwest Florida, were typically low during 2005. Although the strong red tide persisted all year, above-average numbers of sea turtles strandings in that area were not observed until late July. Most turtles did not exhibit any external signs of prolonged illness (i.e. emaciation or tumors) or injury. Live turtles admitted to rehabilitation facilities displayed signs of neurological impairment (i.e., unresponsive or uncoordinated motor functions), and most

eventually died. Necropsies of these animals revealed no significant disease processes likely to be responsible for their initial debilitation, and tissue samples typically tested positive for brevetoxin (a neurotoxin released by *K. brevis*). Due to the lack of evidence of any primary disease processes or injuries to explain the debilitation of the live-stranded turtles, and the ubiquitous presence of brevetoxin in both live-stranded and dead-stranded sea turtles, we attribute the unusually high number of sea turtle strandings in southwest Florida during 2005 to the persistent red tide.

YOYO: A WITNESS TO THE COMMITMENT TOWARDS THE CONSERVATION OF MARINE TURTLES BY THE INHABITANTS OF ZAPARA ISLAND; GULF OF VENEZUELA

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A fundamental tool in the conservation of endangered species is the environmental education of people who are in direct contact with the resource one seeks to protect (indigenous peoples). Recognizing that they have to adopt a protagonistic role in the protection of such resources if they are to recover or persist, indigenous peoples are often willing to participate actively and directly in suggested conservation efforts. The fishing community of Zapara Island located in the South zone of the Gulf of Venezuela, integrated by Añu natives, has assumed this role of protagonist. Such was witness by “Yoyo” an adult male green turtle (*Chelonia mydas*) that was rescued thanks to the Zapara Island community. Yoyo was captured by fishermen, with several movable fractures in the cranial region. The Red de Aviso Oportuno: RAO-Zulia (Network of Opportune Warning) is a group of specialists based in the city of Maracaibo that recieved and rehabilitated the injured turtle. After 6 days in a rehabilitation pool filled with antibiotics and 8 days in salt water these specialists determined that Yoyo could return to the sea since the turtle's wounds had healed and the fractured bones had returned to their normal placement. The present report demonstrates 1) the existence of a real commitment on the part of the community of Island Zapara in the conservation of these animals, 2) shares information regarding the longest rehabilitation experience conducted in the region of the Gulf of Venezuela for marine turtles, and 3) demonstrates the awareness of some indigenous communities that "every turtle counts".

EPIBIONT OCCURRENCE IN GALAPAGOS GREEN TURTLES (*CHELONIA MYDAS*) AT NESTING AND FEEDING GROUNDS

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The Galapagos Islands, Ecuador, contain both important nesting beaches and feeding grounds for green turtles. Pioneering fieldwork carried out in the 1970's by Derek Green documented the occurrence of epibiontic organisms on green turtles at nesting and foraging grounds. As part of an ongoing study of nesting- and foraging-ground activity, the hard and soft body parts of sea turtles were examined for the occurrence of epibionts. Here we report significant differences between the occurrence of epibionts in feeding grounds and nesting grounds in the Galapagos where 913 and 4208 turtles, respectively, have been examined since the 2001 field season. A significantly greater percentage of sea turtles were observed with *Chelonibia testudinaria* in the nesting grounds than in the foraging grounds (W12,11 = 210.0, p less than 0.0001). The occurrence of *Platylepas hexastylos* was found to be significantly greater in the foraging grounds than in the nesting grounds (W11,12 = 78.0, p less than 0.0001) as was a burrowing barnacle species provisionally identified as *Cylindrolepas darwiniana* (F1,2 = 39.64, p less than 0.001). The Galapagos Islands are known to have both resident and migratory green turtles, and it is hypothesized that differences in the concentrations of barnacle larvae found in inshore and offshore waters may account for the differences in occurrence of epibiontic organisms.

USING LESIONS TO ASSESS THE IMPACT OF FISHERIES ON LOGGERHEAD TURTLES

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One of the functions of the WWF Sea Turtle Rescue Centre of Lampedusa, Italy, (CRTM) has been to work closely with local fishermen and other sea-users. This collaborative approach has resulted in thousands of loggerheads arriving at CRTM. We analyse the period between January 2003 and December 2006. In this period we observed lesions associated with human activities in 246 loggerhead sea turtles of 926 examined (26,56%). We considered the type of lesions (their cause and location in the animal) and related these to capture methods (longline 14.04%, trawled 62.74%, taken by hand 20.63%, nets 1.94%, stranded 0.65%). In 215 turtles (87.40%) we found interactions with longlines in 186 animals (75.61%). Associated lesions were located in the alimentary canal due to hook and monofilament line ingestion. In 9 cases (3.66%) hooks were embedded in flippers or the neck causing external lesions. In 20 turtles (8.13%) we observed serious exterior trauma, caused by nylon line restricting blood flow to limbs. We hospitalized 12 turtles (4.88%) with fractures on the carapace or plastron. All of them were captured by trawling and lesions were caused by impacts with big stones in the rear or 'sock' of the fishing net. In the turtles that ingested hooks: 69 were in the mouth, 79 in the oesophagus, 14 in the stomach and 14 in intestines. Six turtles had more than 1 hook lodged in different portions of the alimentary canal. Another 4 turtles had only fishing-line, without a hook,

extending through the entire alimentary canal. The majority of turtles with hooks in the upper digestive tract (mouth and oesophagus) were caught by longline (70.94%), and were usually fit enough to face surgical intervention. In contrast, turtles presenting hooks or line in the lower digestive tract (stomach or intestine) were in serious condition and in most cases were euthanized (67.95%). In the 246 cases observed, 53 turtles (21,54%) died due to the seriousness of their injuries. Thirty-one of these turtles (58.49%)succumbed to lesions in the lower digestive tract (occlusions, tears, constrictions, invaginations), particularly from hooks and especially fishing-lines. In the other 22 turtles (41.51%) the cause of death is correlated to lesions derived from trawling (fractures of carapace and plastron, drowning, etc.). These data seem to confirm that ingestion of hooks and line are the most frequent anthropogenic cause of lesions in observed loggerheads. Moreover, foreign bodies remaining for a long period of time, or that pass through the alimentary canal, cause serious pathology and are the principal cause of death in stranded turtles. These conclusions stress the timely recovery of wounded animals to improve the chances of successful surgery.

EVALUATION OF THE REPRODUCTIVE ACTIVITY OF ADULT MALE LOGGERHEAD SEA TURTLES COLLECTED IN CAPE CANAVERAL, FL

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Cape Canaveral, FL, is well known for the large aggregation of loggerhead sea turtles found in the ship channel each year. The population inhabiting this water has been previously described as having a bimodal distribution: it is comprised of both subadult and adult turtles, but both groups are predominant at different times of the year, with one group apparently inducing the emigration of the other. In particular, the density of the adult male population peaks in April and May, which may be related to courtship and mating, although this hypothesis has never been confirmed. Also, some males have been recaptured at this breeding ground during consecutive years, which may suggest that males, unlike females, may be able to breed every year, and do not undergo long migrations like females do. In an attempt to better understand the importance of the Cape Canaveral shipping channel, and the reproductive cycle of adult male loggerheads, we used several techniques to assess the reproductive activity of these turtles including: ultrasonography, laparoscopy, testis biopsy, and testosterone levels; and we attached satellite tags to better understand their behavior and movements. A total of 11 adult males were collected from April 17th to April 21st 2006. Testosterone (T) levels ranged from 2.4 ng/mL to 221.9 ng/mL. Two distinct groups were detectable with 4 animals having T levels less than 10 ng/mL, and 7 animals with T levels above 150 ng/mL. All turtles with high T levels showed signs of reproductive activity using laparoscopy, and testis biopsy. In most cases, ultrasound analysis showed a large, often round-shaped, homogeneous mass, which we identified as being testis, and occasionally, a distinct epididymal mass was seen. Based on histology, the average testis tubule diameter was 375.8 µm for this group. Laparoscopic evaluations showed that the epididymides appeared as white convoluted tubules, full of sperm. Interestingly, five of these turtles were satellite tagged, and 3 of them migrated north of the Chesapeake Bay. From the 4 turtles with low T levels, 2 showed no sign of reproductive activity based on histology and laparoscopy, although testis was visible by ultrasound in one case. The average testis tubule

diameter was 189.4 µm. The other 2 turtles did show signs of reproductive activity, and we categorized them as being "post-reproductive". Their average testis diameter was 307.6 µm. All 4 of these turtles stayed in the vicinity of Cape Canaveral, and did not undergo migration like the other ones did. In conclusion, we found that some adult males did not show any signs of reproductive activity, which suggests that they may have a multi-annual reproductive cycle. The ultrasound technique did not have the best resolution to assess the reproductive activity of these turtles, whereas laparoscopy, and testis biopsy were the most powerful tools. Testosterone measurement showed that high levels were always associated with reproductive activity, but low levels could be wrongly interpreted, as some turtles were surmised to be post-reproductive. This study will be expanded in 2007, in an effort to increase our sample size.

INGESTION OF MARINE DEBRIS BY LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN THE EASTERN ADRIATIC SEA

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Debris ingestion is reported in almost all sea turtle species. Due to their feeding strategy, oceanic-life stages and species that utilize convergence fronts for migration routes, like leatherbacks and loggerheads, seem to be most susceptible to debris ingestion. These two species apparently ingest more debris than other sea turtles, which may result in variety of physiological sub-lethal effects and even death. The benthic foraging strategy of loggerhead turtle in nearshore waters, where debris accumulation tends to be high, coupled with opportunistic feeding nature of the species, leads to increased chance of debris intake, and possible effect on population health. We examined the presence of anthropogenic debris in 54 loggerhead turtles (mean CCLn-t: 42.7 cm, SD: 11.5), found stranded dead or incidentally captured in the eastern Adriatic Sea (Slovenia and Croatia) in 2001-2004. This region hosts one of the most important feeding habitats for the species in Mediterranean basin, shared by juveniles and adults. We've removed digestive tracts during necropsy and isolated debris. Debris samples were later air-dried and weighted. Debris was found in 19 turtles (35.2%), with plastic being prevalent type of debris, recorded in 13 turtles (24.1%). Nearly all ingested plastics where white colored, light or translucent. Ropes, lines, styrofoam, small pieces of latex and unknown hard material were also present. Dry weight of ingested debris was low (< 0.01 – 0.71 g), with no clear evidence that it directly caused death of any turtle. However, considering relatively high occurrence of debris intake and possible sub-lethal effects that it may cause even when ingested in small quantities, marine debris can be a factor of concern for population health of loggerheads foraging in the Adriatic Sea. *Acknowledgments*: Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, US Fish and Wildlife Service and other donors through the Symposium Travel Committee.

EVALUATION OF FOUR LIVE SEA TURTLES ENTANGLED IN VIRGINIA POUND NETS

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The Virginia Aquarium Stranding Response Program (VAQS) assisted NOAA contractors during a pound net experiment near Kiptopeke, VA from May 6 to June 29, 2005. During this project, eight loggerheads (*Caretta caretta*) and six Kemp's ridleys (*Lepiochelys kempii*), were discovered entangled and recovered from commercial fishing net gear. Of the 14 turtles, four were collected alive (2 loggerheads: DAI-I-3 and DAI-I-7; 2 Kemp's ridleys: DAI-I-10 and DAI-I-14) and transported to the VAQS stranding center for thorough health assessments to determine if the animals were immediately releasable or in need of rehabilitation. These assessments included complete blood counts, chemistry panels, fecal analysis, radiographs and completion of physical and behavioral evaluation forms developed by VAQS. Circumstances of the entanglements were also taken into consideration. Along with lesions consistent with entanglement, the following individual abnormalities were noted: DAI-I-3 was admitted hypoglycemic (58mg/dL), malnourished and lethargic with a core body temperature of 18.6°C; DAI-I-7 was admitted malnourished and lethargic with bilateral conjunctivitis and a core body temperature of 18.6°C; DAI-I-14 was admitted hyperglycemic (152mg/dL), malnourished and lethargic with a core body temperature of 18.7°C; DAI-I-10 was admitted in good body condition and alert with a core body temperature of 19.1°C. Radiographs revealed DAI-I-10 was the only turtle with a full gastrointestinal tract, indicating this animal had been feeding prior to entanglement. Based on the findings from these assessments, DAI-I-10 was the sole turtle deemed a candidate for immediate release. DAI-I-3 and DAI-I-7 were released after 18 days and DAI-I-14 was released after 20 days of rehabilitation.

INFERTILITY OR EMBRYONIC DEATH? THE DEVELOPMENTAL STATUS OF UNHATCHED LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) EGGS ON THE GEORGIA COAST

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The goal of this project was to evaluate egg failure in the threatened loggerhead sea turtle (*Caretta caretta*). Unhatched eggs from fully incubated wild nests were collected from Wassaw, Sapelo and Jekyll Islands on the coast of Georgia during the 2004, 2005 and 2006 nesting seasons. These locations represent the Northern, central and Southern portions of the barrier island chain. Two hypotheses were investigated. First, that egg failure was not caused by infertility; and second that embryonic death occurred most frequently during the first ten days of development. All eggs used for this study were intact and immediately preserved in 10 % formalin or 70 % ethanol. The eggs were dissected, observed macroscopically and the contents were classified according to the amount of development. The straight-line carapace length of recovered embryos was recorded. Categories of development included: undetermined, infertile, fertile (with no embryo present), embryonic disk, early embryonic death (0.1-1.0 cm SCL), mid-embryonic death (1.1-2.0 cm) and late embryonic death (2.0-5.0 cm). Fertility was defined by the presence of an embryo, embryonic disk, blood streaks or metabolized yolk and albumin.

Embryos were staged based on their size and stages were converted into the corresponding days of incubation. These data were examined to determine at which stage of development failure most often occurred. Sampling eggs from different islands attempted to eliminate bias associated with latitude and the impact of human populations. Fertility was greater than 90 % in the eggs sampled. Embryos of all sizes were found, however, most embryonic death happened during the first ten days of incubation (fertile with no embryo present). Suspected causes of death included water inundation, bacterial invasion and root growth in the nest. Deformities were observed and often associated with amelanism. Infertility was very low in this population which indicated there was not a reproductive problem in this adult population. Future investigations should focus on the developmental sensitivity of the embryos or environmental variables which can compromise nest success.

MATERNALLY DERIVED EGG YOLK HORMONES OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*); COMPARASONS WITHIN A CLUTCH AND ACROSS THE NESTING SEASON

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Loggerhead sea turtles (*Caretta caretta*) are non-annual breeders that lay approximately 5 clutches and 120 eggs per clutch per season. Female oviparous vertebrates are known to transfer hormones to their eggs. We hypothesize that egg yolk estradiol increases with a decrease in maternal plasma estradiol across the nesting season. Three aspects of estradiol, testosterone and progesterone variation will be investigated: (1) variation of egg yolk hormones across the nesting season, from early (nests 1, 2) to late (nests 4, 5) season clutches, (2) variation of egg yolk hormones within a clutch, (3) statistical analysis of the relationship between maternal plasma hormone variation and egg yolk hormone variation across the nesting season. All samples were collected on Blackbeard Island, Georgia, May through August 2006. Blood and eggs were collected from nesting females during early (1, 2) and late (4, 5) season nesting events. Three eggs were collected from the top and the bottom of each of the forty-two clutches (23 early, 19 late season nests) to control for possible intra-clutch variation. Temperature data loggers were placed in each nest and dead hatchlings were collected at the end of the season to estimate the hatchling sex ratio. If the hypothesis is substantiated, a seasonal shift to higher concentrations of egg yolk estradiol may suggest a potential hormonal influence on *C. caretta*'s hatchling sex ratio.

DOES MERCURY TOXICITY PLAY A ROLE IN THE DEBILITATED LOGGERHEAD CONDITION?

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An increase in the incidence of debilitated loggerhead sea turtle strandings in the Southeastern U.S. has been observed in recent years. These turtles are characterized by emaciation and heavy burdens of parasites and bacterial infections, but the underlying cause of their condition is unknown. To further investigate, a health assessment was performed on debilitated loggerhead turtles during necropsy or rehabilitation and contaminants were measured in various tissue compartments. A previous study on loggerheads reported that the blood mercury levels were correlated to several health indicators including immune parameters and creatine phosphokinase. This study investigates the potential role of mercury toxicity in the debilitated condition described above. Mercury burdens in blood, scutes, brain, liver, and kidney from debilitated loggerheads will be compared to those reported in healthy turtles captured in the wild and acute stranding mortalities. Correlations between mercury burdens in debilitated turtles and specific health parameters such as immune function, plasma chemistry, and tissue histology will be investigated to determine potential routes of toxicity in these animals. Changes in blood mercury burdens during the months of rehabilitation will also be reported.

BLOOD BIOCHEMISTRY AND HEMATOLOGICAL VALUES FOR WILD JUVENILE PELAGIC LOGGERHEADS *CARETTA CARETTA* OFF MADEIRA ISLAND, NORTH-EASTERN ATLANTIC

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The number of injured or debilitated loggerhead turtles found stranded on/or offshore Madeira Island, Portugal, has been increasing during the last decade. Although the primary cause of sickness is of anthropogenic origin (entanglement on fishing debris, fuel and boat collision), subsequent infection and emaciation overcomes and contributes to decreased fitness and eventual death of the animal. Several animals have been rehabilitated over the last 5 years by

the Marine Turtles Project at University of Madeira, but there is still a lack of data on the basic parameters for blood biochemistry and haematological values for this population. In fact, reference values for blood biochemistry and haematologic parameters have not been established for most free-ranging sea turtle populations, especially juvenile pelagic loggerheads and still little is known on physiologic reference values for this species. Assessment of physiologic values provides a sensitive and less-invasive tool for obtaining valuable information on the health of the organisms, which is a priority for their conservation and management. Any information that improves the understanding of sea turtle health helps their rehabilitation, and the more data on a healthy population, the better the knowledge of sea turtle recovery. Therefore, the objective of this project is to develop a baseline profile for physiological parameters such as plasma biochemicals and differential blood cell counts in pelagic loggerhead turtles, in order to monitor the physiological status of this wild population of sea turtles and to ensure better recovery tools of these threatened and endangered species in the future. Thus, in 2005-2006 turtle seasons the Marine Turtles Project at University of Madeira started a health assessment study of these free-ranging animals. 50 sea turtles were sampled on July-September 2005 and May-July 2006. Animals were captured out in the sea and brought into the laboratory. Animals were visually checked for an external health assessment and biometry data collected. Blood samples were collected from the dorsal cervical sinus and the serum obtained was transferred into Eppendorfs and frozen at -20ºC for later analysis. Sub-samples of blood were also collected for other on-going projects, such as testosterone radioimmunoassay for sexing and laparoscopy was performed for sex determination and gonad biopsy withdrawal for subsequent histology of the gonad and testosterone radioimmunoassay validation. Blood smears were also provided for differential white blood cells counts. These samples' analyses are currently underway. The plasma biochemicals analyzed are: Uric acid, Total Bilirrubin, Total cholesterol, Creatinine kinase, Total Protein, Urea nitrogen, LDH, SGOT, SGTP, Gamma-glutamyl transferase, Albumin, Alkaline phosphatise, CPK, Sodium, Potassium, Chloride, Calcium and Phosphorus. Correlations between physiological parameters and morphometric parameters will be presented, as well as with sex, which was determined by laparoscopy and histology of the gonad. The data will also be compared with some databases already existing for adult and sub-adult populations of the same species, namely in South Carolina and Florida This study is a first contribution to a better knowledge of this pelagic loggerhead population health status, and a helpful tool on the recovery of future animals and subsequent release into the wild. Acknowledgements: Cláudia Delgado gratefully acknowledges travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service, as well as the Portuguese Foundation for Science and Technology (grant SFRH/BD/8413/2002).

CARIBBEAN SEA TURTLE TRAUMA RESPONSE CORPS

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For more than two decades the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), with Country Coordinators in more than 40 Caribbean States and territories, has linked scientists, conservationists, fishers, natural resource managers, policy-makers, industry groups, educators, and other stakeholders together in a collective effort to develop a unified management framework, and to promote a regional capacity to design and implement scientifically sound sea turtle conservation programs. Network participants throughout the region are committed to working collaboratively to build national and regional capacity to

manage shared sea turtle populations. Among these capacity building initiatives is a regional Sea Turtle Trauma Response Corps (STTRC), the aim of which is to strengthen and coordinate the efforts of people throughout the Caribbean Sea to respond to sea turtles in crisis, whether at sea or stranded along the shoreline. Based on recommendations of the 2004 Annual General Meeting of WIDECAST (held in San José, Costa Rica), a number of technical outputs have been designed to support the work of the STTRC, including peer-reviewed guidelines and criteria for field response, veterinary care, and husbandry; standardized reporting forms; database management software; and training and internship opportunities for professionals (biologists, managers, veterinarians, animal rescue practitioners) and laymen alike. I will report on the structure, training, and outputs of the STTRC, including a recently published Field Guide designed to provide first-responders with information on how to respond effectively to a sick or injured sea turtle, including triage, transport and treatment following a boat strike, hook ingestion, oil contamination or more than a dozen other potentially fatal occurrences. I will also report on a recently completed Internet-based manual developed to assist Caribbean veterinary professionals in basic surgical and other treatment protocols. By encouraging and enabling collaboration among range States with regard to sea turtle injury response, rehabilitation and release, the STTRC enhances the survival prospects of endangered Caribbean sea turtles, facilitates the active participation of veterinarians and husbandry professionals in conservation efforts, and provides a model for organizing conservation outreach at multilateral scales.

HEMATOLOGICAL VALUES IN LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*) IN QUEREPARE BEACH, PARIA PENINSULA, SUCRE STATE, VENEZUELA

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Querepare beach is one of the two most important nesting beaches of the leatherback sea turtle (*Dermochelys coriacea*) in the northeastern Venezuelan mainland. This beach has been monitored since 2002 by the project “Research and Conservation of the Sea Turtles of the Peninsula of Paria”. For the first time we have performed a hematology analysis on this sea turtle. Hematological values play an important role in the diagnosis and treatment of all species, and provides valuable information about the health status of leatherback turtles, even considering that there are many factors affecting the blood values. The goal of this research has been to establish the hematological values and to infer the health condition of the gravid females in Querepare Beach. Blood samples were taken from the left hind flippers of 13 nesting turtles between June and July 2005. The curved carapace length (CCL) and curved carapace width (CCW) were measured with a flexible tape. Counting of red and white blood cells were conducted using the Natt and Herricks technique. The mean RBC value was 0.33x106/µl ± 0.06 (0.25 – 0.43) and the WBC was 3.15x106/µl ± 0.7 (1.9 – 4.6). The PCV was 35.4% as determined through centrifugation. The Mean Corpuscular Volume was 1076.9 fL ± 158.3 (878 – 1360). The WBC differential counts were performed manually using light microscopy and Diff-

Quik stains. Four types of WBC were identified in blood: heterophils, lymphocytes, eosinophils and monocytes. The values obtained in this study will be used as a reference in other studies on sea turtles in the country.

UNDERSTANDING STEROID HORMONES RELATED TO REPRODUCTION IN THE NESTING LEATHERBACK SEA TURTLE (*DERMOCHELYS CORIACEA*) SANDY POINT, ST. CROIX

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The leatherback sea turtle (*Dermochelys coriacea*) is a critically endangered species that inhabits all of the worlds' oceans. Although illusive in the water, long term, land-based research projects, such as that at Sandy Point, St. Croix, have provided invaluable insight into the genetics, behavior, and physiology of nesting leatherback turtles. In spite of our progress with regards to research, little is still known regarding the endocrine regulation of reproduction in nesting leatherbacks, including those at Sandy Point, St. Croix. The majority of studies related to reproductive endocrinology have focused on the steroid hormones required for reproduction in smaller turtles, such as the Kemp's ridley (*Lepidochelys kempi*), and green sea turtle (*Chelonia mydas*). Both captive and wild reproductive Kemp's ridley and green sea turtles exhibit distinct, seasonal cycles in steroid hormones, such as testosterone, estrogen, and progesterone (Rostal *et al*., 1997; Rostal *et al*., 2001; Owens, 1997; Hamann *et al*., 2002). Changes in steroid hormone levels in these species are directly related to important physiological and behavioral processes, such as vitellogenesis, follicular development, courtship behavior, and receptivity. Little work has been done, however, with regards to understanding steroid hormones in the leatherback turtle, which is physiologically unique when compared to the smaller, hard-shelled species. Initial work regarding steroid hormone cycles (estrogen, progesterone, testosterone) was described in the Pacific leatherback on a small scale (Rostal *et al*., 2001). However, hormone levels and/or trends over a nesting season have not been investigated on a large, population scale, and no work has been published relating to steroid hormones in reproductive Atlantic leatherbacks. To better understand the basic reproductive physiology of Atlantic leatherbacks on a large scale, blood samples were obtained for the analysis of testosterone, estrogen, and progesterone during the 2005 and 2006 nesting seasons at Sandy Point, St. Croix. "Saturation" sampling of individual turtles was conducted for the entire nesting population (144 and 92 individuals respectively). All individuals were sampled each time a clutch was successfully deposited throughout the nesting season, and the samples were subsequently centrifuged, frozen, and stored for analysis. Although 154 samples have been analyzed, analysis of the remaining 500 samples is currently ongoing. Preliminary results suggest similar levels of testosterone are observed in both Pacific (3.5 - 22.0 ng/ml) and Atlantic (3.0 - 20.73 ng/ml) leatherbacks. Levels of estrogen, however, may be significantly lower in Atlantic leatherbacks. Testosterone, estrogen, and progesterone are highest with deposition of the first clutch, while testosterone and estrogen show a step-wise reduction in hormone levels with each consecutive clutch laid. Progesterone appears to remain high, then drop with deposition of the final clutches. Levels of steroid hormones may vary significantly among neophytes and remigrants. Any correlation between hormone levels and different parameters within the population, such as remigration interval and reproductive age (based on tagging data), will be investigated. Relationships among hormone levels and parameters such as clutch

size, clutch number, and hatch success will also be investigated to increase our understanding of physiological factors that may impact hatchling production.

BEHAVIORAL IMPACT OF ENRICHMENT TOOLS ON CAPTIVE SEA TURTLES, SEA TURTLE INC.

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Sea Turtle Inc. is a rehabilitation center located on South Padre Island, Texas that treats injured or sick sea turtles that strand along the south Texas coast. These turtles are housed in pools designed to be temporary holding pens that lack any texture or rock work. In 2002, a group of students led by Dr. Heidi Marcum approached Sea Turtle Inc. regarding the construction of enrichment tools for captive sea turtles. Enrichment includes using a wide variety of stimulating devices designed to encourage an animal to exhibit its natural behavior, while decreasing abnormal behavior often seen in captive animals. Over the past several years, turtle enrichment devices, termed Baylor Backscratchers have been design and constructed using a variety of materials. Tungsten backscratchers were constructed for use with loggerheads, but the corners were too sharp and caused flaking of the scutes. Backscratchers made from PVC pipe work very well because of their smooth surfaces and inexpensive costs. Currently, the Baylor Backscratcher has been perfected and used with several species, including hawksbill, Kemp's ridley, green and loggerhead turtles. The sea turtles at Sea Turtle Inc. display unique play behaviors when the backscratchers are introduced into their holding pools. However, each species exhibits unique responses to the device. Atlantic greens will loop in and out of the backscratcher. Hawksbills are hangers: they will cling or hang on to the device. Kemp's ridley and loggerheads are shakers that rub their carapace on the bottom side of the Backscratcher. We have seen an improvement in the behaviors of every captive turtle exposed to the device: they spend far less time swimming aimlessly around their tank, or lying motionless on the tank bottom, and spend extensive amounts of time exhibiting previously unseen, but probably species specific, behaviors when interacting with the device. The Baylor Backscratcher has proven to be a cost-effective, reliable method for enriching captive sea turtles. (A DVD demonstrating these behaviors can be requested at lgeco_trip@yahoo.com)

EFFECTS OF TEMPERATURE AND BODY SIZE ON METABOLISM IN JUVENILE LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*)

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Oxygen consumption (VO2) was monitored in six juvenile leatherback turtles (*Dermochelys coriacea*) imported from the British Virgin Islands and kept in a covered outdoor facility at the University of British Columbia. Animals were acclimated to 24 ^{o}C and acutely exposed to 14, 19, 29 and 34 ^{o}C at four different body sizes (0.1, 0.5, 1, 10 kg). Increasing temperature, as well as body mass, significantly increased VO2. However, at the warmer temperature 34 ^{o}C, Q10 fell with increasing body mass (3.4 - 0.5). Maximum stroke rate occurred at the acclimation temperature, falling with exposure to lower and higher temperatures. In contrast, breathing rate

(fR) remained fairly low with changes in temperature across all size classes. Nevertheless, V02 increased suggesting that individuals are using tidal volume to change VO2 with increasing temperature. The intraspecific scaling exponent for VO2 over 2 orders (0.1 - 10 kg) of magnitude of body mass at 24 ^{o}C was from 0.88. However, when regression curve was separated into three individual order of magnitude (0.1 - 1 kg, 0.5 - 5 kg and 1 - 10 kg), the exponent increased with mass. Temperature significantly affected the scaling exponents with scaling exponents at 14 ^{o}C (0.93) and 34 ^{o}C (0.77) not confining theory. The exponent between 19 - 29 ^{o}C is very similar to allometric scaling exponents of other reptiles. We suggest that 19-29 ^{o}C is the preferred temperature for juvenile leatherback turtles with 14 ^{o}C and 34 ^{o}C being well outside of their normal preferences.

CAPTIVE GROWTH RATES OF LEATHERBACK (*DERMOCHELYS CORIACEA*) HATCHLINGS AND JUVENILES

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Twenty hatchlings were collected from the island of Tortola in the British Virgin Islands (UK) and transported to the University of British Columbia, Vancouver, British Columbia, Canada April of 2004 and 2005. Animals were reared in the South Campus Animal Care facility using protocols developed by Jones *et al*. (2000 MTN 90:3-6). Hatchlings were kept in 3 elliptical pools (5m long x 1.5 m wide x 0.3 m deep) filled with ~ 2500 L of seawater. Temperature was maintained at 24 ± 1 ^{o}C. Animals were hand-fed strips of formulated food three to four times daily until satiation. The diet consisted of squid, vitamins (ReptaviteTM) and calcium (Rep-CalTM), blended with flavorless gelatin and hot water. Hatchlings were left undisturbed except for being weighed and measured (weekly). Carapace length, the distance from the center of the nuchal notch to the caudal peduncle (posterior of the carapace), was measured weekly using a digital caliper to the nearest 0.1 mm and mass was determined using a Libra™ scale (+ 0.1 g) from hatching to 1 kg in mass and a larger Libra™ scale (+ 20 g) for animals > 1 kg. Leatherback hatchlings were successfully reared for over a year (> 18 months at present) and extrapolation of the growth data reveals that they are capable of attaining adult body mass (~250 kg) within 5 ½ to 6 years with adequate resource availability. Eckert (2002 MEPS 230:289-293) used reports of visual sightings and incidental captures to show that leatherbacks do not move above ~30^{o} latitude and into water < 26 ^{o}C until they are > 100 cm in carapace length. Growth estimates from the current study show that it would take ~ 3 ½ years for leatherbacks to attain 100 cm in carapace length from hatching and that they would be ~ 100 kg in body mass. This may be the mass when leatherbacks are capable of thermoregulation allowing them to move into colder waters where they can exploit different assemblages of gelatinous zooplankton. This study shows the feasibility of rearing leatherbacks in captivity (previously thought to be impossible) and the extreme growth rates of leatherbacks (considering resource availability) in comparison with the other 6 species of sea turtle.

A GRIM PROGNOSIS: THE EFFECT OF TOXICANTS AND HEAVY METALS ON STEROID-PROTEIN INTERACTIONS IN NESTING GREEN TURTLES, *CHELONIA MYDAS*

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In this study we observed the effect of different environmental toxicants and heavy metals at a wide range of concentrations on the steroid-protein interaction in 14 nesting green turtles, *Chelonia mydas*, from Peninsular Malaysia. Emphasis was placed on hormone-mimicking chemicals (i.e., DDT, DDE, dieldrin, lead, zinc and copper). Five concentrations were used: high (1 ppm), medium (0.1 ppm), low (0.01 ppm), very low (0.0000001 ppm) and control (no toxicants). The effects on testosterone and/or oestradiol binding to plasma proteins (e.g., mimicking, blocking or cancelling out hormone effects) were observed. Our results suggest that environmental toxicants and heavy metals may significantly influence the binding of steroids (testosterone and oestradiol) to plasma proteins that determine the bioavailability of steroids to the tissues of nesting green turtles. Particularly in high concentrations, toxicants and heavy metals can greatly influence the steroid-protein interaction and cause increased exposure of tissues to the biologically active hormone compartment. At medium, low and very low concentrations, even though they might not destroy the steroid-binding interaction, they can reduce the affinity of the steroid-protein interaction. Weaker bonds can result in a significant increase in the biologically active free hormone compartment within the body of the animal. This study suggests that the binding of testosterone and oestradiol to steroid binding proteins in the plasma may be highly sensitive to particular toxicants/heavy metals, even within low concentration ranges. We emphasise that synthetic environmental oestrogens/androgens are stable, have a high degree of bioaccumulation in the body and can accumulate in fat and tissue of animals. Moreover, the disruption of binding of testosterone and/or oestradiol affects steroid-protein interactions by increasing the concentration of the biologically active compartment within the plasma of the nesting turtle. This undesirable outcome can be detrimental for the reproductive/nesting status of those animals and may compromise immune status, susceptibility to disease and survival. *Acknowledgments*: MI gratefully acknowledges travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US fish and Wildlife Service, provided through the Symposium Travel Committee.

REARING LEATHERBACKS IN CAPTIVITY: PROTOCOLS, HEALTH AND RESEARCH

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Leatherback hatchlings are difficult to maintain under captive conditions but a few researchers/laboratories have managed to raise leatherbacks to an age of 2 to 3 years. Even so, there were so few replicates in those early studies that it has not been possible to understand their early developmental biology (hatchling to juvenile) during the ‘lost year’, now commonly referred to as the oceanic -stage. We discuss here our experiences over the past 2 years raising leatherbacks from hatchlings (50 g) to juveniles (20 kg) for studies on their early growth, physiology and development. We brought a total of 27 hatchlings from Lambert Bay

Beach, Tortola, BVI to the Animal Care Facility at UBC, Vancouver, British Columbia, Canada during the summers of 2004 and 2005. Hatchlings were raised in large (2,500 gallon) tanks with water trucked in from the Vancouver Aquarium and Marine Science Center (Vancouver, BC). The three main obstacles to overcome in rearing leatherbacks are i) their oceanic-pelagic nature (no recognition of barriers), ii) designing a suitable food for a cnidovore and iii) water quality. Coliform bacteria were maintained at minimal levels and *Pseudomonas* spp., *Aeromonas* spp. and *Vibrio* spp. were the common bacteria found in the husbandry tanks. Mortality within our study group was usually due to subacute or chronic bronchopneumonia with secondary infections of liver, kidneys and interstitial nephritis. We treated sick animals with Baytril (5 mg/kg) and with combinations of Amikacin (2.5 mg/kg) and Ampicillin but success with these pharmaceuticals were limited. Improving husbandry practices and continued research into the early biology of sea turtles will aid in our understanding of their behavior, ecology and physiology thus enhancing our ability to turn back the scales on their eminent decline. This work was funded by NMFS – SWFSC & PIFSC as well as a NSERC – Discovery grant to DRJ.

ORGANIC CONTAMINANT CONCENTRATIONS CHANGE IN DEBILITATED LOGGERHEAD TURTLE PLASMA DURING RECOVERY IN REHABILITATION

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Increasing numbers of debilitated (emaciated, lethargic, barnacles on skin) loggerhead turtles (DTs) stranding along the Southeast US during the last decade has created concern over the causes of this syndrome. The primary cause is still unknown, but findings indicate a wide range of secondary bacterial and parasitic infections and higher concentrations of organic contaminants in DT adipose and blood compared to healthy turtles. This study investigated the change in plasma contaminant concentrations throughout rehabilitation of live DTs in order to examine mobilization of these compounds concurrent with lipid mobilization and improvements in their health. Blood plasma was collected at four time points: 1) initial presentation; 2) one week after independent feeding; 3) after noticeable increase in body weight and/or hematocrit, but no longer than 11 weeks in rehabilitation; and 4) after a full recovery. Seven DTs from Georgia, South Carolina and North Carolina were sampled successfully during 2004-2005. Polychlorinated biphenyls (PCBs), pesticides and polybrominated diphenylethers (PBDEs) were measured in repeat plasma samples from 3 DTs using gas chromatography/mass spectrometry. Initial PCB concentrations were 9-fold higher than healthy turtles, similar to previous findings. By the third or fourth sampling, PCB concentrations had dropped by ~50% which coincided with increases in weight, hematocrit and plasma lipids by 28.5%, 109% and 684%, respectively. Pesticide and PBDE concentrations increased during early phases of recovery and then decreased at full recovery. The final recovered PCB and pesticide concentrations were similar

to healthy turtles. These findings, along with those presented at the 2006 symposium, suggest that contaminants are mobilized into blood from adipose as lipid stores are depleted and that contaminants are stored in adipose again as DTs recover. The higher blood levels caused by weight loss, circulating to target tissues, may contribute to the progression of this illness. *Acknowledgements*: We thank Bruce Hecker and Jason Crichton from the SC Aquarium; DuBose Griffin, Tom Murphy, David Whitaker, Phil Maier, and Mike Arendt from SC Dept. Natural Resources; Mark Dodd from the Georgia Dept. National Resources; Joanne Braun-McNeill and Larisa Avens from the National Marine Fisheries Service; and Michelle Lee from the Medical Univ. SC for sample collection; and NMFS for partial funding.

AN ALTERNATIVE METHOD FOR ASSESSING BODY CONDITION OF HAWAIIAN GREEN TURTLES

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The objectives of this study are 1) to propose an alternative method of quantifying body condition in Hawaiian green turtles, 2) to compare this method to a field scoring technique based on a subjective estimate of body condition and 3) to determine if differences in body condition exist among foraging aggregations of immature green turtles in the Main Hawaiian Islands (MHI). Two accepted methods to quantify body condition include regression of body mass on straight carapace length (SCL) and the ratio of body mass to SCL3. Both of these methods utilize body mass, however, these measurements are often unavailable due to field conditions, the size of the animal (e.g. large nesting females), or other limitations. An alternative to using mass is to calculate volume based on SCL, straight carapace width (SCW), and body thickness (LAT). The basic shape of a green turtle is approximately a half-ellipsoid. The volume of a half-ellipsoid is given by [(4/3* π * a * b * c) / 2], where a = SCL / 2, b = SCW / 2, and c = LAT. Assuming the density of green turtles is approximately constant, then mass is proportional to volume, and a regression of volume on SCL should provide nearly identical results to a regression of body mass on SCL. This technique provides researchers with an alternative method of assessing body condition when body mass is not available. In this study, body condition of immature Hawaiian green turtles was quantified using the methods described above and results were compared. This stock has increased since protection began in 1978 under the US Endangered Species Act. Increases in the nesting stock have resulted in greater abundance of juveniles in the nearshore waters of the MHI. Analysis of mark-recapture data from sites throughout the MHI illustrates variability in growth rates among sites and a long-term decline in growth rates, possibly due to differences in population density. Differences in body condition, or robustness, of individuals are visually apparent. Body condition field scores were assigned to individuals based on appearance (0 = normal/robust, 1 = mild emaciation, 2 = moderate emaciation, 3 = severe emaciation). Body condition indices were calculated using mass, and using volume as proposed here. Data were statistically tested for differences between sites, and subjective field scores were compared to the quantitative measures. The difference between measured body mass and calculated volume was 19% when the maximum (anterior) body thickness measurement was used for the LAT value. This difference was reduced to 4% when a central body thickness measurement was used and the relationship between measured mass

and volume was nearly 1:1, validating the assumption that density is constant. For the Hawaiian green turtle stock, body conditions indices correlate with subjective field scores, and differences in body condition exist among foraging aggregations. Based on these results, volume is an acceptable means of quantifying body condition for Hawaiian green turtles. This method may be applicable to other species, but further testing is needed.

MULTIPLE ANTIBIOTIC RESISTANT GRAM NEGATIVE BACTERIA FROM THE OVIDUCTAL FLUID OF THE GREEN TURTLES (*CHELONIA MYDAS*) DURING EGG LAYING

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Oviductal fluid was sampled by swabbing the cloacal chamber during oviposition. Three swabs were taken from each turtle. A total of forty turtles were examined. The swab samplings were taken after the turtle laid several eggs while the oviductal fluid is secreted from the oviductal glands. The swabbing was accomplished by inserting the swab ≈ 10 cm into the evaginated cloacal chamber. The samples were used to isolate bacteria following the standard procedures. The following bacteria were isolated *Pasteurella* spp. (44.6%), *Citrobacter* spp. (30.7%), *Salmonella* spp. (10.8%), *Pseudomonas* spp. (4.6%), *Shigella* spp. (3.1%), *Proteus* spp. (3.1%), *Brevundimonas* spp. (1.5%). The isolates were resistant to various types of antibiotics. The presence of antibiotic resistant bacteria in the oviductal fluid is an indication that the embryo becomes contaminated with these bacteria during early phases of embryogenesis. In addition, these antibiotic resistant bacteria may be considered as indicators of pollution in the feeding areas of sea turtles. The source of this pollution is probably due to human activities.

VULNERABILITY OF TURTLE EGGS TO THE PRESENCE OF CLAY IN NESTING BEACHES

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Egg survival can be very low in non-predated nests. Environmental factors such as temperature or hydric potential have been shown to be detrimental to hatching success. In this study we document the negative impact of clay in embryonic development. Soil erosion from adjacent areas or the proximity of nesting beaches to silty substrates can cause the exposure of turtle eggs to significant levels of clay in their incubation substrates. In some Cabo Verde nesting beaches, a high variability on the amount of clay present on nesting substrates was found. Loggerheads did not avoid silty substrates to dig their nests. Apparently, hatching success in natural nests was highly affected by the presence of clay when compare with non-flooded nests in sand. A percentage of eggs incubated in silty substrates were partially or totally covered by clay that was firmly adhered to the eggshell. Many nests in silty areas did not hatched and survivors usually hatched extenuated and totally covered by clay that difficult their movement to the water. Traslocated nest with eggs covered by clay suffered a significant mortality compared to nests with clean eggs after incubation under standard conditions in the hatchery.

Experimental incubation of eggs with a variable surface covered by silt (0, 30, 50 and 80 of the shell surface) showed a strong effect of silt on egg water exchange. Silt-covered eggs suffered an acute water loss that in the most extreme cases was irreversible and caused embryo death. Quick dehydration was especially significant for eggs that had covered by silt the lower half of the egg while eggs that had covered by clay the upper part where the embryo develop where more tolerant to the silt. The high content of salt in the silt due to evaporation of sea water does not seem to be responsible of egg dehydration. Silt washed with fresh water caused similar egg dehydration than unwashed silt. 75% of eggs covered in the 80% of their surface die while only 25 % of controls die. Eggs profusely covered by clay also hatched an average of three days later than controls. Eggs that were covered only by 30 % of their surface produced slower hatchlings compared to controls. Substrates with more than 0.15 % of clay can cause a significant impairment of sea turtle embryonic development reducing hatching success. Physiological reasons to explain the negative impact of clay on eggs remain unknown. Even slightly argillaceous substrates should be actively avoided when selecting sites for nest relocation or creating hatcheries.

CHEMICAL CONTAMINATION OF SEA TURTLE EGGS IN PENINSULAR MALAYSIA: IMPLICATIONS FOR CONSERVATION AND PUBLIC HEALTH

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Chemicals such as organochlorine pesticides (OCPs), polychlorinated biphelyls (PCBs) and toxic metals make their way into the marine environment from a number of agricultural, industrial and domestic sources. Although information is limited, there is some evidence that these chemicals accumulate in sea turtles at various stages of their life cycle. These chemicals are known to disrupt animal development and alter physiology and can therefore potentially affect the viability of sea turtle populations. Furthermore, in areas of the world where the human consumption of sea turtle eggs is prevalent, the chemical contamination of sea turtle eggs also has public health implications. Peninsular Malaysia supports significant nesting populations of green and hawksbill turtles with occasional leatherback and olive ridley nesting. Apart from leatherbacks, their eggs are readily available in markets for human consumption under a government-regulated system, which balances conservation with the needs of the people. The collection and sale of turtle eggs provides many communities with important income and their consumption is thought to provide a good source of protein and has perceived medicinal qualities. The objective of this study was to determine the extent of chemical contamination in sea turtle eggs available in the markets of Peninsular Malaysia and to determine how these chemicals could affect both the sea turtle populations and the human population that is consuming them. The entire east coast and the southern west coast were surveyed for the availability of sea turtle eggs. The sale of turtle eggs was limited to 10 locations, situated entirely on the east coast where nesting primarily occurs. However, the eggs were not always collected locally and often came from as far away as Sabah in Borneo Malaysia. The majority of eggs were from green turtles although hawksbill eggs were also available in certain locations. The number of eggs being sold at each location ranged from a single vendor selling one clutch of eggs at a roadside fish market to 15 vendors selling multiple clutches in the larger city markets.

A sample of sixty-nine eggs were collected from these markets and taken back to Queensland, Australia for analysis of heavy metals, OCPs and PCBs. The concentration of the eggs varied between the areas of collection and the impact of the contamination was put into context with reference to known effects of these chemicals on the development of sea turtle and other reptile eggs. The concentrations were also compared to the World Health Organisation guidelines for acceptable levels of contaminants in food to determine potential health risks for humans consuming sea turtle eggs in Peninsular Malaysia. The findings of this study reveal the chemical contamination of sea turtles in Malaysia and the Southeast Asian region as a real conservation concern. The results also highlight the potential danger of consuming sea turtle eggs and could be used to further promote the reduction of egg harvesting in areas where sea turtle egg consumption occurs.

NEW REPORT OF FIBROPAPILLOMATOSIS IN A SUBADULT OF GREEN TURTLE IN GULF OF VENEZUELA

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More than 60 years ago Fibropapillomatosis (FP) was first described in green turtles (*Chelonia mydas*) and is most principally associated with this species. FP is a debilitating and sometimes fatal disease found in several marine turtle populations worldwide. Depending of the quantity and distribution in the body, it can hinder locomotion, occlude vision, and interfere with feeding and breathing. Only one previous report on FP has been published for marine turtles in the Gulf of Venezuela; therefore, we believe that the occurrence and prevalence of FP in local green turtle aggregations is low. In August 2006, during field work, the team of GTTM-GV found a subadult green turtle with three FP tumors located in the left eye, forward left flipper and, posterior left flipper. The animal was captured by fishermen in entanglement nets and measured 77 cm CCL and weighed 50 kilograms. A team of veterinarians verified the health of the animal before the surgical removal of all FP tumors. The extirpated FP tumor was preserved in formalin 4% for subsequent histopathological analysis. After 3 days the turtle was successfully released.

VULNERABILITY OF LEATHERBACKS TO TEMPORAL NEST FLOODING

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Leatherbacks that nest close to the ocean or in areas with high levels of sand moisture can suffer great embryo mortality. Previous studies have shown that both embryonic development and hatching success are strongly affected by the substrate water content. Eggs are very sensitive during incubation to a permanent exposure to substrates with water contents higher

than 5 %. During 2006 we have investigated the impact of temporal exposures to high substrate moistures that simulate nest hydric conditions after tropical storms of temporal flooding (12%-20% during 2, 6 or 20 days). Eggs were experimentally exposed to the wet treatment at different times during incubation (first, second or last third of incubation), inside closed plastic containers that were incubated in the hatchery at the depth where nests are often found. Results showed that the pliable-shelled eggs of the leatherback turtle are especially sensible to a prolonged exposure to high levels of sand moisture during the first third of incubation. During the rest of the incubation period eggs can tolerate a wet substrate, the twenty days treatment is lethal for most of the eggs during the beginning of incubation. Egg mortality also increased with time of exposition. Acute exposure (48 hours) to extreme high moisture levels (20 %) did not impair embryonic growth at different developmental stages. Eggs seem to be able to tolerate nest chamber inundation during strong but brief storms, typical of tropical areas. The last third of incubation seems to be less vulnerable to the effects of short time inundation. We have also measured embryonic and hatchling size, incubation temperature and incubation duration. Accordingly to the experimental results, hatching success was strongly correlated with substrate moisture during the first days of incubation in natural nests ($r = -0.83$, $F(1\text{-}15) = 32.48$ $P < 0.001$).

EFFECT OF DIFFERENT PROTEIN SOURCES ON THE NUTRITIONAL ANSWER OF HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) JUVENILES

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A randomized experimental design was performed under controlled laboratory conditions for 97 days to evaluate the effect of different protein sources (squid meal, shrimp head meal, soy isolated meal, torula yeast and sesame seed meal) in the feeding of hawksbill turtles *Eretmochelys imbricata* juveniles (average initial carapace weight of 21.14 ± 1.05 g). A highly significant growth rate ($P < 0.05$) was found in animals consuming squid meal food which also showed the best values in the evaluated indeces. Survival varied between 87.5 and 100%. Histidine appears as first limiting amino acid in all experimental diets, while cysteine is presented as a second limiting amino acid when protein sources as soy isolated meals, torula yeast, sesame seed and shrimp head were used. Methionine occurred as second limiting amino acid in diet containing squid meal. Histological analysis showed a larger reserve accumulation of hepatopancreatic cells from animals fed on squid meal than from the rest of the aforementioned treatments. Acknowledgments: We gratefully acknowledge travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service.

HEMATOLOGICAL VALUES OF THE SEA TURTLES *ERETMOCHELYS IMBRICATA* AND *CARETTA CARETTA* IN THE HIGH GUAJIRA

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Hematological values play an important role in the diagnosis and treatment of all species. We have performed a hematological analysis on *Eretmochelys imbricata* and *Caretta caretta* in an attempt to provide valuable information about the health status of the sea turtle, even considering that there are many factors affecting the outcome of observed blood values. The goal of this research has been to establish the hematologic values the sea turtles *Eretmochelys imbricata* and *Caretta caretta*. Blood samples were taken from dorsal postoccipital sinuses from 24 *Eretmochelys imbricata* and 6 *Caretta caretta* between April and August 2005. The counting of red and white blood cells was conducted using the Natt and Herricks technique. Packed cell volume (PCV) and mean corpuscular volume (MCV) were also performed. The curved carapace length (CCL) and curved carapace width (CCW) were measured with a flexible tape. The mean RBC value of *Eretmochelys imbricata* was 0.38x106/µl ± 0.09 (0.19 – 0.57) and the WBC was 5.88x106/µl ± 2.9 (1.9 – 13.4). The PCV was 38.1% ± 4.2 (31 – 48). The Mean Corpuscular Volume was 1006.5 fL ± 161.3 (563.6 – 1290.3). The mean RBC value of *Caretta caretta* was 0.36x106/µl ± 0.09 (0.28 – 0.52) and the WBC was 6.56x106/µl ± 2.6 (3.3 – 9.6). The PCV was 35.7% ± 6.3 (27 – 44). The Mean Corpuscular Volume was 1014.5 fL ± 215.7 (775 – 1281.3). Four types of WBC were identified in the blood of both species: heterophils, eosinophils, lymphocytes and monocytes.

SPECIES-SPECIFIC ACCUMULATION AND METABOLISM OF HALOGENATED ORGANIC CONTAMINANTS IN SEA TURTLES FROM THE EASTERN PACIFIC

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The coastal lagoons of Baja California provide important habitat for several species of Pacific sea turtles, all populations of which are critically threatened or endangered. Monitoring persistent halogenated organic compounds, which have been shown to cause negative health effects in both laboratory and wild animals, is an important aspect in assessing the health of sea turtle populations. Additionally, the differences in dietary preferences exhibited by the various species may lead to differences in exposure to and detoxification of these halogenated toxicants. Glutathione conjugation has been shown to serve as an important detoxification mechanism of such halogenated toxicants. Therefore, we examined halogenated contaminants and detoxification enzyme activity in liver tissue samples collected from sea turtles incidentally killed through fisheries activities. Preliminary data show detection of 2 to 6 of the 28 polychlorinated biphenyl (PCB) congeners analyzed. Total PCB concentrations ranged from 11.8 to 160.9 ng/g lipid, which is consistent with the limited data to date on halogenated

compounds in sea turtles of the Eastern Pacific. Up to 3 dioxin-like congeners were detected in these samples; the most prevalent dioxin-like congener was congener 114, which was detected in 6 samples thus far. The presence of dioxin-like congeners in sea turtles may be cause for concern as these congeners may induce adverse effects at the low concentrations reported here. Glutathione S-transferase (GST) activity and expression profiles suggest possible species differences in detoxification capacity. Future research will include quantification of polybrominated diphenyl ethers in addition to PCBs, as well as further investigation of GST conjugation in more sea turtle specimens from the Eastern Pacific.

REHABILITATION OF TWO JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) FROM THE COAST EL TABLAZO BAY, MARACAIBO SYSTEM, ZULIA STATE, VENEZUELA

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Two juvenile green turtles (*Chelonia mydas*) were rescued after being incidentally caught in fishing nets and maintained in precarious conditions with the intention of local consumption in San Bernardo, a fishing town north of Maracaibo City (Lat:10º59'31" and Long: 71º36'26") on September 9th, 2006. Their CCLs were 31 and 35 cm, and their weights were 2,9 and 3,4 Kg. The turtles were named Peonia and Zapara, respectively. Monthly blood samples were taken to perform the hematology and to monitor their recovery. The clinical evaluation showed signs of moderate dehydration, poor corporal condition, chest hematomas, depression and hyporexy. For the turtle named Peonia, the initial values were: RBC 0,51 (106/µL), WBC 1,98 (103/µL), PCV 30% Hb 9 gr/dL, Heterophils 40%, Lymphocytes 40%, eosinophils 4%, Monocyte 16% MCV 588.23 fL, MCHC 30 gr/dL, MCH 176,47pg, Protein total 3.0 (gr/dL). For the turtle named Zapara the values were: RBC 0.63 (106/µL), WBC 3.33(103/µL), PCV 19% Hb 5,04gr/dL, Heterophils 77% Lymphocytes 16%, eosinophils 1%, Monocytes 6% MCV 301,58 fL, MCHC 26,52 gr/dL, MCH 80 pg. Protein total 1,9(gr/dL). Both turtles presented a stress leucogram. During their recovery, the juveniles were treated with appetite enhancers, B complex vitamins and a diet change. After 6 weeks of treatment, the values were: RBC 0,65 (106/µL), WBC 3,72 (103/µL), PCV 30% Hb 3 gr/dL, Heterophils 69% Lymphocytes 28%, eosinophils 0%, Monocyte 3% MCV 461,53fL, MCHC 10 gr/dL, MCH 46.15, Protein total 3. (gr/dL) for Peonia and RBC 0,38 (106/µL), WBC 6.5 (103/µL), PCV 29% Hb 9 gr/dL, Heterophils 68%, Lymphocytes 27%, eosinophils 0%, Monocyte 3% MCV 763.15fL, MCHC 31.03 gr/dL, MCH 236.84, Protein total 3.0 (gr/dL) for Zapara. The results show a great improvement of their health condition during their stay at the Laboratorio de Investigaciones Piscicolas from La Universidad del Zulia. These juveniles were released promptly after recovery in Los Monjes Archipielago in the Gulf of Venezuela on January 19th, 2006, with the support of the Coastguard personnel of Zulia State.

CORRELATIONS OF BITE PERFORMANCE WITH BODY AND HEAD MORPHOMETRICS IN LOGGERHEAD TURTLES (*CARETTA CARETTA*)

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Little is known about loggerhead (*Caretta caretta*) feeding behavior or bite performance. The propensity of loggerheads to bite forcefully may make them vulnerable to becoming part of the longline bycatch. The mechanics of biting, as well as hooking, by loggerheads on longline fishing gear is not well understood. Therefore we measured bite force, using a bite force transducer, in three age classes of juvenile captive-reared loggerheads (2003, 2004, and 2005). In addition, bite force was measured in four wild loggerheads from either stranding or rescues. All measurements were recorded at the NOAA/NMFS sea turtle facility in Galveston, TX. Morphometric measurements including straight carapace length (SCL), straight carapace width (SCW), head width (HW), head height (HH), head length (HL) and body-mass were recorded from each individual. Mean morphometric values for the juvenile turtles were 12.0 cm SCL, 9.7 cm SCW, 28.3 mm HW, 24.7 mm HH, 45.0 mm HL and body-mass 266 g for the 2005 age class (n=29), 30.7 cm SCL, 25.5 cm SCW, 62.3 mm HW, 53.9 mm HH, 93.5 mm HL and body-mass 4032 g for the 2004 age class (n=180) and 41.4 cm SCL, 34.1 cm SCW, 83.1 mm HW, 72.7 mm HH, 123.1 mm HL and body-mass 9274 g for the 2003 age class (n=32). Mean morphometric values for the wild sub-adult loggerheads (n=4) were 73.5 cm SCL, 59.5 cm SCW, 138.8 mm HW, 245 mm HH, 205.8 mm HL and body-mass 54450 g. The mean maximum bite force for the 2005, 2004 and 2003 age classes of juvenile loggerheads was 22 N, 129 N and 359 N respectively. Maximum bite force from rehabilitating turtles was 887 N. All bite force measurements were logarithmically transformed (log10) and regressed with morphometric data. Maximum bite force values are positively correlated to all body and head dimensions.

MARINE CHELONIAN ILLUSTRATION PART FIVE: EARLY ANATOMIC STUDIES

Chuck Schaffer
Turtle and Tortoise Newsletter, Jacksonville, FL, USA

Scientific illustration provides far more than simply an organism's image. It tells a compelling story, although one told in pictures. Perrault (1676) gave the first detailed description of tortoise anatomy in "Description anatomique d'une grande Tortue des Indes." The first real turtle anatomy appeared in the work of Caldesi (1687), who investigated marine, freshwater, and terrestrial chelonians in "Osservazioni anatomiche di Giovanni Caldesi Aretino intorno alle tartarughe marittime d'acqua dolce e terrestri" (Anatomical observations of Giovanni Caldesi Aretino of sweet water, marine, and land turtles). Gottwald, a contemporary of Caldesi, produced a similar work near the same time, likely by 1690. Primarily an anatomical work, it contains 32 text pages, essentially copious captions for the accompanying 16 figures on 10 fold-out copperplate engravings. The first three appear to depict *Caretta* in overall appearance, with a curious imbrication of the vertebral scutes reminiscent of *Eretmochelys*. The final plate's five figures also picture living non-marine chelonians. The eight remaining plates deal with marine turtle anatomy. Gottwald died in 1700 and never saw his work published. "Christoph Gottwald's Physikalisch-anatomische Bemerkungen über die Schildkröten" (Gottwaldt's lectures on the anatomy of turtles), may never have seen the light of day except for an opportune purchase of

the original plates and text by the publisher Gabriel Nicolaus Raspe of Nürnberg and subsequent publication in 1781. Unfortunately, when the work was reviewed in 1783, there criticism due to the poor translation of Gottwald's Latin into German. The illustrations were also found wanting by the reviewer, but are more accurate and detailed than those of Caldesi, whom the reviewer favored. And Bojanus (1819-1821) presented an exacting monograph on the European pond turtle in Anatome Testudinis Europaeae. Other early anatomical images appeared in the works of Buffon, (1749-1774), Schoepff (1792-1801), Bonnaterre (1789), LaCepede (1788), Sonnini & Latreille (1801), Daudin (1801-1803) and others throughout the sixteenth and seventeenth centuries. Comprehensive research of many obscure tomes is required to piece together the big picture, but is essential to understand the science of that day. Also important are the images, initially hand-drawn. Later, these images were accomplished by mass printing which in turn were succeeded by photomechanical processes. In spite of the global dominance of photography as a illustrative device, it cannot draw attention to details that science requires. Thus, natural history illustrations sporadically continue to be created to enhance photography. The Peterson Field Guides and Jeanette Wyneken's sea turtle anatomy are good examples of contemporary hand illustration. Illustrated zoologies are more than mere curiosities or scientific documents. They represent endeavors of illustration prior to the advent of photography, and as such have a very human element inherent in their presentation. They are repositories of human views, thoughts, appearances, and ideas. These woodcuts and engravings, in wood, copper, steel, and stone comprise a huge body of artistic interpretations of the natural world. Hand-rendered illustrations are a special thing, allowing the viewer to see the image through the eyes of the artist, with all of their biases, prejudices, and preconceptions.

TRACE METAL CONCENTRATIONS IN NESTS OF KEMP'S RIDLEY SEA TURTLES (*LEPIDOCHELYS KEMPII*)

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Trace metal concentrations in eggs have been analyzed for several sea turtle species, but no data exist for those of the critically endangered Kemp's ridley. This study uses eggs as a non-lethal sample source for monitoring trace metal concentrations in the nests of Kemp's ridleys (n = 17) collected at Rancho Nuevo, Mexico beach during the Summer 2002. Several metals (Ag, Cd, Cr, Cu, Hg, Pb and Zn) were measured in eggs, beach sand as well as blood and carapace tissue of nesting females using graphite furnace atomic absorption spectrometer (GFAAS), cold vapor atomic fluorescence spectrometry (CV-AFS) and Inductively Coupled Plasma Mass Spectrometry (ICPMS). Preliminary data (n = 5) suggest that eggs are useful for measuring race metal levels in Kemp's ridley. Cu concentrations in the eggs (2014 ± 761 ng/g wet weight) were approximately 4 ~ 5 times higher than those in nesting females (blood: 397 ± 85 ng/g wet weight; carapace: 455 ± 144 ng/g wet weight) while the later exhibited higher carapace Ag, Cd, Cr, Hg, Pb and Zn concentrations. Cr levels were higher in eggs than those in the blood of nesting females. In addition, egg shell samples exhibited higher Cr and Cu levels than those from egg yolk. Average hatching success rate of these 17 nests was 72% with a range of 0% to 97%. Currently, data analysis includes assessing potential relationships between hatching success rate and metal concentrations as well as determining the role beach sand may play in metal uptake pathways to nests.

BASELINE CONTAMINANT CONCENTRATIONS IN LEATHERBACK SEA TURTLES AND MATERNAL TRANSFER TO EGGS CONFIRMED

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To date, marine reptiles have been seriously underrepresented in environmental toxicology studies. In particular, leatherback turtle studies are extremely rare. Leatherbacks are the largest living turtles, maintaining an exclusively marine existence except for laying eggs on sandy subtropical and tropical beaches. These turtles migrate to cold northern Atlantic waters to forage mainly on gelatinous prey, including jellyfish. The purpose of our investigation was to provide baseline organic contaminant levels in leatherbacks and examine contaminant transfer from females to their clutches. Blood was drawn from six nesting females during egg-laying, and unhatched eggs were collected from their nests following the excavation of hatched nests. Polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and organochlorine pesticides were quantified in blood and egg samples using gas chromatography mass spectrometry (GC/MS). Mean (range) egg concentrations (ng/g lipid) were 171 (7.82-388), 32.3 (9.96-61.9), 16.9 (2.17-32.0) for ΣPCBs, 4,4'-DDE, and ΣPBDEs, respectively. Respective concentrations (ng/g lipid) in blood were 669 (28.2-1670), 100 (34.1-220), and 49.6 (below detection limit-130). Contaminants in paired blood and egg samples were highly correlated with each other. Correlation coefficients (p-values) were 0.9851 (0.0003), 0.9649 (0.0018), and 0.8310 (0.0404) for ΣPCBs, 4,4'-DDE, and ΣPBDEs, respectively. These strong relationships indicate that these contaminants are passed from nesting females to their eggs. This study provides some of the first baseline contaminant concentrations in these marine reptiles, which are essential for detecting future temporal changes in contaminant exposure and comparing this planktonivorous species to other wildlife.

OCCURRENCE OF OKADAIC ACID IN THE FEEDING GROUNDS OF GREEN TURTLES (*CHELONIA MYDAS*) AND DUGONGS (*DUGONG DUGON*) IN MORETON BAY, AUSTRALIA

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Okadaic acid (OA) is a diarrhetic shellfish poison (DSP) produced by a number of marine organisms including the benthic dinoflagellate *Prorocentrum lima*, which is often found on seagrass. As seagrass forms the basis of the diet of green turtles (*Chelonia mydas*) and dugongs (*Dugong dugon*) in Moreton Bay, Australia, these herbivores may potentially be exposed to OA through digestion of *P. lima* associated with the seagrass. In this study, the abundance of epiphytic dinoflagellate *P. lima* on seagrass, and the concentration of OA produced by these epiphytes were measured for four seagrass species at three sites in Moreton Bay. *Prorocentrum lima* were found on all four species of seagrasses collected at all three sites.

Okadaic acid was detected in crude extracts from seagrass epiphytes with a maximum concentration of 459.6 $ng.kg^{-1}$(wwt seagrass) on *Halophila* spinulosa. From this information, the estimated daily intake of OA for an immature (60 kg) turtle and an adult (400 kg) dugong was 92 $ng.day^{-1}$ and 18,383 $ng.day^{-1}$ respectively. Tissues sample collected from stranded turtle and dugong analysed by HPLC/MS/MS showed OA to be below detection limits in muscle and fat.

TO NECROPSY OR NOT TO NECROPSY WHAT WE HAVE LEARNED FROM NOT SO FRESH DEAD SEA TURTLE STRANDINGS

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In response to a record high number of sea turtle strandings in Virginia in 2001, the Virginia Aquarium Stranding Team (VAQS) began to necropsy as many stranded sea turtles as possible in hope of better understanding causes of mortality, as well as gather more information on the life history of these animals. Before 2002, decomposed sea turtles were not routinely examined beyond collecting basic STSSN information, genetics and aging samples. From 2002 through 2006, the VAQS responded to 1014 stranded sea turtles. Of those turtles, 854 were condition 2 (moderate decomposition) and condition 3 (severe decomposition) loggerheads, Kemp's ridleys and leatherbacks. The majority were loggerheads (*Caretta caretta*; 84.9%) of which 450 were condition 2 and 275 were condition 3. The next most frequent sea turtle species to strand was the Kemp's ridley (*Lepidochelys kempii*; 11.1%) with 72 condition 2 and 23 condition 3 carcasses reported, followed by leatherbacks (*Dermochelys coriacea*; 4.0%) with 11 condition 2 and 23 condition 3 carcasses. Small numbers of green and hawksbill sea turtles also stranded in Virginia during this time, but are not included in the following analyses. The VAQS performed approximately 470 internal examinations of condition 2 and 3 turtles since 2002. These examinations provided the VAQS with valuable data which would have been otherwise undetected. For example, a 2-1 female to male sex ratio was observed in loggerheads, Kemp's ridleys and leatherbacks. Upon necropsy, human interactions were confirmed internally in over 20 turtles. Interactions included ingestion of fishing hooks (n=16) and debris ingestion (n=5). Over 100 turtles showed external evidence of vessel interaction. Internal examinations often confirmed recent feeding and assisted in distinguishing between peri- or post-mortem events. The VAQS also performed necropsies on 17 code 2 and 3 previously tagged turtles, enabling collection of data such as sex, diet and human interaction. The VAQS plans to continue examining these not so fresh turtles in the future for the purpose of learning more about the health of the population in Virginia as well as determining the number of animals encountering pre-mortem human interaction.

DOPPLER ULTRASONOGRAPHY FOR THE MEASUREMENT OF BLOOD FLOW IN LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)

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Accurate measurements of blood flow are essential in hemodynamic studies and could be useful to elucidate the diagnosis in injured sea turtles, help in resuscitation procedures and for monitoring anaesthetized patients. The aim of this study was to identify blood vessels of echographic accessibility in the loggerhead sea turtle (*Caretta caretta*) and describe their Doppler waveform patterns, peak systolic velocity, mean velocity, systolic/diastolic ratio and pulsatility and resistive indices. Colour and pulsed-wave Doppler examinations were performed in 10 loggerhead sea turtles (4 juveniles and 6 subadults), using a real-time, B-mode scanner with 5.0, 6.0 and 7.0 MHz sector electronic transducers. Flow measurements were recorded for the left and right aorta, epigastric and iliac internal arteries and, the right hepatic vein. Additionally, great vessels of three dead turtles were injected with latex and dissected for anatomical support. In all arteries a parabolic flow velocity profile was observed. The waveforms of right and left aorta showed an unusual pattern when compared with mammals and their pulsatility (PI) and resistive (RI) indices were lower than those described in dogs. The hepatic vein flow velocity waveform of loggerhead sea turtle is similar to that known in the dog, although the flow velocity in C-wave is higher than that in the A-wave. There is a great paucity in interpretative studies of the Doppler spectrum in reptiles. The low resistance flow pattern observed suggests that the loggerhead sea turtles organs need a continuous blood demand.

INCIDENTAL ENTOMOFAUNA ON THE OVA OF *LEPIDOCHELYS OLIVACEA* COLLECTED FROM STRANDINGS AT THE WILDLIFE REFUGES "ISLA JUAN VENADO", "RIO-ESCALANTE-CHOCOCENTE", AND "LA FLOR", NICARAGUA

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A study was conducted to assess the incidence and taxonomy of insects associated with egg clusters of the olive ridley sea turtle, *Lepidochelys olivacea* (Eschscholtz), at the wildlife refuges of "Isla Juan Venado", "Rio-Escalante-Chococente", and "La Flor" on the Pacific Coast of Nicaragua, Central America. From the 3 sampling sites, a total of 356 insects were collected from October to December 2004. The insects gathered came from 78 *Lepidochelys olivacea*

nests. A total of 278 insects were collected directly from the surface of the turtle egg nesting sites, while 40 specimens were associated directly with dry, totally or partially empty, egg shells. The rest of the insects consisted in 38 adult flies recovered from eggs collected at La Flor and Juan Venado Island, showing symptoms of attack by maggots at different stages of development. These olive ridley eggs with maggots were transferred to the laboratory at UNAN, León and observed under controlled conditions. The following groups were recognized: Five species of Diptera: *Desmometopa varipalpis* Malloch, and *D. singaporensis* Kertesz (Milichiidae); *Megaselia scalaris* Loew (Phoridae), *Eumacronychia sternalis* Allen, and *Argoravinia rufiventris* Wiedemann (Sarcophagidae). Two gender, and three species of Coleoptera: *Hypocaccus* sp. (Histeridae), *Aleochara* sp (Staphylinidae); *Phaleria panamensis* Champion, and *Ulus lineatulus* Champion (Tenebrionidae), and *Omorgus suberosus* Fabricius (Trogidae). One gender, and one species of Hymenoptera: *Camponotus* sp. , and *Solenopsis geminata* Fabricius (Formicidae). Diptera emerged as the most relevant of the three orders, considering that they were the only insects found inside the olive ridley (*Lepidochelys olivacea*) turtle eggs. Only one natural enemy of Diptera associated to the turtle eggs, *Aleochara* sp. (Coleoptera: Staphylinidae) was recovered during this study. Formicidae were observed attacking not only the hatchlings of *L. olivacea* but also preyed upon the pupal stage of Diptera. Most of the collected adults of Coleoptera were observed feeding on empty dry egg shells.

ISOLATION AND PARTIAL SEQUENCE ANALYSIS OF LHX9 IN THE RED-EARED SLIDER TURTLE, TRACHEMYS SCRIPTA, A SPECIES WITH TEMPERATURE-DEPENDENT SEX DETERMINATION

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Many reptiles, including the red-eared slider turtle (*Trachemys scripta*), possess a temperature-dependent sex determination (TSD) mechanism where the temperature at which the developing embryos are incubated dictates the eventual gonadal sex of the animal. A cascade of regulatory genes controlling sex determination has been identified in some mammals and reptiles. Some orthologous genes of this cascade show a high degree of homology among mammals, reptiles, and birds. One such gene, Lhx9, controls the proliferation of gonadal cells in mice and its absence drastically reduces the expression of other genes in the male developmental pathway. In addition, in vitro studies using mouse models have shown that Lhx9 binds to and activates SF-1 (steroidogenic factor 1), a central gene regulating the expression of steroidogenic enzymes in the bipotential gonad. We studied Lhx9 and its role in TSD in the red-eared slider turtle. Using degenerate oligonucleotide primers, we PCR-amplified then sequenced a 342 bp fragment of exon 3 from red-eared slider turtle genomic DNA. DNA sequence alignment of this fragment revealed 92.7% and 84.5% identity with its ortholog from chicken and mouse, respectively. This high degree of sequence homology among the three species indicates that Lhx9 of the red-eared slider turtle may have a similar function in the sex determination pathway as in mouse with its influence on SF-1. We are currently using RACE-PCR to obtain the complete coding sequence of Lhx9 and characterizing the expression patterns of Lhx9 during embryogenesis in the red-eared slider turtle to reveal its role in TSD. Through our understanding of the genetic mechanisms controlling gender expression and their evolutionary progression to genetic sex determination in other vertebrates we may understand the impacts that global climate change may have on TSD species in hopes of preventing their extinction. I would like to thank the Sea Turtle Symposium, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and the US

Fish and Wildlife Service for the generous Travel Grant allowing my participation in the symposium.

BENIGN BUDDIES AND HARMFUL HITCHHIKERS: CONSEQUENCES OF THE CONNECTION OF BARNACLES WITH SEA TURTLES

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Injuries inflicted on sea turtles by barnacles are not generally well-characterized with regard to the barnacle species involved. The approximately one dozen barnacle species that live exclusively attached to sea turtles are largely considered benign commensals. Certainly, occasional wounding and negative effects of hydrodynamic drag have been documented for these crustaceans; however, few barnacle species are categorically considered injurious to turtles. We document several instances from both the Atlantic and Pacific of rarely encountered barnacles that burrow into the limbs and shells of sea turtles. These potentially pathogenic barnacles deeply invade tissues and penetrate bone. Using light and electron microscopy to investigate their attachment mechanisms, we describe how mode of attachment varies among barnacle species and the significance it holds for turtle health.

IMPACT OF DIFFERENT KINDS AND TIMES OF RETENTION IN OLIVE RIDLEY´S (*LEPIDOCHELYS OLIVACEA*) HATCHLINGS IN BLOOD GLUCOSE LEVELS

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The retention of sea turtle hatchlings for tourist purposes in México has become a common practice used each day with more frequency. Too little has been studied about the effects that these practices can have in the hatchlings´ physiology and nutrition. We decided to evaluate if different kinds of hatchling retention scenarios may have an effect in their plasma glucose levels, since it may be used as a parameter that reflects nutritional and endocrinal turtle conditions. Under normal conditions this metabolite has values from 60 to 100 mg/dl. The values for this metabolite can change between species, and it can be influenced by the environmental, physical and nutritional conditions of each organism. For this work, we used 160 olive ridley´s (*Lepidochelys olivacea*) hatchlings, which were retained by periods from 6 to 48 hours under 4 different conditions (water- shade, sand-shade, water-darkness, sand-darkness), after this we obtained blood samples and determined the glucose concentration using a conventional glucometer. We observed that in the retention of hatchlings in sand-shade between 6 and 12 hours the levels of glucose rose lightly and gradually. Turtles held for 6 hrs and 12 hrs at sand-darkness experienced major variation in glucose levels. After 24 and 48 hours of retention the glucose levels rise drastically, and we found that the major differences were related to the turtles kept in sand, particularly individuals kept for 24 and 48 hours

demonstrated the highest variation. The increase in the glucose levels observed in these experiments can be due to the stress generated by the conditions of retention, phenomenon that has been widely related to the liberation of glucocorticoids, that among other processes act in the liver increasing the synthesis of enzymes that promote the gluconeogenesis. This kind of studies allow us, in an indirect way, to evaluate the degree of stress that is induced in the hatchlings that are submitted to periods of brief or long retention and they allow us to be able to evaluate, in an objective way, if such practices should be performed.

SEASONAL DISTRIBUTION AND BEHAVIOR PATTERNS OF JUVENILE AND ADULT MALE LOGGERHEADS IN THE SOUTHEASTERN UNITED STATES

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In-water sampling techniques enable collection of healthy juvenile and adult male sea turtles which are otherwise inaccessible. Much life history information for juvenile and adult male loggerheads has been compiled in recent years. Technologies such as satellite telemetry have facilitated rapid and detailed data collection for free-swimming turtles, particularly with respect to documenting seasonal distributional and behavioral patterns. We have used satellite telemetry to study juvenile and adult loggerheads in the Southeast U.S. since 2004 and 2006, respectively. Following collection by trawling in the shipping entrance channels of Charleston, SC (juveniles) and Cape Canaveral, FL (adult males), a subset of loggerheads was tagged with Telonics ST-20 satellite transmitters. During an 840-day observation period between 16 June 2004 and 30 September 2006, a total of 31,656 detection events were recorded for 24 juvenile loggerheads. Between 17 April 2006 and 30 September 2006 (167 days), a total of 6,599 detection events were recorded for nine adult male loggerheads. In addition to location information, water temperature and dive cycle metrics were also recorded. Resident and migratory individuals were observed among both juvenile and adult male loggerheads; however, juvenile loggerheads were noticeably more resident. Eighty-eight percent (n=21 of 24) of juvenile loggerheads remained offshore of SC between May and November (or for as long as each animal was monitored; minimum = 30 days). In contrast, only 33% (n=3 of 9) of adult male loggerheads remained offshore of central FL between April and September; four adult male loggerheads migrated to Mid-Atlantic states within 4-6 weeks following release, and two adult males were only monitored for 7-10 days. Seven of ten juvenile loggerheads for which over-wintering data has been collected resided on the middle to outer continental shelf off of SC and GA between December and March, returning inshore in April. Two additional juvenile loggerheads remained on the SC shelf until mid-February, at which point they entered the Gulf Stream, and a third juvenile loggerhead over-wintered completely in the Gulf Stream. Seasonal shifts in diving behavior were noted for juvenile and adult male loggerheads. Between May and November, juvenile loggerheads made numerous and short-duration dives daily; however, between December and April, diving behavior was characterized by fewer and longer duration dives. In contrast, adult male loggerheads exhibited a variety of patterns. Potential explanations of changes in diving behavior for both juvenile and adult male loggerheads will be discussed.

SATELLITE TRACKING JUVENILE GREEN TURTLES FROM FLORIDA'S EAST COAST: THE MISSING SIZE CLASSES FOUND

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The nearshore and inshore waters of Florida's east central coast provide optimal habitat for juvenile green turtles, *Chelonia mydas*. Green turtles recruit to these waters at 20-25 cm SCL but are rarely seen at sizes greater than 70 cm. The size classes between 70 and 80 cm and 80 and 90 cm are referred to as the "missing size classes" and are seen only occasionally by biologists conducting long-term in-water research in Florida. The two groups with the longest history and highest number of sea turtle captures are the University of Central Florida Marine Turtle Research group (UCF) and the Sea Turtle Program at the St. Lucie Power Plant. Turtles in the missing size classes represent less than 1% of the overall green turtle captures by UCF in three in-water study sites on the east coast of Florida (n=4862, 1982-2005) and less than 2.2 % of all green turtle captures at the St. Lucie Power Plant (n=4811, 1976-2005) at Hutchinson Island. Prior to this study, fewer than 20 long distance tag returns had been received by the two groups indicating that some of these turtles make their way to the Caribbean basin. To locate these missing size class animals and better understand green turtle life history, satellite transmitters (Telonics ST-20) were attached to 22 green turtles between 70 and 84 cm from the east central coast of Florida. Argos location data were analyzed using the Douglas filtering algorithm. Despite their size, some individuals remained in the area where they were captured for the duration of tracking. The majority of the turtles recruited to new foraging habitats in the Florida Keys while others relocated to the Bahamas and the Caribbean. The central tendency was for turtles to closely follow the Florida coastline although making generalizations remains difficult.

POST NESTING MIGRATORY MOVEMENTS OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN THE YUCATAN PENINSULA, MEXICO

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Due to the regional concern about the drastic decrease in the number of hawksbill (*Eretmochelys imbricata*) nests by 2004 in the Yucatan Peninsula, the largest nesting population in the Caribbean, hawksbill specialists in Mexico identified the most urgent problems to address, as well as the conservation and research issues to execute within the next 5 years in the region. One of the most urgent problems was defined as the ignorance of migratory patterns and the

location of feeding and sheltering grounds for the post-nesting hawksbill females in the region. To address this issue, we are tracking three post-nesting hawksbill females that were captured at their nesting beaches in Campeche, Mexico. We attached satellite transmitters to adult sea turtles, programmed for 24 hrs on. They have been tracked for more than 75 days, traveling more than 1,000 km each, and all have remained in Mexican waters. After being tagged on the nesting beach, the first female, Jolbej, stayed near the coast and after 16 days she returned to the original nesting beach to lay another clutch, and then she began her migration close to the coastline to the area of Isla Contoy and Isla Mujeres at the northeast corner of the Yucatan Peninsula. The second female, Xinxinbaal, started her migration right after she was released, taking 10 days to reach her last known destination at 117 km northwest of Campeche City. The third turtle, Kaansaj, nested again 14 days after her initial release, but on a beach 100 km southwest from the original beach. After nesting the second time, she followed a similar track to Jolbej, until she reached a shallow area in front of Holbox Island at the northeast of the Peninsula. The first and second females are the first two records of nesting hawksbills migrating from Campeche to this area. We calculated the home range (Minimum Convex Polygon) along the tracking days to determine the minimum time to get the final home range area for those turtles. All turtles have been registering characteristic dive patterns during their migrating and resting days, showing differences in their diving behaviors between day and night along their migrating and stationary periods. This type of analysis is proposed as a double check tool for behavior data to define if the turtle is already settled or still migrating. We are integrating the tracking data with biological (reefs, seagrasses) and physical (bathymetry) data as well as potential threats (fishing grounds and seismic surveys) into GIS. We have obtained information about hawksbill migratory patterns, feeding grounds and interactions between anthropogenic activities and sea turtles and their critical habitats in the Yucatan Peninsula.

POST-NESTING MIGRATIONS OF GREEN TURTLES (*CHELONIA MYDAS*) FROM THE ARCHIPELAGO OF GUADLEOUPE (FWI) REVEALED BY SATELLITE TRACKING

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A conservation program for marine turtles in Guadeloupe was established in 1998, and the official Recovery Plan for these species in the French Antilles was formally enacted in 2006. Among the different actions set out by the Recovery Plan is the identification of threats to marine turtle populations on both the local scale and the regional scale, with targeted actions to reduce those threats as much as possible. The Recovery Plan specifically states that information on migratory behavior of marine turtles from the territorial waters of Guadeloupe is necessary to develop regional cooperative plans to conserve these protected species. Three species of marine turtles nest in Guadeloupe: hawksbill, leatherback and green turtles. Of these three, the green turtle appears to be the most vulnerable because they lay the fewest nests on the fewest beaches in the archipelago. Thus, the green turtle is afforded priority status in actions described by the Recovery Plan. As a first step, nesting green turtles were followed using satellite tags in order to describe their post-nesting foraging grounds and to develop an understanding of their migratory range. During the 2006 nesting season, satellite tags were deployed on nesting green turtles on two different nesting beaches: two turtles (Laeticia and Coccinelle) from the island of Marie-Galante and one turtle (Miss Ti-tè) from the island of Petite-

Terre. Each turtle nested between 1 and 3 times on or near the beach where they were fitted with the satellite tags. Within 24 hours of their last nest of the season, each turtle displayed clear migratory movement. Currently, 2 of the turtles have moved north of the archipelago: Miss Ti-tè is in the waters off of St Kitts & Nevis (straight line distance = 194 km) and Coccinelle is in the waters off of Antigua (straight line distance = 144 km). Although both females are from different nesting beaches on different islands, they appeared to follow similar migratory routes: they moved north to Grande-Terre, then circled clockwise around Basse-Terre before heading to Montserrat, then St Kitts & Nevis or Antigua. For the moment, it appears that post-nesting green turtles from Guadeloupe remain in the Lesser Antilles, although longer tracking times and more tracked turtles are needed to verify this hypothesis. A review of available data from other tagging and satellite telemetry projects in the Lesser Antilles suggests that at least some post-nesting green turtles remain relatively close to their nesting beaches. This appears to be the case for hawksbill turtles as well, also based on data available from other projects. This information suggests that an effective regional conservation plan for these species should be focused on the level of the Lesser Antilles. Acknowledgments : We gratefully acknowledge travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service.

ENVIRONMENTAL ASSOCIATIONS OF LEATHERBACK TURTLES IN NEW ENGLAND WATERS

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Leatherback turtles (*Dermochelys coriacea*) have long been recognized as part of the New England seascape, seasonally migrating into coastal and shelf waters to forage on the abundance of gelatinous zooplankton. Information on the spatial and temporal occurrence of leatherbacks in New England waters has historically come from aerial surveys, sightings, strandings and entanglements in fishing gear. Their persistent presence suggests favorable foraging conditions along the coast and on the shelf during certain times of the year, although the environmental cues which determine their arrival, location and departure from the region remain unknown. Using a variety of data sources and GIS techniques I will analyze the temporal and spatial distribution of leatherback turtles in New England waters in relation to oceanographic (physical and biological) and climatic conditions. Despite significant progress in the management of pelagic fisheries with respect to sea turtle by-catch, the impact of coastal fisheries on leatherback populations remains poorly studied. Identifying areas and times of likely interaction between coastal fisheries and leatherbacks in the New England region will benefit management decisions for these fisheries and may help reduce the frequency of leatherback entanglements in this region. Travel support for K. Dodge was provided by Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, US Fish and Wildlife Service, and the Sea Turtle Symposium. This research was supported by the University of New Hampshire Large Pelagics Research Center.

MOVEMENT PATTERNS OF JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) ALONG SOUTHWESTERN ATLANTIC COASTAL WATERS DESCRIBED BY MARK-RECAPTURE STUDIES

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Movements of immature green turtles in the Southwest Atlantic region are summarized in this work. All the turtles were tagged as part of an in-water mark-recapture program conducted throughout the coast of Uruguay, from 2001 to 2006. In all cases, the same methodology was used: inconel tags, model #681, were placed on the trailing edges of the front flippers, along the second scale. Morphometric data (CCLn-t) was collected at the time of tagging, and a photo-identification was taken from both sides of the head in order to have an individual record of each turtle. From a total of 306 immature green turtles that were tagged and released, 16 were later recaptured (29.4-49.9 LSCn-t, mean=40.0, SD=5.3). Fifteen were identified by the flipper tag number and one (who had previously lost both tags) was identified through the photo-id data base. Of the 306 turtles, five were recaptured at distances greater than 180 km, between 5 and 17 months later. Individual minimum travel distances ranged from 180 to 2250 km. Local recaptures on feeding grounds (n=10) some over one year at the same place, suggest residency for extended periods. Although the majority of recaptures took place at the Cerro Verde area (n =7), one turtle was recaptured in la Paloma, Uruguay (distance= 10 km), while the other two were found in Hermenegildo RS, Brazil (distance= 45 km). The mean growth rate of recaptured green turtles was 1.2 cm/yr (n=5, range=0.03-1.97). Also, one old long-range tag return from the Northern Hemisphere was recorded. The turtle was a 29 cm CCLn-t green turtle tagged in April 1977 at Leonsberg, Surinam and recaptured in Valizas, Uruguay in March 1979, an estimated minimum travel distance of 6800 km. Recaptures have shown that at least some juvenile green turtles feeding on macroalgae along the Uruguayan coastal shelf undertake migrations, as indicated by several recaptures at distant foraging grounds in Brazil.

SATELLITE TRACKING OF LEATHERBACK TURTLES FROM CARIBBEAN CENTRAL AMERICA REVEALS UNEXPECTED FORAGING GROUNDS

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From 2003-2006, the Caribbean Conservation Corporation has tracked 12 adult female leatherbacks from nesting beaches located along the Caribbean coast of Costa Rica (Tortuguero & Gandoca) and Panama (Chiriquí Beach). Eight of the transmitters were KiwiSats 101 supplied by SirTrack and four were Series 9000x SRDLs produced by the Sea Mammal Research Unit. All PTTs were attached dorsally to the female turtles during nesting using a custom-fitted harness made of nylon webbing and polyvinyl tubing, and designed to be released within approximately two years. Tracking duration ranged from 23 days to 443 days, with an average of 185 days. The KiwiSats had an average duration of 159 days, while the SDLRs sent information for an average of 238 days. One SRDL unit continues to transmit data after 120 days (transmitter was deployed on June 16, 2006). Nine of the 12 tracks provided sufficient

tracking data to establish a migratory route out of the Caribbean and were extensive enough to suggest possible foraging areas. Of these, four were tracked to the Gulf of Mexico by traveling between the western tip of Cuba and the Yucatan Peninsula of Mexico. The remaining five leatherback turtles were tracked from the Caribbean Sea into the northern Atlantic Ocean, either through the passage between Cuba and Haiti (2) or the passage between the Dominican Republic and Puerto Rico (3). Within the Gulf of Mexico, three leatherbacks stayed within the eastern part of the Gulf off of the coasts of Florida and Alabama, while the forth is currently in the western Gulf of Mexico. The leatherbacks reaching the North Atlantic Ocean either stayed close to the Atlantic coast of North America (2), traveled near Bermuda (2) until reaching the waters off of Nova Scotia, Canada, or traveled straight across the North Atlantic Ocean to waters north of the Azores Islands. There have been recorded sightings of leatherbacks throughout the Gulf of Mexico, in both near shore and offshore waters, as well as flipper tag recoveries from females tagged on nesting beaches in Caribbean Central America. Our tracking research indicates that these animals may be foraging rather than just migrating through the Gulf of Mexico. We conclude that the Gulf of Mexico may represent a significant foraging ground for leatherbacks from the Caribbean coast of Central America. While jellyfish populations in the Gulf of Mexico have been increasing for over a decade, the summer of 2000 saw a population explosion of both native and invasive jellies. Although it is not possible to determine from our study, the increased occurrence of sightings and the movements of leatherback turtles in the Gulf of Mexico could be related to the increase in available prey items associated with the growth in jellyfish abundance. There is also the possibility that leatherback by-catch in fisheries in the Gulf of Mexico could be contributing to the slight decline in nests observed on index nesting beaches in Caribbean Costa Rica.

DISPERSAL AND DIVE PATTERNS IN GRAVID LEATHERBACK TURTLES DURING THE NESTING SEASON IN FRENCH GUIANA

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We present the first combined analysis of diving behaviour and dispersal patterns in gravid leatherback turtles during 3 consecutive nesting seasons in French Guiana. In total 23 turtles were fitted with an Argos satellite transmitter and 16 individuals (including 6 concurrently satellite tracked) were equipped with an electronic time-depth recorder during one inter-nesting interval, i.e. between two consecutive ovipositions. The leatherbacks dispersed over the continental shelf, ranging from the coastal zone to the shelf break and moved over 546.2 ± 154.1 km (mean ± SD) in waters of French Guiana and neighbouring Surinam. They mostly performed shallow (9.4 ± 9.2 m) and short (4.4 ± 3.4 min) dives with a slight diurnal pattern. They dived deeper as they moved away from the coast suggesting that they were predominantly following the seabed. Inter-nesting intervals could be divided into two phases: during the first 75% of the time turtles spent at sea, they dived on average 47 min h-1 before showing a lower and more variable diving effort as they came back to the shore. The analysis of dive shapes, but also the extended horizontal and vertical movements observed in this study, suggest that leatherbacks may feed during the inter-nesting interval, probably to compensate for the energy costs associated with reproduction. This also results in this endangered species being exposed to high risks of interactions with local fisheries throughout the continental shelf. The authors wish to thank the Sea Turtle Symposium, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service for the travel grant allocated to S.F.

ALTERNATIVE ATTACHMENT TECHNIQUE FOR SOFT-SHELLED MARINE TURTLES

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Satellite transmitters fixed on a harness have been, since recently, the commonly used attachment technique to follow oceanic movements of the soft-shelled leatherback turtle (*Dermochelys coriacea*). However, harnesses have recently been reported to have a welfare impact during long term deployments in this species. Here, we present the first long-term (3-months) monitoring of two leatherback turtles tracked with satellite transmitters directly attached on the pseudo-carapace during migration. Three other turtles were concurrently satellite-tracked with a traditional corrodible harness. There were significantly less recorded locations per day and of least quality for turtles equipped with a harness than for turtles without a harness (1.51 ± 1.35 loc. day-1 and 2.47 ± 1.54 loc. day –1, respectively), which suggests a better position of the satellite transmitter on the turtle's back when directly fixed onto the pseudo-carapace. Mean locomotor travel rate (i.e. turtle's own motion taking potential current drift into account) for turtles equipped with a harness was 17.4% slower (0.50 ± 0.12 m.s-1 and 0.59 ± 0.18 m. s –1 respectively) and dives were 12.5% shorter (23.2 ± 14.1 min and 26.3 ± 17.8 min respectively) but were of a similar depth (87.1 ± 81.9 m and 80.7 ± 71.0 m respectively) to turtles without a harness. This indicates a marked hydrodynamic impact of the harness that limits a turtle's swimming and diving capabilities. We conclude that direct attachment of satellite transmitters to the pseudo-carapace of leatherbacks is an improved technique for long-term monitoring and such attachment apparently reduces hydrodynamic constraints for this endangered species. The authors wish to thank the Sea Turtle Symposium, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service for the travel grant allocated to S.F.

AT SEA MOVEMENTS AND DIVING BEHAVIOUR OF OLIVE RIDLEY TURTLES DURING AND AFTER THE NESTING SEASON IN FRENCH GUIANA: CONSERVATION IMPLICATIONS

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The olive ridley turtle, *Lepidochelys olivacea*, contrasts with other marine turtle species in that its generalist diet implies a site-specific behavioral plasticity, as recently reported in a few studies. In areas where environmental conditions are highly variable either spatially and/or temporally, olive ridley turtles are thus expected to show variable foraging and diving behaviors.

French Guyana lies in the Atlantic coast of northern South America where fresh Amazonian waters regularly influence oceanographic conditions on and off the continental shelf. To test the prediction that olive ridley turtles may show a high behavioral plasticity in French Guyana, where about half of the Atlantic population of this species is reported to nest, we monitored the at-sea movements and diving behaviors of ten gravid females via satellite telemetry after they nested in summer 2006. Five of the 10 individuals remained in the vicinity of the departure point and landed a second time near the deployment point within the first month of monitoring, suggesting they re-nested after deployment. The five other individuals left the area immediately after deployment, suggesting they began their post-nesting movements. At the end of the nesting period, all ten turtles moved on the continental shelf, heading north-west to neighboring Surinam and further north to Guyana. The ten turtles concentrated their time in two main habitats, namely at the mouth of large rivers and at the border of the continental shelf, where they showed specific diving behaviors, consistent to our prediction. Data from at least two of the ten study turtles suggest that they were accidentally captured on the Guyanese shield. Such high level of interactions between olive ridley turtles, whose nesting population in French Guiana accounts for about half of the Atlantic population, and regional fisheries implies international efforts for the conservation of this species.

GREEN AND HAWKSBILL TAG RECOVERIES IN THE GULF OF GUINEA, WEST AFRICA

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The PROTOMAC programme (Marine Turtle Protection in Central Africa), a regional network for sea turtle research and conservation in the Gulf of Guinea, has carried out tagging of nesting females, immatures and adults in feeding grounds since 1997. We report for the first time three tag recoveries from hawksbill (*Eretmochelys imbricata*) and green turtles (*Chelonia mydas*) recaptured in Equatorial Guinea which had been tagged in neighboring countries. Two female turtles were tagged while nesting on Praia Grande, in the island of Principe, São Tomé and Principe. The first turtle was tagged in December 2003 (KUD11076) and the second (KUD06326 GD) in November 2003. They were recaptured, respectively, in May 2006 and May/June 2006 near Corisco Island in Equatorial Guinea, a straight line distance of approximately 260 km. The Corisco Bay region is a foraging area for green turtles, of recognized importance at a regional and global scale. However, turtles are threatened by intentional capture by the local fishermen and both of the tagged turtles were slaughtered and consumed. The third turtle (F740) was an immature hawksbill tagged in Cameroon after having been captured incidentally by a local fisherman in the southern region of Ebodje. It was recaptured in Rio Campo, in northern Equatorial Guinea, by a local fisherman who is a dedicated turtle hunter. Thus, we can confirm that the coastal region between northern Equatorial Guinea and southern Cameroon hosts juvenile developmental habitat for hawksbill turtles and that individuals move relatively long distances between the shallow coastal bays while foraging, thus not exhibiting strict site fidelity. We will also discuss the conservation implications of our work with respect to national and international legislation.

ANALYSIS OF THE MOVEMENT OF LOGGERHEAD SEA TURTLES OFF COASTS OF JAPAN

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Loggerhead sea turtles, *Caretta caretta*, off the coast of Japan are known to travel great distances. They exhibit many route patterns, such as heading into the Japan Sea, circling in the North Pacific, and at times wandering off to the shores of California and back. Reasons for the diversity in behavior are still unclear. Argos satellite tracking devices were attached to turtles at different times and conditions off the coast of Japan, and their tracks were recorded, ranging from several months to over a year. The unequally spaced noise data were smoothed under certain criteria to maintain the most reasonable paths taken. Oceanic factors and some randomness are believed to determine the variability in these paths. Relationships were investigated to uncover their behavior and examine which factors were most relevant for turtles in different conditions. The Kuroshio, a major northward-flowing coastal current, other strong currents and eddies, along with numerous preliminary factors, such as temperature, salinity and chlorophyll A concentrations were involved in the analysis. These are believed to play a key role in predicting their movements. Although still uncertain, global warming and other abrupt environmental changes can be expected to alter sea turtle routes significantly, diversify nesting locations, and affect sex ratios in hatchlings. Such consequences are deciding factors for their future.

MAGNETIC WAYMARK NAVIGATION BY HATCHLING SEA TURTLES: INHERITED INSTRUCTIONS FOR A TRANSOCEANIC MIGRATION

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Young loggerhead turtles from eastern Florida undertake a transoceanic migration in which they gradually circle the North Atlantic Ocean before returning to the North American coast. Previous studies indicated that hatchlings exposed to regional magnetic fields that exist at several crucial boundaries of the gyre (i.e., locations where turtles risk drifting off course) responded by swimming in directions that would, in each case, help turtles remain within the current system and advance along the migratory pathway. To investigate further the magnetic navigational system of loggerheads, we exposed hatchlings to several additional magnetic fields, including some that exist along the migratory route and one that exists in a location north of the gyre where turtles are unlikely to go. When presented with fields that exist at locations within the gyre currents, turtles responded by swimming in directions that appear likely to help them advance along the migratory route. In contrast, turtles exposed to a field that exists north of the gyre were not significantly oriented as a group. These results suggest that, over at least some parts of the migratory pathway, young loggerheads may navigate by using regional magnetic fields as a series of open-sea waymarks. In effect, the migration may be accomplished as a series of sequential steps, in which the field encountered at one location elicits directional swimming that

leads the turtles to another location, where another field in turn elicits a response that directs the next segment of the migration.

MIGRATORY BEHAVIOR OF HATCHLING SEA TURTLES: EVIDENCE FOR POPULATION-SPECIFIC DIVERGENCE IN THE LOGGERHEAD (*CARETTA CARETTA* L)

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Migratory bird and insect populations show differences in orientation direction, timing, and distances moved depending upon where they reside in relation to their migratory goals. These differences presumably occur because of selection for behavioral responses that promote the most efficient migratory strategies among members of each population. The purpose of this study was to determine whether migratory behavior in loggerhead hatchlings differs between populations that exit nesting beaches on the East and West coast of Florida. When the turtles emerge from the nests, they initially show a swimming "frenzy" that serves to distance individuals from shallow coastal waters, displacing them toward oceanic currents that are used to transport the turtles to the North Atlantic Gyre. On the East coast of Florida, turtles swim eastward toward the Florida Current (western portion of the Gulf Stream) located relatively close to the shoreline (on average, 2 km offshore at Miami to 33 km offshore at Melbourne Beach). On the West coast of Florida, turtles swim westward toward the Loop Current in the Gulf of Mexico, which is located farther offshore (150 km offshore at St. Petersburg to over 200 km offshore at the Everglades National Park). In a previous study, we demonstrated that for East coast loggerheads, the frenzy consists of continuous swimming for ~ 24 h, followed over the next 5 days by postfrenzy (diurnal, with little nocturnal) swimming activity. No comparable data exist that characterize the frenzy period of loggerheads from the West coast of Florida. We used identical methods to quantify the migratory activity of hatchlings from the West coast of Florida. Hatchlings were captured as they emerged from nests located between Venice and Sarasota, Florida. They were then tethered in water-filled pools under laboratory conditions, where temperature and photoperiod could be controlled to duplicate conditions used when studying the East coast turtles. Activity was continuously recorded over the next six days. The data were analyzed to determine the proportion of time the turtles spent swimming every day, and the proportion of that swimming activity that occurred during the light and dark period of each day. Turtles from each coast showed no statistical difference in the proportion of time spent swimming each day. However, after day 1, West coast hatchlings showed statistically lower levels of swimming activity during the day and statistically higher levels of swimming activity at night than did turtles from the East coast. We hypothesize that these differences may reflect a more diffuse period of active "searching" for appropriate oceanic currents by the West coast turtles, under conditions where greater predation pressures might select for more movement under conditions of darkness. Such a response may be appropriate when migratory goals are located at greater distances, and when turtles must migrate farther from the coast to reach deeper, and presumably less predator-rich, waters.

SATELLITE TELEMETRY STUDIES IN BRAZILIAN NESTING AREAS: PRELIMINARY RESULTS

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Since February 2005, 38 females of four sea turtle species (15 *Eretmochelys imbricata*, 10 *Caretta caretta*, 10 *Lepidochelys olivacea* and 3 *Dermochelys coriacea*) were tagged while nesting, and tracked for information on inter- and post-nesting movements. Additionally, one leatherback female captured by gillnets off the southeastern Brazilian coast was tagged and tracked. Despite the preliminary character of the present data, different species exhibited distinct movement patterns (with some intra-specific variation). Hawksbills tagged in northern beaches of the state of Bahia moved both northward (8) and southward (5); two animals stopped transmissions a few days after deployment. Five females are still transmitting and have been for the past 17 months, and each have been in the same area for over one year. All of the loggerheads, tagged in the same area in northern Bahia on January 2006, are still transmitting and have migrated northward; eight females stopped at the coast of Ceará state; one reached the coast of Maranhão and another is off the coast of Pará state. Five of the ten tagged olive ridleys ceased transmission prematurely. Two transmitters were recovered in different fishing villages, after the turtle's death. Four of the five remaining turtles moved both northward (3) and southward (1); the last female headed northward, crossing the Equator in a high-sea path. The tagged leatherbacks, including the one tagged at the fishing area, migrated southward (one of them reached Argentinean waters), except one which was found dead in a fishing net during internesting movements in the nesting ground. Even though several turtles are still transmitting, the preliminary results stressed the long-range character of migrations for the different species. Considering the presence of a large fishing effort along the entire Brazilian coast and the development of offshore industrial activities sometimes very far from the nesting areas, the available data corroborate the need of integrated, complimentary and international actions to the conservation of marine turtles. Further studies comprising tagging females in nesting and feeding areas, comparisons on the genetic composition of different stocks, and a better comprehension of fisheries' interactions are under development, and will certainly provide important background for conservation decisions. This study is developed by Projeto TAMAR-IBAMA, in cooperation with PETROBRAS/CENPES, for the project "Mamíferos e Quelônios Marinhos".

GETTING THE MOST OUT OF SATELLITE TAGS: HOW DO WE KNOW WHAT TURTLES ARE ATTRACTED TO IN THE OPEN SEA?

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Recent years have marked an explosion of information on sea turtle movements from satellite tags, as well as a number of efforts to characterize the water masses that they travel to and through. Determination of turtle location has improved markedly with better tags and algorithms for filtering tracks. This has enabled us to accurately place turtles on maps of oceanographic variables, such as surface temperature, color, height, and current velocity. However, there are often mismatches in the temporal and spatial scale of tracks and oceanographic data that make the identification of "habitat" difficult. For example, the satellite location data must be summarized on the same temporal scale as the oceanographic data, regardless of whether the spatial scale can be easily rectified. We examined the tracks of ten loggerhead turtles tagged in the Spring and Fall of 1998 near Madeira, Portugal in relation to the ocean habitat they occupied. About half of these animals moved northward toward productive areas of the North Atlantic, while the other half moved southward towards coastal upwelling areas off the African coast. We calculated the straightness index of the ten tracks for individual weekly segments and classified tracks as foraging or traveling based on this index. We then extracted information about the chlorophyll, sea-surface temperature, bathymetry, aviso current, and NCOM-generated current of the ocean surrounding the tracks, and examined the correlation between the straightness index and those characteristics. We found that even after accounting for the effects of current, the gradient in chlorophyll A was consistently related to the foraging behavior of all ten animals tracked regardless of their primary direction of travel. By identifying consistent behavior patterns in relation to oceanographic gradients over broad spatial areas, we can characterize foraging areas for tracked marine turtles in a quantitative manner. This characterization, in turn, can assist with risk assessment by identifying areas or suites of oceanographic variables that are consistent with sea turtle foraging and fishing activities.

USE OF OCEANIC HABITATS BY LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)

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The pelagic ocean is recognized as an important nursery habitat for juvenile loggerhead sea turtles, yet it is the area where we have the least amount of life history information. Generally in the North Atlantic, small juveniles are found in the eastern basin, while large juveniles occupy the western basin. Both of these regions have significant oceanographic features – boundary currents – that compose the frontiers of the North Atlantic Gyre. These are the Gulf Stream, a swift moving warm current that runs northward and is characterized by its low productivity, and the Canary Current, a cold, highly productive southward running current. Archie Carr first hypothesized that loggerhead hatchlings use the Gulf Stream as a migratory corridor and later proposed that small juveniles inhabit the epipelagic realm of the North Atlantic Gyre system, drifting passively with the currents. We used satellite telemetry to track the oceanic movements

and to characterize the habitat use of juvenile loggerheads between 2002 and 2006 in order to gain a better understanding of this pelagic lifestyle. Ten large juveniles (mean = 69 cm CCL, SD = 8 cm) were tracked from the western Atlantic (North Carolina, USA) for up 22 months (mean = 10). Eight small juveniles (mean = 43 cm CCL, SD = 8 cm) were tracked from the eastern Atlantic (Canary Islands, Spain) for up to 6 months (mean = 4). Our analyses examined the physical features of the habitats used by these turtles, focusing on water temperature, bathymetry, distance to seamounts, dive profiles, and associations with geotropic currents. Our results show a strong concordance of loggerhead tracks with the location of currents and associated frontal eddies which suggests that such mesoscale features are important to the foraging ecology of pelagic turtles. Dive profiles from small juveniles revealed that turtles spent most of their time near the surface (< 50 meters, most within 10 meters) and dives were short in duration (< 10 minutes). Turtles from both regions spent the most amount of time in water temperatures between 18 – 21° C. Loggerheads live-out at least the first 10 – 14 years of their lives in the ocean's epipelagia. The world is rapidly becoming aware of human impacts on this oceanic habitat (eg. vessel traffic, marine debris, and fisheries). Defining the importance of these areas for marine species is therefore a crucial step towards their conservation.

AN EXAMINATION OF ARGOS DATA: ACCURACY AND ERROR POLYGONS FOR EACH LOCATION CLASS

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The Service Argos satellite tracking system is commonly used to remotely track movements of sea turtles outfitted with platform terminal transmitters (PTTs). However, the accuracy associated with PTT locations is poorly described, reducing the utility of the data to researchers. Service Argos categorizes locations derived from PTTs into 1 of 6 different location classes (LCs), which are 3, 2, 1, 0, A, and B listed in presumed order of decreasing accuracy. We documented and analyzed (ANOVA) accuracy levels for each LC from data produced by 12 ST-20 transmitters (Telenics Inc.) during a 5-day fixed-position trial. We then used the calculated errors for each LC to form error polygons that encompassed 1 and 2 standard deviations (68% and 95%, respectively) of the data. For the fixed-position trial, all PTTs were placed within a 1 m radius on a house roof, 4 m above sea level with full horizon access from May 10-15, 2005. Transmitters operated under a continuous duty cycle, a minimum 40-second repetition period between consecutive uplinks with tracking satellites and a signal power output of 1.0 watts. A total of 1,265 locations were recorded (mean = 105.5 ± 1.8 per PTT) over the 5-day trial period (LC 3 = 346; LC 2 = 308; LC 1 = 296; LC 0 = 115; LC A = 111; LC B = 89). Mean straight-line error differed among LCs ($F_{5, 1264} = 93.27$; $P < 0.0001$) with LCs B and 0 showing the highest deviations (km) from truth (LC B = 16.93 ± 5.09; LC 0 = 6.18 ± 1.49; LC A = 2.69 ± 0.53; LC 1 = 1.77 ± 0.14; LC 2 = 0.69 ± 0.06; LC 3 = 0.29 ± 0.03). A strong longitudinal bias was detected for LCs 3, 2, 1, and 0 with longitude to latitude error ratios of 1.98, 2.19, 1.77, and 3.09, respectively. No longitudinal bias was detected for LCs A and B, with longitude to latitude ratios of 0.85 and 1.05 respectively. Jennrich-Turner (1969) ellipses rather than circles were constructed to form the error polygons for each LC, which accounts for the longitudinal bias. The area (km^2) of the 2 standard deviation error polygon for each LC was 1.28 (LC 3), 5.93 (LC 2), 41.24 (LC 1), 334.30 (LC 0), 133.09 (LC A), and 7929.71 (LC B). Our results provide documentation of error associated with the LCs of the Argos satellite tracking system, which

allows researchers to make informed decisions about the utility of satellite telemetry as a methodology for remote monitoring of marine turtles. Also, our work allows researchers with data already collected to better interpret and apply that data. Furthermore, with accurate error polygons constructed for each LC, habitat models based on satellite telemetry location data for marine turtles become more feasible.

A TELEMETRIC ASSESSMENT OF SEA TURTLE MOVEMENTS IN TEXAS ESTUARIES

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Satellite telemetry is a valuable tool in identifying habitat use patterns and critical habitat essential to assessing potential fisheries and non-fisheries threats to sea turtle survival and revising out-dated recovery plans. The limited radio, sonic and satellite tracking of sea turtles in nearshore waters of the northwestern Gulf of Mexico (Renaud *et al*., 1995; Landry and Costa, 1999; Landry and Seney, 2006a, b) has generated virtually no information about occurrence and movements of constituent assemblages in adjacent estuaries. Recovery of endangered species like the Kemp's ridley (*Lepidochelys kempii*) depends, in part, on a comprehensive examination of sea turtle use of Texas coastal habitats. To this end, the Sea Turtle and Fisheries Ecology Research Lab (STFERL) at Texas A&M University - Galveston is conducting entanglement netting and satellite tracking surveys to assess sea turtle habitat use patterns in five Texas estuaries - 1) Upper coast: Sabine Lake and Galveston Bay; 2) Mid-coast: Lavaca/Matagorda Bay; and 3) Lower coast: Aransas Bay Complex and Lower Laguna Madre - during 2006-07. Netting effort in 2006 yielded 36 sea turtle captures, all of which occurred in mid and lower coast estuaries. Mean straight carapace length (SCL) for greens (*Chelonia mydas* - 43.3 cm), Kemp's ridleys (30.8 cm) and 1 loggerhead (*Caretta caretta* – 79.0 cm) indicate assemblages were dominated by juvenile/subadult life history stages. Sirtrack KiwiSat 202 transmitters were attached to nine turtles caught in these estuaries during May-August 2006. Track data were generated for 3 greens in the Lower Laguna Madre, 1 green and 1 loggerhead in the Aransas Bay Complex, and 2 Kemp's ridleys in Lavaca/Matagorda Bay. Transmitters also were affixed to two rehabilitated green turtles released into the Aransas Bay Complex and Matagorda Bay. All green turtles exhibited loyalty to seagrass beds in which they were captured during the interval in which they were tracked. However, two greens departed the lower Laguna Madre for shallow, offshore waters along the Mexican coast following the passage of a strong cold front in mid-December. Kemp's ridley movements were more variable, but generally revealed a preference for muddy shorelines of the Lavaca/Matagorda Bay system. These immature ridleys did not appear to migrate from the estuarine environment during the tracking period (June-December 2006) and exhibited more site fidelity than did nesting females tracked in nearshore waters off the Texas and Louisiana coasts during 2005-2006 (Landry and Seney 2006a). The one loggerhead's track lasted only 8 days, yielding very little useful information. Track duration for green turtles was at least three times as long as that for ridleys. Green turtles exhibited an average track duration of 107.5 days as of December 2006 while the two ridleys released in June and August were tracked for an average of 26.5 days. Factors, including attachment protocol and/or tag design, will be examined to resolve short transmission durations for ridleys and the loggerhead. Additional tracking of turtles captured in 2007 will help determine seasonal occurrence, home range, residency times, and habitat preferences for sea turtles in Texas estuaries.

HIERARCHICAL BAYESIAN STATE-SPACE MODEL OF LOGGERHEAD TURTLE (*CARETTA CARETTA*) MOVEMENT BEHAVIOR IN RELATION TO OCEANOGRAPHY IN THE ALBORAN SEA

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Spatially explicit animal movement models are increasingly used to understand habitat selection, in part because of the difficulty in meeting model assumptions of conventional selection analyses. This is especially true for species like sea turtles, which are far-ranging and use spatio-temporally dynamic resources that are hierarchically structured. Moreover, spatial location error inherent to telemetry data poses additional challenges for studying habitat selection. Adapting Bayesian state-space models to location data has been particularly helpful for dealing with location error, and for modeling animal movements in general. The Alborán Sea is an important developmental area for thousands of juvenile and sub-adult loggerhead sea turtles (*Caretta caretta*) that originate from nesting areas in the western Atlantic and eastern Mediterranean. This region also supports large longline and driftnet fisheries targeting a variety of pelagic fish in which juvenile loggerheads are incidentally killed in large numbers. Given the vulnerable status of the Atlantic loggerhead, characterizing important pelagic habitat in the Mediterranean is vital to conservation efforts for this species. We used hierarchical Bayesian state-space models to simultaneously fit 15 Mediterranean loggerhead pathways to Argos satellite tag data, and to probabilistically assign locations in the pathways, based on movement characteristics, to one of two behavioral movement types that were dependent on dynamic environmental features. This framework enabled us to describe what may represent spatially and temporally ephemeral “habitat patches” for juvenile loggerheads in the region. Specifically, we found that loggerheads were most likely to exhibit “intensive search” or “foraging” behaviors when in deeper waters and in areas of low sea-surface heights, characteristic of eddies or upwellings that concentrate prey resources. These findings are consistent with descriptive studies of loggerhead foraging behavior in the northern Pacific, and with movement analyses of other taxa (e.g., seabirds) that use dynamic and hierarchically structured marine habitats. Thus directed movements toward patchy ephemeral resources may be general property for juvenile loggerheads in different populations around the world, and of many other far-ranging pelagic species.

DO LEATHERBACKS FORAGE DURING THE BREEDING SEASON?

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During the nesting season, leatherback turtles are generally presented with a paucity of prey in comparison to time spent in more productive, temperate waters. There are two strategies which

can be adopted during this period. Several species which undertake similar long distance migrations between foraging and breeding grounds will cease foraging during the breeding season and remain relatively quiescent, conserving energy for reproduction and the post-breeding migration (e.g. female elephant seals). Other species will continue to forage, with reduced success, in order to exploit whatever prey may be available (e.g. Adélie penguins). The foraging strategy of green turtles seems to be dependent on food availability. Green turtles forage during the internesting intervals at nesting sites where sea grass beds are present (e.g. Cyprus), but tend to undertake long 'resting' dives when forage is absent (e.g. Ascension Island). Some populations of leatherbacks also appear to forage during the nesting season. On St Croix, USVI, females have shown little weight loss between nesting events, and were probably feeding. To further investigate this phenomenon, we used conventional time-depth recorders and a novel mouth-opening sensor to investigate the foraging behavior of leatherback turtles in the Southern Caribbean. Diving behavior suggested attempted foraging on vertically migrating prey with significantly more diving, to a consistent depth, occurring during the night. No obvious prey manipulation was detected by the mouth sensor, but rhythmic mouth opening occurred during specific phases of the dives, suggesting that the turtle was relying on gustatory cues to sense its immediate environment. Patterns of diving in conjunction with these mouth opening activities suggest that leatherbacks are attempting to forage during the breeding season in the Southern Caribbean and that gustatory cues are important sensory inputs.

RELATIONSHIP BETWEEN TIDAL AND LUNAR PHASES AND THE EMERGENCE TIME OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*), NESTING AT TORTUGUERO, COSTA RICA, IN 2005-2006

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Research on animal behaviour is essential to evaluate and improve conservation strategies. Insights into species ecology are key to strengthen these strategies. Effective conservation strategies are indispensable, especially for projects and programs targeting species listed as Critically Endangered on the IUCN Red List of Threatened Species, like the leatherback turtle. On many nesting beaches night patrol schedules are adjusted to sea turtle emergence times, which can be related to moon and tidal cycles. This is particularly true for nesting beaches where the tidal amplitudes are high, as can be the case of semi-diurnal tidal regimes. The oceanographic characteristics and specifically the mixed semi-diurnal tidal regime of the Caribbean make Tortuguero, Costa Rica, different from many other nesting beaches. We conducted a study to assess the relationship between nesting leatherback turtle time of emergence and the tidal and lunar cycles at Tortuguero beach. Statistical analyses show a significant relationship and two types of behaviour associated with the tidal amplitude: 1. At low tidal amplitudes, leatherback turtles tend to emerge around the time of high tide (within 3 hours before and after high tide); 2. At high tidal amplitudes, leatherback turtles apparently choose to emerge well before or well after the time of high tide (2 to 5 hours before and after high tide). These results have important implications and can help plan adequate night patrol schedules as well as explaining the variety of behaviours that sea turtles can display in response to their environment. *Acknowledgements*: We thank Caribbean Conservation Corporation for logistical and data collection support. We gratefully acknowledge travel support from the French Rhône-Alpes region but also from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service,

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DIFFERENCES IN ORIENTATION AND SWIMMING BEHAVIOR BETWEEN THE INITIAL GROWTH STAGES OF GREEN TURTLES

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Headstarting is the practice of growing hatchlings in captivity to protect them from the high rates of natural predation that would have otherwise occurred in their early stage. Concernes have been expressed whether the head-started turtles disperse to the open sea after the release like wild turtles. In other words, are they capable of reaching the open sea since they have been reared in captivity? However, this question has not yet been investigated in field surveys. In order to investigate the growth stages which hatchlings keep their willingness to migrate offshore, we monitored the orientation and swimming behavior of green turtles in the initial growth stages from day 0 to day 56 that were released from the beach. The eggs of the experimental turtles were collected at Ibaruma beach, Ishigaki Island, Japan, and then implanted into the artificial beach of Yaeyama Station, Seikai National Fisheries Research Institute, Japan. After hatching, the turtles were divided into 3 groups, and reared for 0 day (n = 6; SCL = 4.6 + 0.17), 7 days (n = 6; SCL = 4.7 + 0.12) and more than 28 days (n = 6; SCL = 5.8 + 0.54), respectively. The tracking experiment from the shore was conducted by a small boat for 3 hours. During the experiments we measured the moving trajectory and speed of the turtles, the wave direction and the speed and the direction of the surface current. In the results, all of the turtles moved to the open sea, but actually the swimming speed decreased and the moving distance from the shore shortened for larger turtles. Also, the direction of their movements and headings were variable. Especially, there were significant differences of the behavioral characteristics between “1 day” and “more than 28 day” old turtles. The turtles reared for more than 28 days were not able to migrate offshore effectively. The beat frequency of their flippers became slowly as the turtles grow, according to another experiment using the acceleration data logger. In this experiment, the significant orientation of the turtles to the refracted wave could not be identified because the ocean wave came from an almost constant direction. These results suggested that turtle release programs should not release post-frenzy turtles from shore. *Acknowledgement*: JO gratefully acknowledges travel support from the donors through the Symposium Travel Committee.

EFFECTS OF SAMPLING RATE ON ARCHIVAL DIVE RECORDERS – IMPLICATIONS ON THE INTERPRETATIONS OF DIVE BEHAVIOR ANALYSIS

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Archival dive recorders (ADR's) provide essential information for understanding underwater behavior of diving organisms. Changes in sampling rates of ADR's may have significant impacts on interpretations of dive data, yet effects of sampling rate have not been explored in detail. Because data are stored in a limited amount of onboard memory, an ideal sampling rate needs to be determined for each study considering an acceptable trade-off between the duration of deployment and the resolution of dive records. Slower sampling rates can extend the deployment duration yet reduce the resolution of dive records, which could alter results of analyses on individual dives. Alternatively, faster sampling rates prohibit long-term data collection due to memory limitations. In order to determine the lost information due to slow sampling rates, we re-sampled data collected via ADR's deployed on leatherback turtles in St. Croix, US Virgin Islands. The original data were collected at 5 sec interval. Descriptive statistics and classification of dive profiles were compared among various sampling rates. We used a k-means cluster analysis for the classification of dive profiles, where the 'true' number of clusters was determined based on the original 5-s data. The same clusters were used for slower sampling rates. A total of 8,303 dives were recorded for 10 leatherback turtles at the original 5 s sampling rate. Re-sampling at 10 and 30 s resulted in 1% and 5% of dives being missed, respectively. Slower sampling rates resulted in concatenation of multiple dives or short dives being missed altogether. Missed dives were shallower than detected dives (At 10 s, $mean_{missed}$=29.5 m, SD=47.8, $Mean_{detected}$=86.2 m, SD = 57.5; At 30 s, $mean_{missed}$ =37.0 m SD=48.2, $mean_{detected}$=88.2 m, SD=57.0). Additionally, missed dives were shorter in duration than detected dives (At 10 s, $mean_{missed}$=7.3 min, SD=9.7, $mean_{detected}$=12.6 min, SD=5.7; At 30 s, $mean_{missed}$=7.5 min, SD=9.7, $mean_{detected}$=12.9 min, SD=5.4). We found five clusters for the original data, based on the within and between cluster sums of squares. At a 10 s sampling rate, 88% of the dives were classified into the same category as they had been during the 5 s sampling. At a 30 s sampling rate, 75% of the dives were classified correctly. Decreasing the sampling rate further accentuated these results with more missed dives, and more dives classified incorrectly during cluster analyses. Consequently, slower sampling rates can create a bias in descriptive statistics and dive classifications. However, we found that analytical manipulations, such as changing the maximum surface depth, can correct for some of these errors and can help regain information from slower sampling rates. Sampling rate should be of important consideration especially in those studies that are interested in characterizing dive shapes and making inferences about the behavior of animals from dive profiles.

TRACKING JUVENILE GREEN TURTLES WITH GPS AND TDRS PROVIDES A HIGH RESOLUTION RECORD OF SHORT-TERM DIEL MOVEMENTS AND DIVE PROFILES

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As part of a juvenile green turtle habitat utilization project, the short-term movements and dive profiles of juvenile green turtles were obtained by radio tracking over three to five day periods in a shallow water (1 to 3.5 m) lagoon on Florida's East Coast. A six-meter-long instrumented tether was used to follow their movements. A TDR attached to the tether proximal to the turtle's carapace recorded depth and temperature at five second intervals. A GPS receiver on the float attached to the distal end of the tether recorded the turtle's position at one or five minute intervals. The combination of the TDR and GPS data has provided high-resolution movement and dive profiles of diel behavior. Contrasts are drawn between dive behavior during foraging, during movement between foraging areas or sleeping sites, and during nighttime hours. Considerable variation in movement patterns was observed for individual turtles within a night and between nights, and between different turtles.

INTERNESTING HABITAT AND NEST FREQUENCY AT A GLOBALLY SIGNIFICANT LOGGERHEAD NESTING POPULATION DESCRIBED USING ARGOS TRACKING

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Ten adult loggerhead female turtles were equipped with Kiwisat 101 PTTs early in the nesting season on Masirah Island, Sultanate of Oman; one of the world's largest breeding aggregations for this species. Data collection, management and mapping were undertaken using the Satellite Tracking and Analysis Tool (STAT; Coyne and Godley, 2005), a utility of seaturtle.org. Internesting habitat and movements differed between turtles. Six turtles remained within 10-20km of Masirah for the entire internesting period and 4 made circuitous pelagic excursions of 50-300km. Each turtle was consistent in its internesting behaviour as a "wanderer" or "sedentary". No relationship between turtle size and internesting behaviour was found. We investigated if the increased time a turtle's transmitter spent in the air during the nesting process resulted in a) consistent acquisition of high quality locations placing the turtle on or near the beach (within Argos limits for the LC) b) increased number of high quality locations or c) increase in total number of uplinks received by the Argos satellites. Only the absolute number of uplinks provided consistently convincing evidence of nesting activity at approximately two-week intervals for most turtles, with peak numbers rising to 20 uplinks or more above baseline during inferred nesting activity. It appeared that the turtles deposited up to 6 clutches (mean 4.4, range 3-6, n=9) at approximately 2-week intervals (mean of means 16.0 days, range of means for individual turtles: 14.5-17.7 days, n=10; over all range for individual intervals: 13-19 days, n=33) on specific beaches before migrating away from the island at the end of their nesting season. The transmitter ceased to function after recording three nests for one turtle and hence the

average number of nests may have been marginally higher than reported here. Previous estimates for the Masirah Island nesting aggregation size incorporated clutch frequencies of 1.33 and 4 nests per turtle resulting in estimates of 25,700 – 52,700 turtles nesting per year (Ross, 1998). Data presented here indicate Masirah's turtles may be more fecund than suggested and hence this new datum reduces further the lower population size estimate. If our early season females are typical, using Ross' original data for nesting levels, revised estimates range from 23,300 – 47,900 turtles nesting per year, thus maintaining the status as one of the world's largest breeding aggregations of loggerhead turtles. Acknowledgements: We thank the Masirah Rangers Unit for field assistance. AFR wishes to thank Nancy Papathanasopoulou for her efforts of coordination and support regarding this project and Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, US Fish and Wildlife Service and the Sea Turtle Symposium for a grant to attend the Symposium. The project is sponsored by the TOTAL Foundation and TOTAL Oman. Coyne, MS, BJ Godley. 2005. Satellite Tracking and Analysis Tool (STAT): an integrated system for archiving, analysing and mapping animal tracking data: Marine Ecology Progress Series 30: 1-7. Ross, JP. 1998. Estimations of the nesting population size of loggerhead sea turtles, *Caretta caretta*, Masirah Island, Sultanate of Oman. Pages 90-93. In: Epperly, S.P. and J. Braun, compilers. Proceedings of the Seventeenth Annual Sea Turtle Symposium. U.S. Department of Commerce. NOAA Technical Memo. NMFS-SEFSC-415.

THE FIRST SATELLITE TRACKING OF A SEA TURTLE FROM SYRIA: THE POST-NESTING MIGRATION OF A GREEN SEA TURTLE (*CHELONIA MYDAS*)

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Significant levels of green turtle nesting in Syria were only first verified during a survey in 2004 when a population ranking in the top ten of the Mediterranean was discovered at Latakia Beach (Rees, Saad & Jony, in press). A flipper tagging project was initiated that should obtain results on turtle movements and nesting ecology in the ensuing years. In July 2006 a single green turtle, named Kay, was equipped with a Kiwisat 101 Argos PTT after she had completed a nest. Data collection, management and mapping were undertaken using the Satellite Tracking and Analysis Tool (STAT; Coyne and Godley, 2005), a utility of seaturtle.org. The objectives of the action were to obtain the first detailed information on green turtle movements from Syria and to raise national and international interest in and awareness of the nesting turtle population in Syria. Unfortunately, no internesting habitat was determined as the turtle immediately migrated away from the nesting beach after transmitter deployment, making no further nests. The turtle approximately followed the coastline south to Egypt, passing through territorial waters of the intervening states and then westwards along the Egyptian coast to the border of Libya. At that point the acquisition of location data became far less frequent. All subsequent locations, until the last one received in late October, placed the turtle still near the coast on the Egyptian side of the Egypt / Libya border. Results from this turtle give an indication that the African coast is utilised as overwintering and foraging habitat for adult, female green turtles of Syria and complements the more extensive findings of tracking studies undertaken in Cyprus (Godley *et al*, 2002) and Turkey. Improved communication and conservation measures along the Mediterranean African coast are therefore essential to ensure better protection for this critically

endangered population. We recommend more satellite transmitters are deployed in Syria, in the coming years, in tandem with the flipper tagging programme. This would reveal internesting habitat, thus supporting the setting up of a marine park in the Latakia Beach area and further verify Egypt's importance as between-breeding foraging habitat for adult green turtles. Acknowledgements: The transmitter was purchased by a generous grant from the British *Chelonia* Group with additional support coming from Ford – Middle East and seaturtle.org. We thank Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, US Fish and Wildlife Service and the Sea Turtle Symposium for travel grants to attend the Symposium. AFR additionally thanks the Total Foundation for sponsorship to attend the Symposium. Coyne, MS, BJ Godley. 2005. Satellite Tracking and Analysis Tool (STAT): an integrated system for archiving, analysing and mapping animal tracking data: Marine Ecology Progress Series 30: 1-7. Godley, BJ, S Richardson, AC Broderick, MS Coyne, F Glen and GC Hays. 2002. Long-term satellite telemetry of the movements and habitat utilisation by green turtles in the Mediterranean. Ecography 25: 352-262. Rees, AF, A Saad and M Jony. In Press. Discovery of a "major" new nesting area in Syria for the critically endangered Mediterranean green turtle. Proceedings of the Twenty Fifth International Symposium on Sea Turtle Biology and Conservation, 16-22 January 2005, Savannah, Georgia. NOAA Technical Memorandum.

THE INFLUENCE OF PERMANENT SURFACE CURRENTS AND MESOSCALE EDDIES IN THE DISTRIBUTION OF IMMATURE LOGGERHEAD SEA TURTLES IN THE WESTERN MEDITERRANEAN

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We tested whether surface currents affect the distribution of loggerhead sea turtles (*Caretta caretta*) in the western Mediterranean by comparing the dispersal of ten satellite-tracked turtles (average SCL = 46.3 cm; range: 37.1-61.1 cm) with satellite images indicative of the position of mesoscale eddies and the Algerian current. The ten tracked turtles spent most of the time within a single basin (the Algerian basin), with only short excursions to the Balearic Sea. Other adjoining basins (the Alboran Sea, the Gulf of Lions and the Tyrrhenian Sea) were completely avoided, despite long average tracking (120.9 ± 67.0 days). The distribution pattern of the turtles tracked matched well that of the recently entered Atlantic water, that fills only the Alboran Sea and the Algerian basin. Avoidance of the Alboran Sea by turtles was because the specimens approaching it were taken by the Algerian current and forced to drift eastward. In fact, the comparison of the turtle tracks with the satellite images revealed that only 7.9% (range: 0-20.9%) of the fixes were associated with the Algerian current, but 28.3% (range: 0-60.0%) of the maximum longitudinal displacement of each turtle occurred while in the Algerian current. Conversely, only 1.6% (range: 0-2.1%) of the fixes were associated with mesoscale eddies and they did not generate any net latitudinal or longitudinal displacement of the turtles. Furthermore, only simulation experiments incorporating the westward drift generated by the Algerian current and the existence of a barrier to dispersal between the Algerian basin and the Balearic Sea reproduced the dispersal pattern of the tracked turtles. However, the pattern of surface currents

does not explain the prevailing southward bearing of the turtles after being released and the avoidance of salty areas located north to latitude 41ºN, even in summer. Therefore, we conclude that the distribution of loggerhead sea turtles in the western Mediterranean is largely determined by the pattern of surface circulation, although mesoscales eddies play no role in the process, and that habitat selection may also be relevant as turtles avoided areas filled with high salinity water.

DIVING BEHAVIOR AND MOVEMENTS OF OCEANIC STAGE NORTH ATLANTIC LOGGERHEADS

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Juvenile loggerhead sea turtles (*Caretta caretta*) occurring in the Azorean waters are mainly derived from the nesting populations in the southeastern U.S., a fact based on length frequency analyses, tagging studies and, more recently, molecular markers. The discovery of their migration to the Eastern North Atlantic raised the scientific effort of their studies in Azorean waters. Behavioral studies of juvenile loggerheads have been conducted in the Azores archipelago using satellite telemetry since 1994. During 2000, 16 juvenile loggerheads were instrumented with SLTDR's (Wildlife Computers). The positions of each turtle were used to map the movements. Also the diving behavior of each turtle was analyzed. The tracks were layered with a bathymetrical image using ArcGIS (v. 9.1, ESRI) to relate bathymetric features, such as seamounts, with the distribution and diving behavior of this species.

POST-CAPTURE MOVEMENTS OF LOGGERHEAD AND GREEN TURTLES FROM FLORIDA'S SOUTHEAST COAST USING TAG RETURN DATA

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Tag return data from 123 loggerheads and 53 green turtles, originally tagged at the St. Lucie power plant between 1984 and 2006, provided unique insight into post-capture movements of these animals. The power plant is located on Hutchinson Island, on the southeast Atlantic coast Florida USA. Beginning in 1976 a sea turtle monitoring program was initiated to capture and release sea turtles entrapped in the power plant's intake cooling water canal. From 1976 to October 2006 the program has captured (including recaptures) 6825 loggerhead sea turtles (*Caretta caretta*), 4913 green sea turtles (*Chelonia mydas*), 45 hawksbill sea turtles (*Eretmochelys imbricata*), 45 Kemp's ridley sea turtles (*Lepidochelys kempii*), and 31 leatherback sea turtles (*Dermochelys coriacea*). Because the power plant operates on a continuous basis, the intake canal provides a constant sampling of sea turtle aggregations in the nearshore habitat of Florida's east coast. Tag recoveries from 176 loggerhead and green turtles released from the power plant site were recorded in Cuba (3%), Nicaragua (5%), Maryland

(1%), Virginia (2%), North Carolina (7%), South Carolina (3%), Georgia (2%), and Florida (78%). Species specific and size specific movements were also examined in this study.

FEMALE-FEMALE AGGRESSION IN LOGGERHEAD SEA TURTLES: STRUCTURE OF INTERACTION AND OUTCOME

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Aggressive behaviour between females of the same species is not widely documented, particularly in marine vertebrates. Between 2003 and 2006, in-water surveys were conducted to collect information about loggerhead sea turtle (*Caretta caretta*) marine ecology at the temperate breeding area of Zakynthos in Greece. Between April and July, along a 5.5 km stretch of nearshore area, 92% (n = 1333) of sighting events were of solitary females, 4% (n = 60) were of male-female interactions and 4% (n = 60) comprised female-female interactions. The structure of female-female loggerhead sea turtle interactions was analysed for 58 sighting events, each lasting an average of 3.4 minutes (SD ± 1), comprising a total of 3.1 hours observation time. We found that female interactions involved ritualized escalation in behaviour from passive displays (e.g. head-tail circling) to aggressive combat (e.g. sparring). We suggest that circling individuals evaluate opponent size, sparring individuals test opponent strength, and the positioning of the prehensile tail signals motivational intent to either escalate or abort. The presence of intruder females triggered basking and swimming turtles to respond in 100% of events (n = 19), whereas, while residents resting on the seabed responded on 69% occasions (n = 27), they were almost four times more likely to escalate to aggression. While contests were usually initiated when the intruder entered the visual range of the resident, in 12% of instances contests were initiated by tactile advances (nuzzling or biting of carapace) from the intruder. Our results suggest that certain sites may be preferentially sought after and defended by female loggerhead sea turtles.

MIGRATORY ROUTES AND RESIDENT AREAS OF ADULT FEMALE AND MALE FLORIDA GREEN TURTLES

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Green turtles, *Chelonia mydas*, are the second most abundant sea turtle in Florida waters - juveniles and adults inhabit nearshore and inshore waters, with adults found primarily in the

southern regions. The Florida green turtle was listed as endangered under the U.S. Endangered Species Act in 1978 and was afforded varying levels of protection under Florida law prior to the federal listing. Nesting is concentrated along the central east coast but extends southward around the tip of the peninsula and along the southwest Florida coast. The nesting trend for the Florida green turtle is increasing, as determined from index nesting beach surveys conducted since 1989. From 1994 - 2000 we used satellite telemetry to track 16 post-nesting Florida green turtles from the Archie Carr National Wildlife Refuge and three male Florida green turtles captured nearshore along the central Florida east coast. Nesting Florida green turtles were tagged during the latter part of the nesting season in order to maximize the likelihood of elucidating post-nesting migratory routes and resident areas. Three of the post-nesting females were recaptured in subsequent nesting seasons (2 - 6 years later) and satellite tagged again to examine fidelity to both migratory routes and resident areas. Male green turtles were captured during the breeding season in the intake canal of the St. Lucie Nuclear Power Plant, on the east Florida coast, and are the first adult male Florida green turtles to be tracked using satellite telemetry. Females typically departed from the vicinity of the nesting beach within days of their last nesting event and arrived at their resident areas within days to a few weeks. Sufficient data were received from eleven of the sixteen post-nesting females and two of the three males to identify resident areas. Tracking periods ranged 26 to 430 days with a mean of 117 days. Resident areas were well-defined and relatively small and were within Florida waters extending from the northern Florida Keys to Cape Sable along the southwest Florida coast for all but one female who migrated to the Bahamas. The three females tagged in subsequent seasons migrated to essentially the same resident areas, only one (the Bahamas migrant) took a slightly different return route. Males occupied similar resident habitat as females. Our findings underscore the critical importance of Florida waters to adult Florida green turtles, provide important information for shaping marine habitat protection, and shed light on contributing factors to the beginning of a likely recovery phase for this endangered population.

MULTIPLE STRATEGIES OF NEST SITE FIDELITY BEHAVIOR OBSERVED IN LOGGERHEAD TURTLES

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Nest site fidelity of loggerhead turtles (*Caretta caretta*) has received attention in the past, but not from the unique perspective offered by satellite telemetry. Nest site fidelity is a metric of the juxtaposition of multiple nests laid by an individual within a single season. Variability in nest site fidelity of loggerheads has been noted through tagging studies. However, these results are limited in scope as total coverage of nesting areas is not possible resulting in partial and skewed data for describing the behavior. For example, quantitative measures of fidelity (e.g. maximum distance between nests) become inherently underestimated if turtles deposit nests long distances away from their other nests that consistently go unobserved. We used satellite telemetry to describe nest site fidelity for loggerhead turtles (n = 22) of the northern subpopulation of the U.S. nesting aggregate and to determine if turtle size predicted the behavior. Observations occurred during the 2004 and 2005 nesting seasons with our capture efforts to attach transmitters and tags beginning mid to late May each season. Satellite locations, which have relatively low precision, were linked to nest locations identified and GPSed (high precision location) by beach monitoring crews. The GPS coordinates of turtle nest sites were then used to calculate mean distance between nesting events and the maximum total

shore line each turtle used to deposit all its nests. Satellite locations correctly linked with proper emergence locations 100% of the time when later compared with visually confirmed observations (n = 13) by nighttime field crews of study animals during nesting attempts. During our analysis we identified multiple behaviors of nest site fidelity in the study population. Turtles expressed either strict nest site fidelity by consistently nesting in a specific localized area (n = 16; 72.7%), or loose nest site fidelity by nesting within a more broad region (n = 6; 27.2%). On average, strict nest site fidelity turtles placed all nests within a 2.94 (± 0.87) km stretch of beach (range 0.82 – 6.55 km). Conversely, loose nest site fidelity turtles on average deposited all nests within 41.57 (±15.84) km of beach (range 17.59 – 64.55 km). However, turtle size (curved carapace length) was not a good predictor (r = -0.032; P = 0.50) of nest site fidelity (maximum distance between nests). Based on observations of the nesting habits of northern subpopulation loggerheads reported by Richardson (1980), and Hawkes *et al*. (2005) – both used tagging project data – the majority of our tracked turtles were expected to exhibit loose nest site fidelity. Instead, the contrary was observed with 27.3% of observed turtles exhibiting the behavior. Familiarity to specific nesting sites is thought to provide advantages for reproductive success to individuals, creating a plausible mechanism for evolution of strict fidelity turtles. Furthermore, a reduced expression of loose nest site fidelity among the population may be a relic of past climate changes like ice ages when that trait would likely have been highly adaptable, but since such time, has waned.

PILOT STUDIES EXAMINING SATELLITE TRANSMITTER ATTACHMENT ON CAPTIVE-REARED LOGGERHEAD SEA TURTLES

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Use of satellite telemetry to collect in-water data is prevalent in the sea turtle community, and many research programs have had great success tracking adults. Texas A&M University at Galveston's Sea Turtle and Fisheries Ecology Research Laboratory (STFERL) satellite-tracked five immature Kemp's ridleys (*Lepidochelys kempii*) averaging 37.1 cm SCL (SD=7.3) for 12–59 days (mean=37.6, SD=17.3) during 2004–2005. Estimated battery life was 9–12 months, prompting concerns regarding causes for premature transmission loss, including turtle death, biofouling, and attachment failure, the latter of which is examined here. The STFERL and NOAA Sea Turtle Facility (NSTF) conducted a pilot study examining satellite transmitter attachment using four captive-reared loggerheads (*Caretta caretta*) that were approximately 2.5 years old and averaged 40.1 cm SCL (SD=1.3 cm). Dummy Sirtrack KiwiSat 202 transmitters were attached to the first two vertebral scutes with PowerFast two-part marine epoxy (n=2) or PowerFast covered with SonicWeld steel-reinforced epoxy putty (n=2). The loggerheads were held at the NSTF in a divided raceway from 10 January–23 May 2006 and maintained at 27–30 C and 28–35 ppt. Transmitter attachments were examined for integrity and photographed weekly, and turtles were measured monthly. The loggerheads grew an average of 1.3 cm SCL (SD=0.5 cm) during 10 January–11 May, and all transmitters were still attached on 23 May (Day 135). The turtles were transported overnight 23–24 May from the NSTF to Panama City, Florida for NOAA's annual turtle excluder device (TED) testing. Upon arrival, they were placed in outdoor pens, where one loggerhead was observed rubbing against a piling. Both PowerFast-only attachments failed within four hours (Day 136), and one transmitter was found at the piling's base. One PowerFast/SonicWeld attachment held until 4 June (Day 146), and the fourth attachment remained secure until its removal on 22 June (Day 164). The original loggerheads

were re-outfitted with the unattached transmitters using the same adhesives for use in a trial examining transmitter-TED interactions. The experimental turtles and four same-age controls were sent through a shrimp trawl equipped with a Super-Shooter TED at a 50-degree angle on 22 June 2006. Methods followed the NOAA standard small turtle TED test protocol. One experimental and one control loggerhead failed to reach the TED within five minutes and were recorded as "captures;" however, the transmitter did not impede the experimental turtle's passage through the trawl net. The other turtles successfully escaped from the trawl via the TED, but two of the experimental loggerheads were slowed when their transmitters temporarily wedged between the TED's bars. The dummy transmitters sustained no obvious damage, and all four were removed later that day. Results of these pilot studies and the small sample size employed mandate further examination of transmitter attachment and TED interactions, particularly as they apply to telemetry of smaller, faster-growing life history stages. The STFERL and NSTF plan to undertake larger trials during 2007. Many thanks to the Harvesting Systems Branch, NOAA Pascagoula for enabling the TED trials and videography. Research conducted under FWC Permit TP #015.

POST-NESTING MOVEMENTS OF WILD AND HEAD-STARTED KEMP'S RIDLEY SEA TURTLES

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This study was undertaken to gain information on movements of post-nesting Kemp's ridley sea turtles (*Lepidochelys kempii*) in Gulf of Mexico waters through satellite tracking. The objectives of this study were to: (1) predict where and when Kemp's ridley turtles would lay additional clutches during a nesting season, (2) investigate movements and habitat utilization during and after the nesting season, (3) compare movements and habitat utilization of wild and head-started individuals, and (4) compare movements and habitat utilization during successive tracking periods. This was the first study initiated to investigate the movements and habitat utilization by Kemp's ridley turtles that nested in the U.S.A., to compare the movements of wild and head-started adult Kemp's ridley turtles, and to compare the movements of individual Kemp's ridley turtles during and after different nesting seasons. Twenty-eight Kemp's ridley turtles that nested in south Texas, U.S.A. were outfitted with satellite (UHF) radio transmitters. These Telonics ST-6/ST-20 Platform Transmitter Terminals (PTTs) were configured in a backpack style and attached to the anterior of each turtle's carapace using thin layers of fiberglass cloth and polyester resin. PTTs were programmed with a transmission (duty) cycle of 6 h on/6 h off to extend the battery life. Transmitters were deployed during the months of April, May, and June, between the years of 1997 and 2006 (2-4 per year). The turtles selected for this study were the first uninjured individuals encountered during a nesting season. Thirty-six PTTs were deployed on the 28 individuals, with one individual receiving three successive PTTs, six receiving two successive PTTs, and 21 receiving one PTT. Seventeen of the turtles tracked were wild, nine had been experimentally imprinted to Padre Island National Seashore and head-started, and two had been taken directly from Mexico as hatchlings and head-started. Head-started individuals ranged from 12 - 19 years of age when the PTTs were applied. Turtle movements were monitored via satellite until transmissions ceased due to transmitter detachment or failure. All data were screened to eliminate land locations, duplicate points, points where the rate of movement of a turtle between two consecutive locations exceeded 6 km/hour, and locations that were obviously inaccurate. Data were received from individual PTTs for 1-15 months. Most identified positions were in 20 fathoms water depth or less. Tracking data

were successfully used to predict where and when some of the turtles laid additional clutches in south Texas within a nesting season. Most of the tracked turtles left south Texas and traveled northward, parallel to the coastline, after they completed nesting for the season, with their last identified locations in the northern or eastern Gulf of Mexico. However, four briefly traveled southward to waters off the coast of Mexico and then moved northward. Three turtles remained in south Texas waters through the entire tracking period, but the tracking periods for these three were among the shortest recorded. Movements of wild and head-started turtles and movements of individuals during and after different nesting seasons were generally similar.

LEATHERBACKS AT HIGH LATITUDES: WHEN DO THEY MIGRATE SOUTH?

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Atlantic leatherback sea turtles migrate annually from foraging grounds off eastern Canada and the northeastern United States to southern foraging and breeding areas. Using a Cox proportional hazard model, we investigated the timing of 32 southward migrations of subadult and adult male and female turtles equipped with satellite-linked transmitters off Nova Scotia. Our results suggest significant effects of maturity, latitude and longitude on departure date. Carapace length, sex and sea surface temperature were not significantly related to date of migration. Based on these effects, we estimate that 50 and 95 percent departure dates for turtles in different northern foraging areas can differ by more than a month.

HABITAT SELECTION IN LOGGERHEAD (*CARETTA CARETTA* L.) AND GREEN TURTLE (*CHELONIA MYDAS* L.) HATCHLINGS: A COMPARATIVE LABORATORY AND FIELD STUDY

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Loggerhead and green turtle neonates migrate from Florida's East coast during a 24-36 h frenzy. Postfrenzy loggerheads, days to weeks old, are often found resting in flotsam (typically *Sargassum*), but green turtles of comparable age "disappear". In this study, we compared (i) the frenzy and postfrenzy activity of the two species to determine how long they were active, (ii) how they responded to flotsam under laboratory and field conditions, and (iii) whether experience played a role in habitat (flotsam) selection. Ten hatchlings about to emerge from six nests of each species served as subjects in the laboratory experiments. They were placed that night in either a large tank without ("unexposed") or with ("exposed") *Sargassum* located on one side of the tank. Location and activity of the exposed turtles were recorded three times daily (morning, afternoon, after dark) for three days. Green turtles showed a significantly longer frenzy period than loggerheads, manifested by higher levels of activity over all three days (X2 probabilities < 0.01). During the postfrenzy, green turtles rested in flotsam during the day, and flotsam or open water at night, while loggerheads rested either in flotsam or open water, regardless of photophase. During most observations, inactive green turtles spent significantly more time in flotsam than open water, compared to loggerheads (X2 probabilities < 0.001). On day 4, exposed turtles were removed and housed together with the unexposed turtles in another tank and, that evening, five turtles from each group were returned to the test tank which now

contained floating artificial (plastic green) flotsam on one side, *Sargassum* on the opposite side, and open water in between the two mats. Observations on day 5 revealed that loggerheads were evenly distributed between flotsam types and the open water, whereas green turtles preferred flotsam. The unexposed and exposed loggerheads showed no differences in habitat choice, suggesting that prior exposure to *Sargassum* had no effect. Exposed green turtles, however, showed a significant preference for *Sargassum* over plastic plants, compared to the unexposed turtles. Posthatchling loggerheads and green turtles were taken offshore and released simultaneously on opposite sides of *Sargassum* mats. The proportion of turtles of each species that crawled into the flotsam did not differ statistically (13 of 17 loggerheads and 11 of 17 green turtles; Fisher Exact Test p = 0.71). Loggerheads that crawled on the mat rested near the surface where they were easily seen from a boat by human observers, but green turtles concealed themselves by hiding within the mat. Loggerheads choosing open water stopped swimming and remained near the mat. Green turtles choosing open water swam away. The field data, like the laboratory results, suggest that green turtles seek refuge in flotsam. They also indicate why green turtles are rarely observed in *Sargassum*. Unlike loggerheads, green turtles do not occupy the mat surface. MMS would like to thank the following organizations for their generous donations: Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service.

OBSERVED RELATIONSHIP BETWEEN COASTAL GEOMAGNETIC ANOMALIES AND NESTING DENSITY OF GREEN AND LOGGERHEAD TURTLES IN TORTUGUERO, COSTA RICA

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Satellite telemetry has made it possible to accurately identify the courses followed by female sea turtles migrating from breeding or feeding grounds to nesting sites sometimes upwards of one thousand kilometers away. However, the mechanism by which they navigate these long distances in the open-ocean and return with such accuracy (i.e. at Tortuguero, the most common distance between returns by tagged nesting females was only 0.2km) in successive years to nest remains uncertain, but assuredly requires the use of a compass. Lohmann (1991) demonstrated that loggerhead sea turtle hatchlings (*Caretta caretta*) can orient themselves in response to an imposed earth-strength magnetic field of either a normal or reversed nature and may use this ability to navigate. Furthermore, a decrease of magnetic intensity over the course of the experiments (2-5%) led to a decreased orientation response. A fine-scale (cycle of 0.5Hz producing one measurement every meter) total field magnetic survey was conducted along fifteen and three eighths miles of Tortuguero National Park, Costa Rica using a GEM Systems proton magnetometer. The diurnal variation of the Earth's magnetic field was simultaneously measured by a second, stationary GEM proton magnetometer cycling at 0.3Hz. All geomagnetic data presented is in its corrected form. Residual coastal anomalies measured approximately 1.5 meters from the swash zone ranged in intensity from -45 to 106 averaged over 0.125mile intervals. Spectral analysis of the geomagnetic data from miles -1 to 3.75 using the PAST program reveals a statistically significant Spearman's rho cross-correlation (p=.00001 ρ? 0) with nesting frequency, when turtle nesting data is offset by 0.625 miles to the north. This offset in the correlation may be due to the influence of the dominant long-shore current encountered by

the turtle as it approaches the beach to nest, in essence deflecting it from its original target determined by its internal magnetic compass. Further statistical analysis is required to accurately describe the complex relationship between localized geomagnetic anomalies and nesting density for the remainder of the dataset from miles 3.75 to 15.The whole body of the dataset was not included due to a discontinuity in data collection between the two sections of the rookery. The nest density measurements in the unanalyzed portion were averaged over extended periods of time and may not be directly comparable with the more detailed data. A previous study of coastal geomagnetic anomalies conducted at Saint George Island, Florida, USA by Pilarczyk *et al*. 2004 led to a similar conclusion of a strong correlation with nesting density to changing residual field strength. An additional study was carried out on the Space Coast of Florida, USA in June of 2005 in order to support the relationship found in these two locations, as well as to assess the influence of anthropogenic effects on the magnetic field, as much of this field work was conducted on the rookery beach immediately adjacent to Patrick Air Force Base.

EXPECTATIONS FOR SATELLITE TRANSMITTERS DEPLOYED ON LOGGERHEAD TURTLES

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Satellite telemetry is a commonly applied technology used to remotely track sea turtle species. Knowledge of expected data acquisition rates for tracking equipment are crucial prerequisites for developing plausible research objectives. Currently expectations of performance by transmitters after deployment are poorly described in the literature. We aimed to strengthen the knowledge base of data acquisition rates for the different location quality classes (LCs) during 3 periods (nesting season, post-nesting migration, and post-nesting foraging) of the adult female loggerhead turtle life stage. We also described transmitter longevity, and documented peeks and lulls in transmissions during the daily cycle. Satellite transmitters (n = 12) (ST-20; Telonics Inc.) were operated under a continuous 24-hour duty cycle with a 1.0 watt transmission power and a 40-second minimum period between consecutive uplinks. Transmitters were subjected to an initial 5-day pre-deployment trial to acquire baseline transmission data before being secured to adult female loggerhead turtles during nesting attempts on barrier islands in Georgia (May 2005). Acquisition of high quality locations (LCs 3, 2, 1, and A; see McElroy *et al*. 2006) decreased significantly ($F_{1,154}$= 203.68; $P < 0.0001$) and averaged 3.60 and 4.22 locations/day, respectively. The longevity of our satellite transmitters ranged from a low of 165 days to a high of 455 days (mean = 340 ± 61 days). The best transmission periods observed during this study were between 2:00 am and 5:00 am (EST) as well as 12:00 pm to 4:00 pm in the afternoon. The times when the fewest transmissions occurred were from 10:00 pm to 1:00 am, and from 7:00 am to 9:00 am. The negative effect of deployment on transmission rates of high quality locations was expected, though the magnitude was surprising. The differing transmission rates observed during the 3 periods of the adult female life stage were interesting as these results suggest strong variation in surfacing behavior for adult female loggerheads during different portions of their life history. It is possible that because females don't seem to forage during the nesting season they would need to conserve energy stores potentially leading to less need for prolonged breathing periods at the surface. Because a 24-hour duty cycle was used, our results should be viewed as the maximum amount of data researchers could expect

from transmitters during the respective life history periods. Duty cycles could be altered to prolong transmitter longevity, but data acquisition would likely suffer as a result. Also, latitude and longitude can alter transmission rates due to changes in relative position of transmitters to the orbits of tracking satellites as well as other factors. As such, our results are most applicable to studies on the east coast of the United States from New Jersey south to Florida.

PILOT EVALUATION OF METHODS TO REDUCE BIOFOULING OF SATELLITE TRANSMITTERS

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A recognized problem in satellite telemetry of sea turtles is transmission loss before the end of battery life. Multiple factors are suspected, including biofouling and antenna damage on a platform terminal transmitter (PTT). However, independent tests of these factors are difficult to evaluate after a turtle is released. To evaluate biofouling in a more controlled setting, we simulated transmitter deployments at dock sites in the eastern and western Gulf of Mexico. The conceptual evaluation tested two treatments and interaction, though was without adequate replication for a proper ANOVA design. Replica PTTs were bolted to the outside of a weighted five gallon bucket. To simulate PTT attachment to a turtle's carapace, the transmitter and adjacent bucket surface were covered with epoxy. Buckets were submerged off docks at Sarasota, Florida and Pelican Island, Texas during August 2006. Current flow past the buckets was equivalent to slow swim rates of turtles, judged on visual assessment of drift algae. Each bucket was retrieved weekly to photo-document patterns and rates of biofouling. Four treatments were arrayed around the bucket's exterior: (1) a control with a bare surface transmitter and bare epoxy attachment area, (2) clear spray-on antifouling paint on the transmitter and no treatment to the epoxy, (3) brush-on antifouling paint to the epoxy but no treatment to the transmitter, and (4) a combination of spray-on treatment to the transmitter and brush-on paint to the epoxy. The pilot study was designed to generate only qualitative results on a limited array of antifouling treatments. Despite this, the preliminary results were clear. A combination of antifouling spray and brush-on paints clearly reduced the rate of biofouling more than either spray or paint alone, or the control. Epifaunal colonization was most rapid on the control and covered the saltwater switch in less than four weeks. Biofouling organisms were primarily teneid or sabellid worm tubes at the Florida site and algae, acorn barnacles, and oysters at the Texas site. The most effective inhibition of biofouling requires treatment(s) across the entire transmitter and epoxied surfaces. Biofouling is a significant concern when deploying PTTs in waters of high turbidity. Follow-up studies incorporating an expanded spatial scope are warranted. This pilot study concluded Part 1 of a three Part series into surface antifouling methods. Future trials will evaluate whether anti-fouling treatments may affect signal transmissions or the saltwater switches, hopefully with participation at additional test locations. Part 2 of the study will repeat replica PTTs with the same antifouling treatments for transmitter and epoxy attachment surfaces, but also include transducer paint applied to the saltwater switches and antenna. Part 3 of the study will evaluate actual PTTs with all antifouling treatments on all surfaces.

SATELLITE TRACKING OF SOUTHWEST FLORIDA LOGGERHEAD TURTLES DURING INTER-NESTING MOVEMENTS, POST-NESTING MIGRATIONS, AND FORAGING RESIDENCY

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As highly migratory animals, sea turtles face threats in a range of oceanic habitats that they traverse during each nesting migration. We deployed satellite tags on thirteen nesting female loggerheads at a major rookery in the Gulf of Mexico to establish their spatial ecology in relation to potential threats. The path analysis yielded valuable insights into the extent of movements within the internesting period, along divergent post-nesting migrations, and for home ranges established at a foraging residency. We compare track paths in relation to local zones of potential hazard, including offshore dredging, boat traffic near inlets, and harmful algal blooms. We compare estimated swim speeds during internesting, post-nesting, and foraging periods. We establish home ranges from fixed kernel estimates, including 50% and 95% estimates to determine core areas within the foraging residency. A limited subset of females gave information on seasonal shifts of home range in response to changing water temperature. Hurricanes did not appear to affect most turtles, but we report an instance of a turtle moved over 300 km by currents generated by Tropical Storm Alberto. We examine case studies of turtles that swam to final residency whereupon turtles circled in a predictable fashion as if reorienting. Four females undertook relatively short (50-288 km) and coastal migrations that were largely unaffected by current systems. Eight females undertook long migrations (613-1235 km) that were international or an open ocean path that crossed major currents. One female was an outlier with an entirely uncharacteristic internesting and post-nesting migration that requires some additional scrutiny. We evaluated the track paths with respect to remotely sensed oceanographic data. Turtles headed SE encountered a following stream with the Florida Current, those headed SW encountered two cross-currents from the Gulf of Mexico Loop Current, and those heading NW encountered a counter flow of the Loop Current.

IS AVES ISLAND WILDLIFE REFUGE THE MOST IMPORTANT SEA TURTLE COURTSHIP AND MATING AREA IN THE CARIBBEAN?

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Aves Island Wildlife Refuge has been monitored since the seventies because it is recognized as an important nesting area for the green turtle (*Chelonia mydas*) in the Caribbean. However, courtship and mating events that occur there have never been reported. Observations of mating activity in the vicinity of Aves Island began in 2005 and 2006 for the project “Monitoring and conservation of green turtle (*Chelonia mydas*) population in Aves Island Wildlife Refuge.” Because the research priority is focused on the nesting activities, in-water observations of the turtles were conducted for a few days of each month using binoculars from the highest part (21 meters) of the naval base. The preliminary data determined that the courtship and mating activity occurred between the end of May and the beginning of October, an observation which is similar to results from other mating areas around the world. In the early stages of the breeding period, the presence of males is higher than females and pairs are scarce. In general, the

animals are observed in areas of water depth between 8 to 15 meters and where the movement of the waves is low. The mating activity peaked in July, from four matings per day to sometimes ten or twelve when nocturnal matings were observed. The pairs were typically surrounded by three to six males. After July, the number of events is highly variable with less pairs per day and occuring farther from shore (>600 meters). By the middle of August and during September, the mating activity returned to the areas where the observer was able to see the events, registering normally one or two per day. The observations permitted the detection of a pair located 6 to 8 meters from the coast, making it possible to tag a male green turtle after many years. These sightings were complemented with some snorkeling, to try to get information about the bottom characteristics of mating areas. The work developed at Aves Island shows that this could be the most important sea turtle courtship and mating area in the Wider Caribbean. The minimum human activity in this area is a favorable condition for mating activity. To get better results, observation effort must be increased, and activity periods must be more precisely established and ranked. At the same time, it is vital to get higher resolution binoculars and night vision equipment, and to use adequate boats to check the sites farther offshore. The island is an excellent area for an in-depth study on breeding behavior, as well as a study site to collect DNA samples to elucidate the parental contributions to offspring.

AN ASSESSMENT OF METHODS FOR ESTIMATING SPECIES' RANGES

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Estimating ranges used by marine turtle populations for foraging, migration and reproduction is an important part of assessing their conservation status and developing spatially-explicit management plans. Minimum convex polygons (convex hulls) are a well accepted method for estimating species' ranges, particularly in circumstances in which presence-only data are the only kind of spatially explicit data available. While MCPs are simple to both understand and implement, they are subject to tremendous bias that varies both with sample size and the shape of the underlying range. Another commonly used method of calculating ranges is kernel density estimators (KDE). KDE is a computationally complex method that is difficult to understand and would be beyond the means of most users to implement if not for "blackbox" tools available in many statistical and GIS packages. KDEs are subject to bias with small sample sizes and, in particular, are sensitive to a user-selected value termed "bandwidth". Here we explore the use of ?-hulls, a generalization of MCPs, that greatly reduce the errors inherent in simple convex hulls. ?-hulls provide a means for excluding discontinuities within a species range. Like MCPs, ?-hulls are relatively simple to apply. Also like KDEs they include a user selected value termed "alpha". We provide suggested rules for the automated selection of an optimal alpha value. We compare and contrast the range estimates received from each method, using data from actual case studies, and discuss the advantages and disadvantages of each in detail. ?-hulls performed better than MCPs and while not significantly better than KDEs, they are much easier to implement and understand, the latter being an extremely valuable attribute when translating results to resource managers or the general public. Burghman MA, and JC Gox. 2003. Bias in species range estimates from minimum convex polygons: implications for conservation and options for improved planning. Animal Conservation 6:19-28. Seaman, DE, and RA Powell. 1996. An evaluation of the accuracy of kernel density estimators for home range analysis. Ecology 77:2075-85.

THE FRENZY AND POSTFRENZY ACTIVITY OF THE FLATBACK SEA TURTLE (*NATATOR DEPRESSUS*) FROM QUEENSLAND

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Flatback hatchlings are unique in that they are larger than other cheloniid hatchlings and have a restricted pelagic phase. Unlike the other six pan-oceanic sea turtles, the flatback turtle (*Natator depressus*) has a nesting and foraging range restricted to within the Australian continental shelf. Immature stages lack an oceanic stage and remain in Australian continental shelf waters throughout life. Here we characterize the initial in-water behavior (swimming frenzy and postfrenzy) of this species in the lab under natural light-dark cycles. Each hatchling was tethered via a lycra harness to a lever arm that interfaced with a recording mechanism in the center of a pool. The hatchlings were free to swim in any direction but could not touch the pool sides or bottom. Electronics recorded periods of activity and inactivity over time. Flatback hatchlings are strong swimmers. Their frenzy was similar to that described for *Caretta caretta*, *Chelonia mydas*, and *Dermochelys coriacea*, characterized in an earlier study done on the Atlantic coast of Florida, USA. The flatbacks swam vigorously during first night and first daylight period. Post frenzy behavior patterns developed slowly over the following several days as the turtles shifted behavior so activity was predominately diurnal. However, like leatherbacks, some individuals remained active for part of the night. Unlike other cheloniids, they showed no interest in food by the end of their third or fourth day in the water. In this respect they more closely resembled leatherback hatchlings which are also large in size, and emerge with a substantial yolk supply. This is the first systematic study of the initial migratory activity of hatchling *N. depressus*. The form of the frenzy in flatbacks, a species without an oceanic stage, implies that, like some other sea turtle species (*C. caretta*, *C. mydas*, and *D. coriacea*), the primary role of the "frenzy" is to promote rapid dispersal to deeper, offshore water. Comparative studies of hatchling activity during the early phase of migration reveal that different strategies are employed during both the frenzy and postfrenzy phase of migration. The hawksbill (*Eretmochelys imbricata*) in Malaysia, for example, lacks a frenzy whereas the flatback in Australia and other cheloniids studied in Florida swim continuously for the first 24-36 h after they enter the sea. These results suggest that factors shaping behavior during the frenzy and postfrenzy period vary. Those factors are hatchling size, energy stores (yolk supply), swimming speed, and ecology. While we found similarities in the flatback frenzy with that of three other species, we are cautious as there may be no "typical pattern" of frenzy and postfrenzy activity during migration. We are just beginning to appreciate these differences through descriptive studies, all of which suggest that a number of factors (e.g. morphology, ecology, physiology and oceanography) may select for unique activity patterns that differ not only among species, but even among populations within species (see abstract by Madrak *et al*., this volume).

ADVANCES AND OBSTACLES FOR THE CONSERVATION OF THE YUCATAN PENINSULA HAWKSBILL POPULATION – LESSONS LEARNED AND WHY WE SHOULD STILL WORRY

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With few exceptions, hawksbill populations tend to be small and with declining population trends. One of the exceptions has been the population nesting on the Yucatan Peninsula (México). During the 90s the abundance increased steadily and by 1999 reached a maximum of over 6,400 nests, representing about 40% of all reported nests in the Greater Caribbean. The incipient recovery was probably due to decades of protective measures at the national level which included the total ban on sea turtle take in 1990 and in the region with the implementation of similar national legislation and of CITES that significantly curtailed the extraction of this species. Nonetheless, and in spite of continued nesting beach conservation, nestings declined drastically, reaching less than 2,400 between 2000-2004; a 63% drop in barely 5 years. This event prompted urgent attention both within the country and outside. In 2005 a technical meeting of government conservation agencies, academia and NGOs analyzed the information available to identify priority actions. It also highlighted the persistence of serious gaps in knowledge, monitoring capacity and law-enforcement particularly for the hawksbill's life stages in the marine habitats. Over the next two years, greater attention has been directed to studies on the levels of turtle use in the region, satellite tracking of post-nesting hawksbill females, and re-analyses of long-term tagging data. The Interamerican Convention for the Protection and Conservation of Marine Turtles, has also played a key role, recently passing a resolution exhorting Parties to look for synergy between international instruments, monitor use and traffic of hawksbills, and strengthen key research lines. Although important advances have been obtained, adequate knowledge is scanty and new obstacles now include large tourist development that can place at risk the long-term integrity of the breeding environment of the species. This presentation provides a review of the advances, status of the populations nesting in the Yucatan Peninsula and the remaining challenges.

ESTIMATION AND CONSERVATION OF THE SEA TURTLE POPULATION IN MOHELI COMOROS

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The islands of Moheli are considered one of the most important nesting sites of *Chelonia mydas* in the Indian Ocean. The study aims to estimate the population size, assess the threats and needs of this population, and serve to aid in the development and implementation of a national sea turtle recovery plan. By the counting of tracks and tagging since 1999, we estimated the nesting females to be about 6000 per year with more than 16,000 emergences at Moheli Island.

Half of these emergences occur on the beaches of Itsamia village, south east of the Islands. However this population is threatened by hunting (mainly), habitat degradation (sand extraction, sedimentation and general degradation of coral reefs and sea grass beds) and the natural predation of hatchlings. In this action plan, we have developed programmes including Research/monitoring, education/awareness, training, socio-economic alternatives (ecotourism and fishing), law enforcement, and regional co-operation. In each programme a diagnosis of the situation and the specific aims and actions to be developed are discussed. The implementation of the programmes is also considered. In this part we discuss the work plan, costs and the effectiveness evaluation system. The establishment of the Moheli Marine Park in 2001 has been instrumental in the conservation of sea turtles and their habitats. The efforts of local communities in conserving their close natural resources (including sea turtles) are obviously successful. Their participation is an important key for any conservation programmes and should be reinforced. An Integrated approach, taking in to account development and conservation goals, has been highly recommended. Conservation efforts will be successful if we are realistic about demographic constraints and set realistic goals. We have then to be aware that the population recovery will be slow.

THE STATUS OF MARINE TURTLES IN MEDITERRANEAN MOROCCO

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The loggerhead is the most frequent sea turtle species observed along the Moroccan Mediterranean coasts. Records of leatherback and green turtles are more rare. Morocco does not have known sea turtle nesting beaches. The migration of loggerhead turtles between the Atlantic and the Mediterranean must include passage through the Straits of Gibraltar, highlighting the importance of the northwestern Atlantic coast of Morocco, including Tangier. Based on strandings information, reports from fishers and market surveys, the majority of sea turtles that occur in Mediterranean Moroccan waters are juvenile and sub-adult loggerheads. Mortality from fisheries interactions and pollution appears to be relatively small. We also report on other actions being undertaken for sea turtle conservation in Morocco, including education-awareness of fishermen, stimulating regional/international cooperation, and working to strengthen national laws to protect turtles.

TEMPERATURE VARIATION IN GREEN TURTLE (*CHELONIA MYDAS*) NESTS DEPOSITED IN NATURAL BEACH AND ENGINEERED DUNES IN THE ARCHIE CARR NATIONAL WILDLIFE REFUGE

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The Archie Carr National Wildlife Refuge (ACNWR), located on Florida's Indian River coast, experienced severe erosion during the hurricanes in 2004. In 2005, sand from inland quarries was used to restore the dunes to help protect coastal properties along 74% of the refuge. The remaining 26% remained unaltered. The sand also provided increased reproductive habitat for the three species of marine turtles nesting on the refuge. The real extent of restored nesting

habitat is not necessarily the most important factor in restoration; the suitability of physical attributes also determine habitat quality. The physical characteristics of the newly placed sand potentially differ from those of the natural sand. These differences in sand characteristics may alter the incubation environment, affecting the temperatures found within the nests. Temperature is important in sex determination as well as the proper development of incubating eggs. We studied these engineered dune areas one year post construction to determine if any differences in clutch temperatures existed. To determine if temperatures in nests deposited in natural and engineered dune areas varied, temperature data loggers were placed in the center of green turtle clutches on the night of oviposition. Results were analyzed using a one-way ANOVA to determine any variation in mean temperature between the two treatments and how this affects reproductive success (the percentage of eggs that produce hatchlings which emerge from the nest). Florida is one of the United States' major nesting grounds for green turtles. The importance of the ACNWR as a rookery has increased as the number of green turtle nests has risen sharply over the past two decades. As the value of this beach as a marine turtle nesting habitat increases, it is important to maintain attributes that continue to provide a proper incubation environment. It is the stated policy of the National Wildlife Refuge System that, "wildlife comes first." As management of the Carr Refuge beach intensifies, the maintenance of habitat conducive to marine turtle reproduction should assume primacy over coastal development and related issues, if that objective is to be met.

IMPACTS IN THE CONSERVATION OF THE MARINE TURTLES ON THE PART OF FISHING COMMUNITIES WAYúU IN THE GULF OF VENEZUELA

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The indigenous cultures at world-wide level present a series of special characteristics that differentiate them to each other, such as social aspects, Cosmo-vision, language, schemes of life, means of subsistence; and Venezuela does not escape to that reality. In the Gulf of Venezuela (Zulia State) the indigenous culture Wayúu has two important characteristics in its economic and cultural development, as they are it fishery and the marine turtles like symbol of prosperity, wealth, food and medicine. However these reptiles have been taken to a point of risk on the part of man that are considered like species in extinction danger; what entails to the deep revision of the impacts that can originate a proposal of conservation in a community like the Wayúu. Based on the direct observation in field, as well as the interviews made to the inhabitants of the zone (in its majority Indigenous Wayúu) have considered possible measures to avoid the use of these reptiles, so that it is not attempted to his survival, but that goes agreed with the own customs of the ethnic group. Some positions are observed which could be opposite to the conservation of the marine turtles, so and as they settle down in the Venezuelan legislation; in addition to which economically the marine turtles are to pound fundamental of approximately 350 families (single in Venezuela) who use these animals as nutritional and economic sustenance, also are important part within the culture (beliefs magical-religions). Therefore it is necessary that agreed plans of handling with all the reality consider and that is economically profitable as much for the vigilant and/or regulating beings like for the Wayúu

natives. One such sets out the creation of cooperatives fishing with monitoring on the part of fishermen, as well as the cultivation of shrimps and oyster, like economic alternative and ecologically viable throughout the coast of the zone of the Gulf of Venezuela, thus gradually to be improving the population levels of the marine turtles in this important zone of feeding.

CROSSING BORDERS: ATTEMPTS TO ESTABLISH TRANSNATIONAL SEA TURTLE CONSERVATION NETWORKS IN THE MEDITERRANEAN

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It has been suggested by academic research that Environmental Non-Governmental Organisations (ENGOs) can play four primary roles in environmental regimes: (a) mobilizing international public opinion, (b) transnational coalition building, (c) monitoring of states' environmental commitments and (d) advocating precaution and protection of the environment, acting independently of state interests and epistemic communities (Ringius 1997). Such had been the rationale behind the proposals to create two regional networks focusing on the conservation, research and monitoring of sea turtles at the Mediterranean ENGO and inter-governmental level: 'MEDSETCON' –Mediterranean Sea Turtle Conservation Network- (proposed in 1999) and a 'Clearing-House Mechanism for Marine turtle Populations in the Mediterranean' (proposed in 2001). 'A network amplifies and disseminates ideas, research and information to an extent that could not be achieved by individuals or institutions alone' (Stone: 2002:3). Despite initial unanimous endorsement by Mediterranean ENGOs, neither of these proposals displays a foreseeable future, a fact that begs explanation. Based on extensive archival data (draft documents, resolutions passed, email communications, experts' opinion, survey data etc.) we investigate to which extent these failures can be accounted for in terms of ENGOs' differences in (a) available resources –to be committed to this endeavour-, (b) ideology –e.g. 'ecology' vs. 'conservation' positions, 'environment' vs. 'economy' positions and so on- or (c) a mix of both (Dalton, Recchia, and Rohrschneider, 2003; Rohrschneider and Dalton, 2002). Although this is a work in progress, the initial information analysis suggests that the heretofore failure to establish an operational network could be attributed to the variety of capabilities and level of commitment of the actors involved: namely, some ENGOs, albeit willing to participate, lacked both material resources and technical know-how to spearhead these initiatives, while others more affluent and established, lacked the willingness to actively engage in setting up of the network. Issues of ideological differences do not seem to play a prominent role in the outcome, although one cannot dismiss the possibility that lack of previous experience in broad, transnational cooperation (i.e. at the Mediterranean level) is sustained, in a 'loop' fashion, by a culture of ENGO-'particularism', a situation where the actors are more interested or limited to the 'particular' (i.e. national) scope of their work and are unable to function within a broader context. National, piecemeal approaches to sea turtle protection in the Mediterranean are insufficient in initiating, implementing or facilitating comprehensive integrated conservation actions on a regional level.

TURNING THE TIDE OF MARINE TURTLE EXPLOITATION IN THE WIDER CARIBBEAN REGION

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Centuries of over-exploitation have devastated marine turtle populations, causing the near extirpation of some of the largest nesting populations the world has ever known, such as in the Cayman Islands, bringing other nesting and foraging populations to the brink of extinction, and contributing to these species' globally threatened status. Although marine turtles enjoy iconic status in many cultures and sectors and are protected from exploitation in many parts of the world, commercial and artisanal marine turtle fisheries persist – and persist in placing pressure on already depleted populations. Effective conservation necessitates not only effective management of marine turtle exploitation but also effective coordination between range States. In April 2001, TRAFFIC published the results of its investigation of marine turtle exploitation and trade in the northern Caribbean Sea. Following on the findings of this report that turtle meat, eggs and other products in the region continue to serve basic subsistence needs, as well as commercial markets, and that management is complicated and even undermined by a patchwork of regulatory regimes, varying levels of enforcement effort, and generally inadequate conservation investment, the Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) commissioned TRAFFIC International to undertake a complementary study focusing on the Lesser Antilles, Central America, Colombia and Venezuela. The recently published report – Turning the Tide: Exploitation, Trade and Management of Marine Turtles in the Lesser Antilles, Central America, Colombia and Venezuela – reviews exploitation, trade and management of marine turtles in 26 countries and territories, virtually completing analysis of these issues across the Wider Caribbean Region (excluding only the Guianas). In addition to a regional overview and national chapters for each of the jurisdictions examined, the report provides detailed recommendations aimed at bringing marine turtle exploitation in line with the principles and practice of sustainable use, including the FAO Code of Conduct for Responsible Fisheries, optimizing turtle conservation activities in the region, and providing the basis for a concerted effort to develop a unified region-wide approach to management. This report represents the first in-depth regional analysis of marine turtle management, in that it goes beyond the legislative framework to the implications of that framework for the sustainability of marine turtle populations, and to the operational measures being taken by government agencies, NGOs, local communities and other actors to manage exploitation and conserve marine turtle populations. It also details the implications of the management regime in place in one jurisdiction for the marine turtles that spend parts of their lives in other jurisdictions, thus providing further evidence of the need for a multilateral approach to marine turtle management and conservation in the region. The report's comprehensive assessment of management shortcomings and priorities for rectifying these at both national and regional levels is designed to serve as a guiding reference for ongoing deliberations by national and intergovernmental bodies on marine turtle management needs in the region, for many years to come.

A TOOL TO ANALYZE THE THREATS AND IMPACTS ON SEA TURTLES

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This project was developed in four beaches of the Caribbean coast of Costa Rica during the nesting seasons of 2004 and 2005. Tortuguero, Pacuare, Cahuita-Black Beach and Gandoca beaches are important nesting sites for *Dermochelys coriacea*, *Chelonia mydas*, *Eretmochelys imbricata* and *Caretta caretta*. The tool is based on a matrix that included the analysis of four criteria (severity, reach, contribution and irreversibility) applied to each threat or impact. For each criteria the magnitude of the impact was assessed by assigning a score that ranged from very high (5), high (4), medium (3), low (2) or very low (1). This way an impact with little importance could have a minimum qualification of 4 points when assessing all 4 criteria. The impacts used for all beaches were drainage, coastal lightning, trade of sea turtle products, tourism, poaching of nests, hunting of nesting females and beach erosion. Data collected show that in Tortuguero beach the impacts with the highest scores were the hunting of nesting females and beach erosion, while the lowest score was attributed to drainage; the impacts that most contributed to sea turtle mortality were hunting and poaching of nests. In Parismina-Pacuare beach, erosion and nest poaching scored the highest, and drainage the lowest. In this beach the impacts with the highest contribution and reach scores relating to mortality were beach erosion and poaching of nests. The case in Cahuita is very similar to that of Parismina-Pacuare, while in Gandoca tourist behavior and beach erosion were the most important impacts in terms of total score, mainly due to the contribution, reach and severity of these impacts. This tool, which is quickly adapted may be useful in other scenarios where the anthropogenic impacts must be assessed.

STREAMLINING AND IMPROVING THE REPORTING AND MANAGEMENT OF SEA TURTLE STRANDING DATA

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In North Carolina, participants of the Sea Turtle Stranding and Salvage Network (STSSN) collect sea turtle stranding data for the North Carolina Wildlife Resources Commission (NCWRC) that are in turn used by many state and federal managers. Receiving data that are accurate and delivered in a timely manner is crucial to making effective management decisions. In March 2006, we introduced the Sea Turtle Rescue and Necropsy Database (STRAND), an online reporting system hosted by SEATURTLE.ORG, to NC-STSSN participants and encouraged its use. This system allows the complete stranding record to be submitted directly into a database coordinated by the NCWRC within 24 hours of the stranding event. Here we illustrate this system's many features and how STRAND has worked beneficially now that it is in practice. These features include drop-down boxes that eliminate typographical errors and integrated error checking that reduces incomplete data. Reports cannot be submitted when certain fields are left blank, and therefore the total number of stranding reports with missing notes and/or tagging information (two of the most common mistakes) has been greatly reduced. A photo upload option provides thumbnails embedded into the report making it much easier to

associate the data with a photo and managers can quickly verify species, wounds, or other characteristics. Perhaps the most useful tools are the latitude/longitude converter and mapping graphic. With these tools, every entered stranding receives a geographic location in standard decimal degrees format, which can be verified with satellite maps to ensure the coordinates entered match the location description. This feature alone has greatly helped save time and increase accuracy. In addition, reports, graphs, and photos are generated that are available to the general public who seek data and information on sea turtle strandings in North Carolina. This system can serve as a model for other programs that may benefit from a similar on-line reporting scheme. An unexpected problem has been encouraging participants to use the new technology. A total of 314 strandings were reported by 101 individuals from March through December 2006. Of these, 64 were entered directly into the system by the original data collector. The remaining 250 strandings were submitted to and entered by the state coordinator. Continually encouraging its use and providing training on how to use STRAND may help increase participation. Working with volunteers that have tried out the system will help make it more user-friendly and efficient. In the future we hope to make the database capable of multiple queries and producing graphs and tables for very specific subsets of the data. As the system develops and becomes more widely used among STSSN participants, STRAND will prove to be a useful tool providing the most up-to-date and accurate data for managers.

PULLING WEEDS FOR LEATHERBACKS:AN EXPERIMENTAL TEST OF INVASIVE BEACH PLANT REMOVAL ON (*DERMOCHELYS CORIACEA*) NEST PRODUCTIVITY

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Invasion of sea turtle nests by plant roots has been documented in most species. However, this is the first known study to document and record the effects of plant roots in leatherback nests. Roots dehydrate eggs and trap hatchlings. Hatchlings emerging from the nests may be trapped in the vine networks so they do not reach the water. From May to July 2006, we investigated the effects of beach vegetation on the nest environment and leatherback productivity rates, at Sandy Point Wildlife Refuge in St. Croix, USVI. Nest productivity was defined as hatching and emergence success rates. Thirty-five nests were relocated to two pairs of replicated experimental plots (two with undisturbed vegetation and two with vegetation mechanically removed prior to the start of relocation, VG and VR, respectively) and a control plot that was free of vegetation at the start of the nesting season. No plant removal occurred after nesting season started so plants growing seaward could invade nests. Before and during incubation, water table and rainfall were measured at the sites to assess potential moisture. Entire clutches were caught during oviposition and randomly assigned to each of the plots. The eggs were then left to incubate undisturbed until the nest hatched. After emergence, we excavated the nests, and surveyed the nest contents. Overall, the VG and VR sites differed in detail in hatching and emergence success but did not differ overall from the control. Three of the 35 nests did not hatch, one in each plot type. Two of these clutches were in the experimental plots and were thoroughly invaded by roots. Root invasion occurred in 13 of 13 nests at the VG plots, 14 of 14 nests at the VR plots, and 5 of 8 nests at the CONT plot. Emerged hatchlings from several nests in VG and VR plots became entangled by the roots in the nests and or the vines on the beach surface. The similar productivity of the treated plots, control plot, and nests relocated outside of the experimental plot free of vegetation, suggest that mechanical removal of the vegetation may

be a viable solution for the spread of vegetation throughout the leatherback-nesting environment. However, removal of plants before the nesting season and relocations was not sufficient to protect the clutches. Regular maintenance is needed to control vegetation throughout the incubation period.

THE FORGOTTEN HURRICANE EFFECT: A SUMMARY OF FLORIDA SEA TURTLE DISORIENTATION FOLLOWING THE 2004 ATLANTIC HURRICANE SEASON

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As the lead agency for protection of marine turtles in Florida, staff in the Florida Fish & Wildlife Conservation Commission (FWC) must review and issue permits approving all activities involving marine turtles, their nests, or hatchlings. This includes oversight of permitted individuals conducting sea turtle nesting surveys along approximately 1300km of beach each year. In addition to the nesting data collected, permit holders also report sea turtle disorientation data. During the 2004 nesting season, Florida experienced elevated hurricane activity with direct impacts from 4 major storms. Immediate impacts from the storm included nest loss due to inundation or erosion, accretion of sand atop of nests, decreased hatching success, and loss of nesting habitat due to erosion. Lingering effects included damage to the beach and dune environments resulting in a variety of problems for nesting and emergent sea turtles. Persistent erosion resulted in less suitable nesting habitat for female turtles. Loss of and damage to both dune vegetation and habitable structures increased the number of lights visible from the beach and complicated sea-finding behavior. Emergency dune reconstruction and sand placement with gentle slopes allowed physical access to areas previously unattainable to both nesting and hatching sea turtles. During the 2005 nesting season, several hurricane-impacted counties along the east coast of Florida documented increased sea turtle disorientation events when compared with the previous 10-year county averages. However, several hurricane-impacted counties along the west coast and panhandle of Florida reported fewer sea turtle disorientation events when compared with the previous 10-year county averages. Statewide there was an increase in the number of disorientation events, as well as an increase in the number of both hatchlings and adults being disoriented, despite less overall nesting.

STRENGTHENING SEA TURTLE CONSERVATION ON THE BAJA CALIFORNIA PENINSULA: BUILDING A CONSERVATION NETWORK

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The Grupo Tortuguero works with local communities to recover migratory sea turtle species and reverse declines of diversity, complexity and connectivity of ocean basins. The objectives of this project are: 1) to build a diverse network of fishermen, students, teachers, activists, researchers, funders, managers, indigenous community members and other coastal citizens.; 2) draw on these relationships to understand threats, generate new knowledge and develop locally-appropriate solutions and 3) empower local leaders to communicate the conservation message and share these solutions widely. It is our objective to build a diverse network and through that network facilitate the development of conservation leaders. We build and strengthen our conservation network through technical training and leadership development at biannual group meetings, offering connectivity grants to individuals throughout our network, and conducting international exchanges. Annual Meetings: Each year the Grupo Tortuguero holds a conference in Mexico for all members, collaborators and the general public. This meeting has grown from 45 in 1999 to 350 in 2006! Participants share data and ideas, develop regional strategies, and learn leadership skills. The purpose of the meeting is to foster collaborative efforts between researchers, community members, enforcement officers, and regional conservation organizations. Most importantly, conservation strategies are debated and developed, and critical personal relationships are formed and renewed. The annual monitoring meeting is a time for monitoring teams throughout the network to come together and celebrate the work they are doing to preserve the region's sea turtles. This meeting focuses exclusively on monitoring, and therefore is open only to community monitoring teams and their partners. This meeting gives team members a chance to focus on their work, sharing their data, experiences and lessons learned. Connectivity Grants: We offer connectivity grants to support individuals from communities throughout the network to travel to and work with other communities. Through connectivity grants we are able to send individuals to experience the work being done in different communities, giving them the opportunity to learn from, as well as teach, others working to save sea turtles in the Eastern Pacific. Connectivity grants strengthen the human connections that create the conservation network as well as the work being done on the ground within the communities through the exchange of vital information and experiences. International Exchanges: Understanding the transpacific migrations of endangered sea turtles and the importance of community based projects for the global conservation of sea turtles is critical to building awareness and stimulating local and international conservation efforts. Ander these premises, we have carried out a program designed to establish cultural connections and common perceptions for local and international conservation with a social, economic and ecological vision. This program involves individuals from five nations, representing various sectors, dedicated to better understanding community conservation practices and forming an international conservation vision.

BLACK SEA TURTLE CONSERVATION IN MICHOACAN: CONSERVATION BASED IN COMMUNITY

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Since 1982 the University of Michoacan has carried out black sea turtle conservation activities in Michoacan, Mexico. During the last five years we have observed a small increase in the nesting activities of turtles in Colola. We present the results of conservation activities in Colola for the last five years and include an analysis of community participation in these activities.

OLIVE RIDLEY SEA TURTLE COMMUNITY CONSERVATION ON CHENNAI COAST INDIA

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This paper illustrates our efforts for conservation of olive ridley sea turtles by involving the fishermen community dwelling on the beach side fishing villages in Chennai, India. The coast of Chennai is the nesting site of the endangered olive ridley sea turtles. The nesting beaches of the fishing villages, such as, Periya Neelangarai, Injambakkam, Panaiyur, Nainar kuppam - Uthandi and Reddy Kuppam – Kanathur are patrolled by the youth of the fishing community of respective villages. They have been initiated by Tree Foundation from the year 2002 to protect, relocate the eggs and release the hatchlings in the sea on a volunteer basis. These volunteers are known as the “KADAL AAMAI PADHUKAVALRGALL” (SEA TURTLE PROTECTION FORCE). This initiation of community conservation of olive ridley sea turtles has progressed in the last four years from the protection of 27 nests to 90 nests and releasing of 2222 hatchlings to 8821 hatchlings. Also in the year 2006 there was no illegal poaching of eggs and no loss of nests to predators. This paper also elucidates the methods of motivation adopted to spread the awareness of the role and importance of the sea turtles in the coastal marine bio-diversity. The main programs conducted for educating the fishing community are - one day environmental education workshops for the youth and children at zoos, sanctuaries, etc., slide shows, (in the fishing villages and at 11 Panchayat, Aided and Private Schools along the East Coast Road covering 10,062 children), sand model competitions, street plays, puppet shows, peace rallies, the Pungamiya plantation for bio-diesel project, youth workshops to form men self-help groups, sea turtle awareness programs for the trawl boat and mechanized fishing community at the Kasimedu fishing harbour. MEASURABLE SOCIAL IMPACT • More than 6000 fisher folks of the five villages made to understand the role of the turtle in the coastal marine bio diversity • 13 fishing villages covered in awareness programmes • Around 422 youth volunteering as KAP members • All the children in the above fishing villages have stopped playing Cricket with the turtle eggs which used to be their earlier pass time • The Wildlife Wing of the forest Department’s joint Program with TREE Foundation’s KAP (Sea Turtle Protection Force) in 2005-2006, increased awareness among the fishing community. I would like to thank the ISTS for accommodation and the Ford Foundation for their financial support to attend the symposium

SEA TURTLE MONITORING AND CONSERVATION IN THE WEST AFRICA MARINE ECO-REGION

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Six species have been confirmed in the waters of Wamer (West Africa Marine Eco-Region): *Caretta caretta*, *Eretmochelys imbricata*, *Dermochelys coriacea*, *Chelonia mydas*, *Lepidochelys kempii* and *L. olivacea*. The area covers the five coastal states of Senegal, Cap Vert, Mauritania, Gambia, Guinea Bissau and Guinea Conakry. This ecoregion is biologically very rich in marine animal-life. It is characterized by: Zones of world importance for the nesting of green and loggerhead sea turtles; Zones of significant feeding and juvenile development for sea turtles; The convergence of important migration corridors, particularly for loggerheads, green turtles and leatherbacks. However, in spite of the richness of the region, the state of conservation of the marine turtles of the area is considered to be unfavourable, due to damage and disturbance to the nesting sites, and to the capture of individuals for consumption and traditional use by the local population. Since 2002 a vast conservation plan for the marine turtles of the area was initiated by the following organizations: WWF, UICN and the FIBA, in accordance with the Memorandum of Understanding on the conservation of marine turtles along the Atlantic coast of Africa (CMS, Abidjan 1999), which encourages the establishment of regional, national and local-scale projects. The major objective of this plan is to improve the state of conservation of the marine turtles in the area. Since its launching several activities have been undertaken, in order to assess the distribution of these species, raise awareness among the local fishermen, and strengthen the conservation capacities of the actors in the field (including non-governmental organisations and other official institutions qualified in this field). The activities of this programme are expected to continue for five years (2002 – 2007).

THE INTEGRATED APPROACH OF GOVERNMENT, PRIVATE ORGANIZATIONS, AND INDIVIDUALS TO FACILITATE SUCCESSFUL REHABILITATION OF SEA TURTLES IN THE CHESAPEAKE BAY

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The Chesapeake Bay is an important foraging ground for juvenile sea turtles, with some studies suggesting site fidelity. Since 1990, the Maryland Department of Natural Resources (MDNR) and the National Aquarium in Baltimore (NAIB) have worked cooperatively to respond to sea turtle strandings within Maryland waters, including the Chesapeake Bay. MDNR responds primarily to dead sea turtle strandings, while NAIB responds to and rehabilitates live sea turtles. In addition to strandings, in 2001 MDNR implemented a sea turtle tagging and health assessment study in the Maryland portion of the Chesapeake Bay. Working cooperatively with local watermen, sea turtles incidentally caught in pound nets, a type of passive, stationary fishing gear used to catch finfish, are photographed, measured, weighed, sampled for tissue and blood, tagged (flipper and PIT), and released. MDNR maintains a positive relationship with

local watermen to assess and monitor sea turtle populations within Maryland waters. Few live sea turtle entanglements in commercial or recreational fishing gear have been documented in the Maryland waters since 1990, but during the summer of 2006 two sea turtles were reported through MDNR's pound net project showing trauma from recreational fishing-related injuries. The injuries were not associated with incidental capture in the pound net, but occurred prior to the animals entering the net. On June 7, 2006 an underweight Kemp's Ridley sea turtle (*Lepidochelys kempii*) measuring 13.0 kg and 45.7 cm (notch to tip curved carapace length (ccl)) was caught. MDNR staff identified monofilament fishing line trailing from the mouth, with a presumed esophageal fishhook. The monofilament line extending from the mouth had caused severe ulceration and injury to oral mucosa and muscle. MDNR staff attempted extraction of the fishhook with the dehooking kit issued by the National Marine Fisheries Service (NMFS) but were unable to remove the hook. The animal was transported to NAIB, where medical staff were able to successfully remove the hook using a combination of the NMFS dehooking equipment and endoscopy. The animal underwent three months of rehabilitation to allow wound healing and weight gain, and was equipped with a satellite tag and released on September 8, 2006. On July 27, 2006, an underweight loggerhead sea turtle (*Caretta caretta*) measuring 49.0 kg and 80.6 cm (ccl), was incidentally captured, and recreational fishing line was found entangled and constricted around the right front flipper, nearly severing the flipper mid-humerus. The animal was transported to NAIB, where a successful amputation of the flipper was performed. At the time of submission of this abstract, the animal is still at NAIB for long-term rehabilitation. If the animal is successfully rehabilitated, it will be released with a satellite tag for long term follow-up. These two case studies reflect how positive cooperative relationships between local watermen, private stranding facilities, and governmental agencies to efficiently respond to, rehabilitate, and release entangled sea turtles in Maryland.

A SPATIAL DATABASE OF SEA TURTLE NESTING HABITAT FOR THE WIDER CARIBBEAN REGION

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Caribbean sea turtles need unobstructed sandy beaches for egg-laying, healthy marine and coastal ecosystems for foraging, and safe passage through migratory corridors. Identifying, characterizing, and evaluating sea turtle habitat use over large geographic landscapes is central to the successful management and restoration of migratory populations. Two recent treaties in the Wider Caribbean Region (WCR) mandate that Parties collaborate in collecting these data and in managing shared populations, all of which have declined dramatically in the past 200 years. In support of this mandate, we conducted the first regional assessment of primary nesting habitat for all six Caribbean species. To gather baseline data we distributed questionnaires to primary data gatherers, including managers, researchers and conservationists, in more than 40 countries and territories and conducted a thorough literature review. Data providers identified the most important nesting sites for each species, and provided site information including: name, location, species nesting, annual number of crawls per species (binned as 1000), and monitoring status. A confidence level (high, moderate, low) determined by the date the data were collected, the nature of the monitoring effort, and the data source(s) was assigned to each

nesting site. The data were assembled in an Excel database and represented spatially in several ArcGIS shapefiles. To date we have identified more than 750 discrete nesting sites (representing over 1300 species-specific nesting sites) from nearly every country and territory in the WCR. This unprecedented dataset has enabled the first comprehensive analysis of the distribution of critical nesting habitat in the Central Western Atlantic region, and revealed a number of important data gaps and opportunities for future study. Among the results is the finding that nearly half of all identified nesting sites support fewer than 25 crawls per species per year. In the case of Critically Endangered (cf. IUCN Redlist) hawksbill turtle, ca. 75% of all nesting sites associated with known crawl abundances support fewer than 25 crawls per year and 90% support fewer than 100 crawls/yr (less than 1% support 500 or more crawls/yr). Another important finding is that an annual crawl abundance could not be estimated for one-third of the more than 1300 species-specific nesting sites identified. As these sites are among the best known in the WCR, this implies that many areas still lack the necessary resources (financial, human, logistical, political) to support basic population monitoring, a reality with significant implications for evaluating national and regional population recovery efforts. The database will be maintained and updated by the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). Follow-up efforts will collect data on critical foraging areas and migration routes. In assembling a spatial landscape of high use habitats in the WCR, the project offers valuable tools to support the management of regional sea turtle populations, identifies gaps and opportunities for future data collection, provides a foundation for the designation of a regional network of "index sites" for population monitoring, and contributes a template for other regions to follow.

SECOND YEAR IN A CONTINUING STUDY OF MARINE TURTLE NESTING ACTIVITY AND REPRODUCTIVE SUCCESS IN AREAS OF GEOTEXTILE TUBE INSTALLATIONS; BREVARD COUNTY, FL, 2006

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In 2004, Florida's east coast was directly impacted by two major hurricanes. The harsh winds and high surf severely eroded the dunes, causing massive destruction of beach front properties. One of the affected beaches was the Archie Carr National Wildlife Refuge (ACNWR) in Brevard County, FL. Since the establishment of the ACNWR in 1990, no armoring (sea walls, groins, or other man-made structures) has been permitted. However, in response to the extensive damage caused by the hurricanes, emergency permitting allowed for the installation of large, sand-filled geotextile tubes in four areas of beach within the boundaries of the ACNWR. The ACNWR is a globally significant nesting beach for three species of marine turtles: green turtles (*Chelonia mydas*), loggerheads (*Caretta caretta*), and leatherbacks (*Dermochelys coriacea*). Because of the importance of this beach, justifiable concerns regarding the possible interactions between marine turtles and geotextile tubes arose on the part of agency officials and marine turtle conservationists at several levels. Special conditions for the installation and maintenance of the tubes were agreed to in an Order of Delegation entered into by Brevard County and Florida Fish and Wildlife Conservation Commission (FWC) and mandated through FWC permits. This study, now in its second year, is a continuing examination of the interaction with marine turtles at the four tube installation sites. Comparisons were made by combining nesting season data collected in 2005 and 2006 and comparing them to control nests using parametric

statistical tests. Control nests are the randomly selected nests that are assessed annually in Brevard for the Index Nesting Beach Program (INBS).

JUVENILE GREEN TURTLES AS A FLAGSHIP SPECIES: STARTING POINT FOR THE FIRST MARINE PROTECTED AREA IN URUGUAY

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From 1999, the organization Karumbé has worked throughout the coast of Uruguay to increase knowledge on the biology, ecology and conservation status of the juvenile green turtle (*Chelonia mydas*). The coastal-marine area of Cerro Verde in the Rocha state (33 º 56 ' S; 53 º 30 W), was highlighted as a region of great importance and diversity of critical habitats for this species. During its juvenile stage *C. mydas* utilize this coastal and insular ecosystem as a developmental and foraging ground. The area presents a great diversity of species (algae, invertebrates, fishes, marine birds, whales, dolphins and sea lions, among others) of interest for its conservation and which also play a significant role for this ecosystem. The green turtle has been adopted as a flagship species selected to act as an ambassador, for this habitat. By focusing on, and achieving conservation of sea turtles, the status of many other species which share its habitat may also be improved. The success reached with this flagship species, constituted the baseline for the development of new projects and studies on other species with the same characteristics (*Tursiops truncatus*, *Eubalaena australis*, *Pontoporia blainvillei*, *Sterna* sp.). The Cerro Verde area has suffered a constant degradation per decades, principally for the use and inadequate development of the coastal zone, illegal fishing, overexploitation of the marine resources, vehicle transit along the coastal fringe, pollution by trash waste and toxic tributaries from agriculture and tourist development without any kind of management and control. From 2004, Karumbé and other organizations started to promote the incorporation of the Cerro Verde area (2000 coastal hectares and 7000 marine hectares) within the National System of Protected Areas (SNAP). Finally in the year 2006 the Cerro Verde area was presented as the first Coastal-Marine Protected Area of Uruguay (CMPA) before the National Commission Advisors of the SNAP under the category "Habitat/Species Management Area" described by the Decree 52/2005 (Regulation of the Law 17.234). The creation of this first CMPA, the development of an effective management plan the future integration of other marine areas to the SNAP, are the first steps towards the reduction of the present threats in the most important developmental and foraging habitats for the green turtles in Uruguay.

THE NEW RED LIGHT DISTRICT: FIELD TESTING NEW LIGHTING TECHNOLOGY AND LIGHT MANAGEMENT TECHNIQUES IN SARASOTA COUNTY, FLORIDA

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New lighting technology and light management solutions are being field tested in Sarasota County in an effort to reduce the negative impacts of artificial lighting on marine turtles. Each project or application provides an opportunity to determine and improve efficiency and effectiveness of light management techniques. In 1997 Sarasota County adopted a Marine

Turtle Protection Code providing lighting standards for new and existing coastal development and publicly-owned lighting adjacent to important nesting habitat. While lighting standards guide the property owner to compliance, the standards do not provide solutions for all situations where lighting necessary for public safety is difficult to shield, and lighting replacement may be cost prohibitive or lacking in suitable options. Several scientific studies have demonstrated that the spectral properties of specific light sources have varying degrees of impact on marine turtle species. The Florida Marine Research Institute Technical Reports, "Understanding, Assessing and Resolving Light-Pollution Problems on Sea Turtle Nesting Beaches" (Witherington & Martin 2000) indicates that long-wavelength light sources (low-pressure sodium vapor, red light-emitting diode (LED) lighting, true neon, etc.) are far preferable to short-wavelength light (high pressure sodium vapor, mercury-vapor, metal-halide, fluorescent, etc.). Acknowledging that there is no "turtle-friendly" artificial light source, Sarasota County staff have pursued best available technology and light management techniques involving long-wavelength light sources. Monochromatic light filters, monochromatic coated lamps, and red LED light sources are utilized to address coastal lighting that provide for pedestrian safety and vehicular ingress, egress and parking in close proximity to sea turtle nesting beaches. Each project or application has been measured for performance, some revealing more success than others. LITERATURE CITED

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THE PRESENCE OF SEA TURTLES IN THE PREVIOUSLY UNEXPLORED ISLANDS OF TRISTAO AND ALCATRAZ, GUINEA

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The Tristao Islands are an estuarine complex formed by the delta of the Kogon river in northern Guinea, near the border with Guinea-Bissau. Five islands form this archipelago, including the large island of Katrack, which is bordered by mangroves and has a 20 km long beach. The only other island with some beach is the smaller Kapken Island. This area was designated as a Ramsar site in 1992, and supports a rich biodiversity that has not been well studied. So far, no study on sea turtles had been undertaken on these islands. The present study did not confirmed nesting by loggerheads in this area even though it has been reported by the local people. Hawksbills nest on Katrack and occasionally on Kapken. Meat and eggs are consumed by the local villagers. Strandings of adult and subadult green turtles are common on the beach of Katrack. Kakriti and Katimiri (localities of Katrack) would constitute possible developmental areas for hawksbills and greens. The small island of Alcatraz called "Island of the Birds", also classified as a Ramsar site, is not a nesting area, but turtles are found in its waters.

USE OF MICROSATELITTE MARKERS FOR ASSIGNING KEMP'S RIDLEY NESTING FEMALES TO UNKNOWN NESTS ON THE TEXAS COAST

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There has been a significant increase in nesting by Kemps ridley sea turtles at Padre Island (PI) and nearby beaches in Texas. This is in part the result of a long-term experimental program that involved “imprinting” hatchlings on PI that had been hatched from eggs relocated from the main nesting beach at Rancho Nuevo, Mexico. Since 1995, the number of nests recorded in Texas increased from 4 to a record of 102 in 2006. Although nests are identified and monitored in Texas, it has not been possible to observe and tag each Kemp’s ridley nesting along the extensive stretch of coastline. It is unclear how many nests were laid by the same female turtles, and this information is important to obtaining accurate estimate of the annual numbers of females nesting. We explore using a genetic approach to inferring the number of individual nesters from genotypes determined from dead embryos and hatchlings sampled from clutches laid in Texas. We have developed and optimized 9 microsatelitte loci for Kemp’s ridleys to match genotypes for nesters and offspring of unknown parentage. We evaluate whether microsatellites are a useful tool in determining how many females are nesting in Texas. Results will be used to address management questions regarding abundance of nesting females.

CAN WE IMPROVE OUR CONSERVATION BANG FOR THE BUCK?

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Given that conservation actions are costly and society has limited resources to devote to sea turtle recovery, an important question is which actions can deliver the greatest impact for the lowest cost. An approach that can shed light on this question is cost-effectiveness, which uses a biological metric to measure the benefits of conservation actions, and an economic one to measure costs. The cost-effectiveness approach prioritizes those actions that have the greatest biological impact for a given level of economic cost. We use a matrix model framework to simulate changes in the population growth rate (lamda) from various Pacific leatherback conservation actions (compared to a baseline with no action). The “bang for the buck” of conservation actions is measured as the ratio of the biological impact (measured by a change in lamda) to the economic cost of the action. We consider various Pacific leatherback conservation actions, including nest protection in the Western Pacific, time-area fishery closures in California, and longline gear innovation. Cost estimates for the conservation actions were derived through field visits and interviews and fishery data. For each action, we generate a long-term (>15 years) population time-series and calculate the present value of conservation costs over the same period. We find that incorporating costs into the decision model prioritizes different conservation actions than if we considered biological impacts alone, and that a given rate of population growth can be achieved at a lower cost. Using cost information in conservation decisions thus has the potential to improve our performance and free up resources for other important conservation priorities.

EFFECTS OF HURRICANES ON SEA TURTLE NESTS ON COZUMEL ISLAND, MEXICAN CARIBBEAN: BEACH VARIABILITY

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Cozumel Island is one of the most important sea turtle nesting areas of the Mexican Caribbean. Loggerheads (*Caretta caretta*) and green turtles (*Chelonia mydas*) nest on the island. Almost 20 km of nesting beaches (8 km of them within a Marine National Park) have been protected by the local and Federal governments for about 20 years. This portion of the eastern coast, were turtles nests are monitored, is divided in 11 beaches which have different lengths, morphology and nesting activity. The northern half of the Caribbean coast of the Yucatán Peninsula, where Cozumel Island is located, is the area most frequently struck by hurricanes in México. The year 2005 had an atypically good turtle nesting season, with the greatest amount of nests registered in 15 years (n=1987). Paradoxically, it also had a severe hurricane season, with two strong hurricanes Emily (July 16th) and Wilma (October 21st), the most powerful hurricane ever registered in the Atlantic, hitting the island. Both hurricanes occurred during the nesting season, affecting nests directly (because of tide, waves and sand erosion) and indirectly (due to exposure to sun and predators). We assessed the effects of the hurricane Emily on sea turtle nests on Cozumel Island, considering the variability between the different beaches. We located and marked sea turtle nests on the 11 beaches before the hurricane impact. After the hurricane we measured nest survival and evaluated hatchling success and predation rates. We found that some beaches had significantly more clutches than others (*Caretta caretta* chi-square=103.2, p*Chelonia mydas* chi-square=850.9, pF = 1.33; p = 0.28). Predation rates were affected by hurricane impact. We assessed beach characteristics that may have influenced these patterns. These results are useful to direct conservation efforts and resources to the most vulnerable beaches, resulting in a more efficient use of resources and a more effective protection of these species on the island. The presentation of this study has been made available through generous donations by the following organizations: Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service.

MOVING FORWARD IN THE RESEARCH AND CONSERVATION EFFORTS OF THE MOST IMPORTANT LEATHERBACK TURTLE NESTING BEACHES IN THE VENEZUELAN MAINLAND

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The most important sea turtle nesting populations in Venezuela are found on some islands such as Aves Island Wildlife Refuge, Los Roques Archipelago National Park, Margarita, and Coche, and on the mainland, in the Paria Peninsula, close to the large nesting populations of Trinidad and Tobago. The most important nesting sites monitored since 2000 during the reproductive season in the Paria Peninsula are Cipara Beach (62º42'W, 10º45'N) and Querepare Beach (62º52'W, 10º42'N), where the key species is the leatherback turtle (*Dermochelys coriacea*) and there are few turtles of other three species, mainly the loggerhead turtle (*Caretta caretta*). Female leatherback turtles were tagged with metal and PIT tags, whereas the Cheloniidae species only received metal tags. Curved carapace measurements (CL and CW), general condition, presence of tag scars, date and time of the observations, including the translocation of nests to a protected hatchery are registered on standard data sheets. The translocation of nests is needed to protect them from poaching. Daily censuses were made to estimate the total number of reproductive events. The field work was conducted between March 15th and August 31st. In 2006, for the first time since 2000, the number of one hundred females between both beaches was exceeded: a total of 128 leatherback females were tagged. Recaptures were observed again, as well as movement of females between Cipara and Querepare Beaches plus other nesting areas in the northern and southern Paria Peninsula and Trinidad. Over 12,000 leatherback turtle hatchlings were released, an important increase in comparison with the previous record of more than 10,000 hatchlings. It must be noted that storm activity was reduced with respect to last year. Field project activities were conducted under scientific permits from the Environmental Ministry (MINAMB). The biological information indicates that there are no other sea turtle nesting populations of this size on mainland Venezuela. If more data would be available from the projects carried out on Margarita and Coche Islands, it would be possible to determine whether Cipara and Querepare are the most important leatherback turtle nesting beaches in Venezuela. To accomplish the goals of public awareness and training of local communities for a better engagement toward sea turtle protection, stronger efforts were made in the area. Activities included the first Workshop of Sea Turtles and Ecotourism held in Querepare Beach with the assistance of an international guest from Nature Seekers Incorporated (Trinidad). Over 20 lectures were made in public and private elementary schools and for military personnel. A Workshop on sea turtles for teachers of the Arismendi Municipality area was held to validate an educative guide about sea turtles.

RESOURCE ALLOCATION - SPLITTING THE TURTLE

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Most sea turtle populations throughout the globe suffer from a variety of threatening processes, many of which are difficult to manage or eliminate. Moreover, it is becoming increasingly apparent that management actions need to be developed at a multi-disciplinary level and be at ecologically relevant scales. The northern Great Barrier Reef green turtle population is one of the largest in the world, yet recent research is showing some worrying signs. This population is subject to several threatening processes that occur at various spatial and temporal scales. In particular the population, regarded locally as a fishery, is exposed to both legal traditional (Australia and south Pacific nations) and commercial (PNG and Indonesia) hunting throughout much of its range. One recently proposed management strategy for the nGBR green turtle population is the development of Total Allowable Catch "quotas" for the Torres Strait region. In this project we conducted comprehensive literature and interview based surveys to assess, and quantify all known "post juvenile recruitment" threats to the population. We then developed a matrix to examine these threats for potential management actions, the economic and social costs of managing each threat and the likelihood of success. Based on this matrix we found that TACs have the potential to place a disproportionate share of the costs associated with management on communities, and could lead to conflict between communities as TACs are negotiated – especially in light of the poor knowledge of population status.

HOW CAN MONITORING OF HATCHING SUCCESS GUIDE SEA TURTLE MANAGEMENT?

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Natural green turtle hatching success and hatchling production data have been collected at Tortuguero, Costa Rica on an annual basis since 1998. We analyzed these data to determine if monitoring of hatching success can inform conservation strategies and help managers choose between activities such as nest relocation and/or focused beach patrols by park rangers. To determine which variables influence green turtle hatching success and hatchling production, we analyzed data from a sample of 1,416 green turtle nests laid 1998-2005. Hatching success averaged 63.5% and average emerging success was 61.2%. While this is higher than recorded in previous studies at Tortuguero (42.0%-57.8%), and our estimate is within the observed range from other nesting beaches, it is slightly lower than the average reported for rookeries bordering the Atlantic (n=6, 71.5%), Indian (n=3, 71.2%) and Pacific (n=12, 73.6%) Oceans. We used the number of hatched eggs as the response variable, and year, Julian date, beach zone, distance to the vegetation, distance to the high tide line and mile were used as potential cofactors in a GAM model. Only year, Julian date and beach zone had significant effects. It seems nests laid early during the nesting season produced fewer hatched eggs than nests laid later in the year. The model accounted for only 7% of the observed variance. Interannual variation in average hatchling production could be caused by variation in rainfall, beach dynamics and nest density. As neither distance to the vegetation, distance to the high tide line or mile had significant effects, we conclude that nest relocation is inappropriate as a conservation strategy at Tortuguero. Graphically plotting illegal take along the northern five miles of nesting beach,

however, indicates that the rates of illegal take are highest around Tortuguero village. Increased patrols by park rangers or local turtle spotters along this 800 m section of beach may help reduce illegal take of green turtle eggs. We conclude that monitoring of hatching success is crucial for guiding nesting beach management strategies at Tortuguero and other sea turtle nesting beaches. The alternatives, to base management decisions on default practices or analyses of data from other nesting beaches, may result in suboptimal conservation actions and investments. We also suggest monitoring at Tortuguero should be extended to include nests laid during the entire nesting season from June until the end of October. Acknowledgments: We gratefully acknowledge the hard work of all the Research Assistants and program participants who helped with the data collection, and the continuing support of the Ministry of Environment and Energy of Costa Rica, especially the park rangers at Tortuguero National Park. AH thanks the Caribbean Conservation Corporation and all the other donors through the Symposium Travel Committee for travel support to participate in the symposium.

PASTA: "BIG PICTURE" COLLABORATIVE SCIENCE TO ADDRESS THE CAUSES OF SEA TURTLE POPULATION CHANGE

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In 2005 and 2006, we convened a working group of sea turtle biologists, modelers, oceanographers, and fishery scientists to discuss why populations of leatherbacks and loggerheads appear to have ocean basin-wide population changes that are different in the Atlantic and Pacific. "PASTA" – the Pacific-Atlantic Sea Turtle Assessment – has resulted in important data synthesis and evaluation of stressors that reveal critical differences among sea turtle populations. The contrast between Atlantic (stable or increasing) and Pacific (generally decreasing) is most striking for leatherbacks, and there is evidence of correlation among nesting sites. Our project addresses three primary questions: a) Why are the status and trends of northern loggerhead and leatherback turtle populations different in the Pacific and Atlantic? b) What are the relative impacts of key stressors on these populations? and c) What are critical data gaps that need to be addressed by science and management? Our emphasis is on broad scale impacts and trends in direct harvest, nesting beach development, coastal fisheries, pelagic fisheries, and climate change that may affect foraging grounds. Our products include GIS maps, life cycle models and dispersal models. While the causes of population decline (and increase) are multiple and interacting, our analyses of stressors in the north Atlantic and north Pacific have allowed us to generate testable hypotheses about the relative roles of each through time. Differences in the life history strategies of the two species in each ocean basin may be contributing to their response to climate change and fisheries. By combining a wide range of expertise from a variety of disciplines, we have been exposed to new ways of thinking about human and natural impacts on sea turtle populations. Most importantly, our workshops have promoted interdisciplinary networking among our attendees, a desirable result that will benefit sea turtle research and conservation in the future.

CHANGES TO ARMORING AND OTHER BARRIERS TO SEA TURTLE NESTING FOLLOWING SEVERE HURRICANES STRIKING FLORIDA BEACHES

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Florida (USA) beaches host one of the two largest loggerhead nesting assemblages in the world, the second largest group of nesting green turtles in the wider Caribbean, and regionally significant numbers of nesting leatherbacks. Although a large part of the Florida coastline is sandy beach suitable for sea turtle nesting, there are lengthy stretches with coastal armoring and other barriers. We defined barriers to nesting as structures that would prevent access to a portion of beach where nesting could occur. The vast majority of these structures were constructed by humans to protect buildings threatened by erosion (e.g., armoring), to allow human access to the beach (dune cross-overs), to keep aeolian transport of sand on the beach away from the dune (sand fencing), to defend property lines (other fencing), and to serve other needs such as recreation. Many of these structures are large, dense, and relatively permanent (e.g., concrete and rock), but may be covered and uncovered by the extensive sand movement from hurricanes. Other structures are less permanent and can be washed away by hurricane storm surge. Many categories of structures are built and re-built by property owners as a response to erosion near buildings constructed on the dunes. The purpose of this study was to measure changes in the linear extent of barriers to nesting following four major hurricanes striking Florida in 2004. Pre-hurricane measurements were made April 2001 to May 2002 in four regions of Florida: northeast, southeast, northwest, and southwest. We randomly selected 16 km in each region to be surveyed, for a total of 64 km throughout the four regions. We determined the position and extent of barriers using a differentially corrected global positioning system (GPS). In 2004, four hurricanes ranging in intensity from 2-4 on the Saffir-Simpson Hurricane Scale, struck Florida, affecting each of the four regions surveyed in this study. We conducted post-hurricane surveys in 2005 between May and November. We recorded both positive and negative changes in the linear extent of barriers to nesting. There was a net reduction of sand fencing in northeast and northwest Florida, and a net reduction of revetment rocks (a type of armoring) in the southwest region due to covering by sand. However, linear extent of barriers increased in northeast and southwest Florida due to seawall additions and additional sand fencing. In a previous survey of random, representative, beach lengths composing 24.5% of Florida's coastline, barriers to sea turtle nesting took up 18.0% of the total surveyed beach length.

NESTING ROOKERIES ALONG THE SOUTH EASTERN COAST OF BANGLADESH UNDER THREATS

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Although they are a flagship species, sea turtle populations in Bangladesh receive little interest or support from legislative and authoritative institutions. In the revised 2005 Bangladesh Wildlife Preservation Amendment Act all sea turtles were classified as protected species. Yet, sea turtles in Bangladesh still face severe troubles, both in offshore waters and on inshore nesting grounds. For example, in the of Sundarban World Heritage Site there is stll no protected area for sea turtles, despite the tourism and other infrastructure development activity that continues to grow on an annual basis. Similarly, the government declared the south-eastern coast areas of Bangladesh 'Ecologically Critical Areas' or ECA, which include Sonadia Island, St. Martin Island and Cox's Bazar-Teknaf Peninsular coast. Yet again, many activities are still occurring that clearly degrade the local wildlife habitats - including those occupied by sea turtles - with no apparent provision prohibiting these activities in sight. In addition, the shrimp trawlers of Bangladesh still do not use TEDs, beach development occurs on an unabated rate, shrimp hatcheries operate in local estuaries utilized by turtles, resorts and road building contribute to local pollution in watersheds, illegal turtle egg collection still occurs, turtles are killed by offshore fishing activities such as gill netting, turtles are negatively affected by beach front lighting and from tourist night activities, and nesting females and hatchlings are killed and consumed by feral dogs. As a result, sea turtles are not nesting on some beaches previously used for oviposition. Clearly there is much work to be done to protect sea turtles in Bangladesh. I am extremely thankful to Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, Ford Foundation and US Fish and Wildlife Service for their financial support to attend the symposium.

FIRST ASSESSMENT OF MARINE TURTLE ACTIVITY IN THE DEMOCRATIC REPUBLIC OF CONGO

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Three species of sea turtle are found in the Democratic Republic of Congo (DRC): the olive ridley (*Lepidochelys olivacea*), the leatherback (*Dermochelys coriacea*), and the green turtle (*Chelonia mydas*). In 1982, a law was established to protect threatened species in the DRC and along the Congolese coast; the DRC is also a signatory to the Memorandum of Abidjan for the conservation of sea turtles along Atlantic Africa. However, a study in November 2005 indicated that the main threats to sea turtles are direct consumption and commercial trade. In a period of two weeks, 85 olive ridleys, 37 leatherbacks, and 8 green turtles that had been killed in the villages, in the market at Muanda, and in fishing encampments were counted. More studies are now needed to identify the nesting areas and to determine which species nest in the DRC. The

role of the local communities will also be taken into consideration to ensure an effective conservation and management program.

STRENGTHENING SEA TURTLE CONSERVATION ON THE BAJA CALIFORNIA PENINSULA: UNDERSTANDING THREATS, GENERATING KNOWLEDGE AND DEVELOPING SOLUTIONS

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The Grupo Tortuguero works with local communities to recover migratory sea turtle species and reverse declines of diversity, complexity and connectivity of ocean basins. The objectives of this project are: 1) to build a diverse network of fishermen, students, teachers, activists, researchers, funders, managers, indigenous community members and other coastal citizens.; 2) draw on these relationships to understand threats, generate new knowledge and develop locally-appropriate solutions and 3) empower local leaders to communicate the conservation message and share these solutions widely. The results of 5 years of scientific study and developing new knowledge will be presented here. In order to obtain critical information on abundance, mortality and biology of sea turtles, the Grupo Tortuguero has continuously monitored sea turtle populations at coastal foraging sites along the Baja California peninsula since 2001. Community teams, comprised mostly of local fishermen, implement monthly in-water mark-recapture programs, survey index beaches for stranded sea turtles, and document evidence of sea turtle poaching/consumption in their communities. These monitoring surveys have been designed in conjunction with NMFS-SWC La Jolla scientists and allow us to quantitatively track changes in juvenile turtle populations on developmental sites, as well as the success of our efforts to reduce threats to sea turtles (poaching and bycatch). This long term scientific effort has provided valuable information about the sea turtles inhabiting the region, including the number of organisms in each area, size class and species distribution. Furthermore, the collaboration of the monitoring teams with research institutions has helped in the evaluation of sea turtle population health in the region, and with this new understandings of the interaction between turtles and human consumers have arisen. Together with our community monitoring teams, we are continuously working to use scientific knowledge to develop new strategies for sea turtle conservation. Examples of these strategies are the modification of fishing gear to reduce incidental capture of sea turtles, conducting aerial surveys to locate areas of high abundance of sea turtles in order to establish areas free of fishing, and identification of other economic activities, such as ecotourism, that are beneficial for communities and promote the conservation of sea turtles.

DOES THE CURRENT RESERVE SYSTEM IN THE GULF OF CALIFORNIA AND BAJA, MEXICO, PROVIDE PROTECTION FOR A COMPLEX OF MIGRATORY MARINE SPECIES?

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The distribution of species in space and time is determined both by the natural history characteristics of a species as well as oceanographic and climatic factors that are often difficult or too time-consuming to reasonably quantify. However, the presence of a variety of taxa in a specific geographic location may indicate an important use area. Areas identified as valuable to a particular species or group of species based on their presence or absence may serve as a proxy for identifying important habitat where species-specific natural history information or relevant oceanographic data are not readily available. A cross-species approach is also more broadly applicable to marine conservation as a whole. By identifying areas that are useful to multiple species, we may implement the most protection for the least economic and spatial investment, factors particularly important in areas heavily reliant upon fishing, such as our study area in the waters surrounding the coastal states of northwest Mexico. The purpose of our study is to apply this cross-taxa approach for the conservation of migratory marine megafauna by mapping the distributions of several highly migratory species, including loggerhead (*Caretta caretta*) and green turtles (*Chelonia mydas*), in and around the Gulf of California, Mexico, to identify areas of overlap. We map species distribution using sighting data and establish a specific density threshold to determine whether the area is more valuable than other areas based on the presence or absence of individuals. Then using kernel analysis on telemetry data, we make a probabilistic determination of high-density areas which we term high-use, or "habitat" areas, for each of the species in order to differentiate between use areas and areas such as transitory corridors. Here we present the analyses for loggerhead turtles and green turtles in the waters of the Gulf and off the west coast of the Baja Peninsula. Loggerheads are not known to nest anywhere in the eastern Pacific and it is assumed that, within this region, their presence in a particular area indicates foraging behavior. The nearest nesting grounds for green turtles are over 1000km away, so their presence here is also assumed to be for foraging. In this area, loggerheads feed primarily on pelagic red crabs (*Pleuroncodes planipes*) and may come into conflict with local fisheries, creating the risk for bycatch. Green turtles are primarily herbivorous, but their presence in offshore waters makes them susceptible to bycatch as well. We map loggerhead and green turtle distribution in and around the Gulf to identify potentially important habitat. We then compare our habitat areas with the reserve system currently in place in the Gulf and along the west coast of the Baja Peninsula. The reserve system was not set up for the protection of migratory marine megafauna, with the exception of El Vizcaino Biosphere Reserve in Baja California Sur, but it may prove to be vital in protecting species such as marine turtles if the locations of the reserves are congruent with high-use habitat.

THE CONSERVATION OF SEA TURTLES IN PROTECTED AREAS OF QUINTANA ROO, MEXICO

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Of the 900km of coast of Quintana Roo in the Mexican Caribbean, 200km are nesting areas for hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*), green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) sea turtles. A total of 104km (52% of the total) are within one of the 14 protected areas in this state: 1) Yum Balam Flora and Fauna's Protection Area, 2) Contoy Island National Park, 3) Manatee Lagoon and Chacmochuc Ecological Conservation Zone, 4) Western Coast of Isla Mujeres, Punta Cancun and Punta Nizuc National Park, 5) Puerto Morelos Coral Reef National Park, 6) Cozumel Coral Reef National Park, 7) Punta Sur Colombia Lagoon Flora and Fauna State Refuge, 8) Sea Turtle State Sanctuary Xcacel-Xcacelito 9) Tulum National Park, 10) Sian Ka'an's Coral Reef Biosphere Reserve, 11) Sian Ka'an's Biosphere Reserve, 12) Manatee State Sanctuary at Chetumal Bay 13) Banco Chinchorro Biosphere Reserve and 14) Xcalak Coral Reef National Park. However, the beaches adjacent to Xcacel: Chemuyil, Aventuras, and Xel-ha are not legally protected and are some of the most important sea turtle beaches in the state. This study describes the most relevant aspects in the conservation of sea turtles in the protected areas of this region. We analyzed nest management and found that the nesting population of green turtles has increased while the loggerheads have decreased in the last five years. Erosion and poaching are some of the factors that decrease the production of hatchlings. However, the reduction of nesting habitat caused by tourism and urban development along the coast is the main problem for both species. The most important factors that determine the operation of the protected marine areas are discussed. As well as the agents that establish the connectivity between them, considering the highly migratory behavior of these organisms, showed in the results of the different tagging programs in the study area. The sea turtle's role as an umbrella species that draws attention is also discussed. Therefore more efforts should be done to protect the beaches and increase the hatchling production. Finally, it is important to say thanks to the support given by the 27th Sea Turtle Symposium Organizing Committee as well as the following organizations: Western Pacific Regional Fisheries Management Council, Disney Animal Kingdom, US Fish and Wildlife Service, US National Marine Fisheries Service, and the Committee of Sea Turtle Protection in Quintana Roo.

BACK TO THE NATURAL NESTING BEACH: A TRANSITION FROM EGG CORRALS TO *IN SITU* IN THE KEMP'S RIDLEY SEA TURTLE

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The Kemp's ridley has historically been the most endangered sea turtle in the world. The majority nest at Rancho Nuevo, Mexico. To prevent poaching and predation, almost all of the

nests have been relocated to protected egg corrals for several decades. Because of this and other conservation measures, the number of nesting females has steadily increased for over a decade. If the trend continues, it will become necessary to leave some nests in their natural location. A two year study was conducted to evaluate the effects of allowing nests to incubate in their natural location following a mass nesting, or "arribada". The findings from the initial year of the study suggest that there were a limited number of predators in the section of the beach examined (raccoons, skunks, coyotes, ghost crabs, birds, ants, and flies). However, nests were frequented on a daily basis by several of the predators. These predators were very efficient at detecting nests and finding hatchlings. During the second year, the same types of predators were identified; however the vertebrate predators visited the nesting area less frequently. There were several factors which could account for the variation in predator abundance. Data from both years suggest that the restricted number of predators may lead to predator satiation. Therefore, leaving nests in a restricted area from an arribada may represent an efficient management strategy for enhancing hatchling survival. Temperature data from nests left *in situ* and those moved to one of the three Rancho Nuevo corrals were examined. Data were similar to previous years, indicating that the corral nests were slightly warmer than the *in situ* nests. For all of the nests examined, those laid early in the nesting season were predicted to produce a male bias whereas those laid later in the season were predicted to have female bias.

EVALUATING THE IMPACT OF FISHING PIER CONSTRUCTION ON TOTAL EMERGENCES FOR TWO SPECIES OF SEA TURTLES NESTING IN PALM BEACH COUNTY, FLORIDA 1997-2000

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We have estimated the effect of a 990-foot fishing pier on sea turtle emergences (nesting, non-nesting, total) at Juno Beach, Palm County, Florida for the 1997-2000 nesting seasons. The data include approximately 8,000-10,000 emergence locations per nesting season identified by global positioning system units with sub-meter accuracy. We define 1997 as the year before construction, 1998 the year of construction and 1999-2000 as post construction years. We conduct a spatial analysis by estimating the density of emergences (number of emergences per unit length of beach) as a smooth function of beach location. This approach reveals a significant decrease in density near the pier in the second post-construction year (2000) in contrast to pre-construction (1997). The ratio of total emergence densities between 1997 to 2000 (364—650 feet north of the pier) is 1.39 and is 1.24 between 2000 and 1997 (.49-.53 miles south of the pier). This approach also reveals a distributional shift in the locations of nests comparing the second year post construction and pre-construction even though the emergence counts are similar. Three species of sea turtles (loggerhead (*Caretta caretta*), green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*)) nest on Juno Beach, but in different proportions (loggerheads comprise 90.5% of all emergences, greens 9% and leatherbacks .5%). We investigate the relationship between total emergence density from 1997 to 2000 by species. The results for loggerheads are similar to those for all species because the loggerheads comprise the vast majority of our data. This said, we do observe quantifiable differences in the impact of the pier on green turtles compared to loggerheads. For green turtles the ratio of total emergence densities comparing 1997 to 2000 (3 miles south of the pier) is 1.8 and between 2000 and 1997 is 1.75 (.6 miles south of the pier). There is a significant decrease in total emergence density for loggerheads in the vicinity of the pier where post construction emergence patterns change to within .5 miles north or south of the pier. However, for the green sea turtles there is not the

same significant decrease in the vicinity of pier. The post construction pattern for green turtles show increased emergences several miles north and south of the pier.

CHALLENGES TO CONSERVING MARINE TURTLES IN THE SOUTH PACIFIC: GREEN TURTLES A CULTURAL ICON AND FAVOURED FOOD

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Throughout the South Pacific Islands turtles, particularly greens, have been food for 3,500 years. Marine turtles are also important cultural icons appearing in art, important for many cultural practices and are a totem for many Pacific Island peoples. Current indications are that the number of green turtles continue to decline precipitously -primarily due to local hunting combined with habitat loss and predation on nests by humans and animals. Yet there is very little reliable information on the current status of turtles here. There is no systematic recording of capture, nor monitoring and protection of nesting beaches, and in fact there is little record of important nesting beaches and feeding areas. Recent efforts by communities, local and regional NGO's, government agencies, and regional organisations are starting to produce information on country status and important nesting beaches that are being incorporated into community and country conservation plans. This paper will present preliminary results from this ongoing work from four countries: Fiji Islands, Solomon Islands, Tuvalu and Vanuatu that indicates the hope and challenge for future conservation.

SEA TURTLE CONSERVATION IN THE SOUTH CARIBBEAN, TALAMANCA, COSTA RICA: 2006 SEASON

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This program included the beaches in Cahuita National Park (Puerto Vargas and Black Beach - 82º49"W, 09º45"N) and Gandoca beach (9°59.972' N, 82°60.530' W) in the Gandoca-Manzanillo National Wildlife Refuge. Both of these protected areas are located in the south Caribbean of Costa Rica. Conservation work has been carried out since 1990 in Gandoca, and 2000 in Cahuita-Black Beach. The activities of the program have been divided into five areas: Research and Conservation, Environmental Education and Public Awareness, Political Advocacy, Social and Economic Alternatives and Conservation Planning. The main species recorded in these beaches was the Leatherback sea turtle (*Dermochelys coriacea*) with 9,805 total nests in Gandoca and 1,176 nests in Cahuita-Black Beach since the beginning of the program. The main impacts on the population in the region are poaching of eggs, beach erosion, marine debris carried by the currents and rivers, as well as hunting for nesting females. Conservation actions led to a reduction of illegal poaching of eggs from 100% to 3% in Gandoca, and 20% in Cahuita-Black Beach. A total of 496 nesting females have been tagged with passive integrated transponders (PITs) in Gandoca for the period 1999-2006, and 125 in Cahuita-Black Beach. The information generated shows that this population inter-nests in both places and in other beaches in Panama and Costa Rica, which highlights the importance of coordinated conservation action at a national and international level.

THE CHALLENGES AND OPPORTUNITIES OF TURTLE CONSERVATION IN SOUTHERN TIP OF TANZANIA'S COAST

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Tanzania has a coastline of about 800 km of which the last 45 km fall in Mnazi Bay - Ruvuma Estuary Marine Park (MBREMP). The park was gazetted since July 2000 as the second Marine Park in Tanzania formed under the Marine Parks and Reserves Act number 29 of 1994. It is in the transboundary between two sister countries Tanzania and Mozambique where Ruvuma river forms a boundary. The Park has four main turtle nesting beaches within its coastline. As a strategy to safeguard this endangered animal following the assessment that revealed that turtles in this area are being threatened by deliberate fishing, slaughtering nesting females and poaching eggs from nests, the Park developed a long term turtle conservation programme in October 2003 and its implementation started at the beginning of 2004. Four Community Turtle Officers (CTOs) were selected to work together with MBREMP staff. Both groups received theoretical and practical training on turtle conservation. Since then, there has been progress in turtle conservation activities that included beach patrols, protection of nests, tagging nesting female turtles, recording the number of dead turtles and collecting skin samples for DNA analysis. Raising awareness and the transfer of knowledge on turtle conservation was encouraged to allow a large number of park community members to be informed. The total number of turtle nests in 2006 shows a substantial reduction especially when compared with the two previous years of 2004 and 2005 whereby 34 and 19 nests were recorded, respectively. The former successfully produced 2,122 hatchlings which were all green turtles while the later that had 18 nests of green turtles 1 nest of a hawksbill turtle produced 1302 and 65 hatchlings, respectively. Until mid December of 2006, only 12 green turtle nests with 336 hatchlings were recorded. The possible causes of the reduction in nesting are more than likely multiple, including higher mortality caused by pollution or capture by fishers (either deliberate or accidental by-catch). It is also possible that there is a naturally lower nesting intensity which is part of the natural cycle with relatively higher numbers every 2-3 years. The challenges in implementation lie on absence of trans-boundary conservation and management efforts and violation of regulations by local communities outside the park area. The next side of Mozambique has not been declared as a protected area providing a loop hole to illegal fishermen even from the Tanzanian side to deliberately engage in fishing turtles. It is recommended that the two sister countries should initiate trans-boundary conservation and management efforts that will promote eco-tourism and other economic opportunities leading to poverty alleviation in the communities that traditionally harvest turtles.

RECYCLED GLASS AS SEA TURTLE NESTING SUBSTRATE: RESULTS FROM ABIOTIC TESTING AND ANALYSES

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Since the early 1960's, Florida has conducted beach nourishment using offshore sand sources to address critical shoreline erosion. Critically eroded shoreline areas pose a myriad of environmental concerns (e.g., limited nesting habitat for sea turtles and shorebirds, increased

risk of inundation of sea turtle nests, destruction of threatened beach flora). Potential sources of beach compatible sand include offshore inter-reef sedimentary infills, upland dunes, inland sources, and aragonite sand from the Bahama Banks. In addition, Coastal Planning & Engineering, Inc. (CPE) have proposed using recycled glass cullet as a potential alternative source material for beach fill. Recycled glass cullet has physical properties similar to natural silica sands, making it a viable alternative beach fill material along critically eroded shorelines. This research marks the first study to investigate the abiotic properties of recycled glass cullet as an alternative beach fill material in relation to the nesting habitat requirements of marine turtles. Specifically, temperature, moisture content (dew point temperature and relative humidity), and respiratory gas exchange are considered the most important abiotic variables affecting the survival of reptilian embryos. In this case, sea turtles were identified as the species of concern. Florida serves as one of the most important nesting environments for sea turtles in the United States, with more than 50,000 nests annually. The main concern arises when an alternative sediment type may produce a foreign nesting environment. Within the glass cullet, the synergism between moisture, temperature, and gas exchange must be similar to natal beach conditions in order to avoid impacts to developing embryos during incubation. The purpose of this study was to determine if glass cullet mixtures exhibit the same abiotic characteristics (temperature, moisture content, and respiratory gas exchange) when compared to the natural beach sediments. By constructing a simulated sea turtle nesting hatchery, and utilizing thermal/moisture logging sensors and gas probe samples, it was determined that recycled cullet does uphold the abiotic nest chamber parameters to allow for proper sea turtle embryo development and success. Simulated nests containing recycled glass cullet all recorded average temperatures that fell within the acceptable incubation range for sea turtles and moisture content showed no significant differences from the beach sand controls (t-test, $P>0.05$). Similarly, gas probe samples analyzed from all the experimental cullet nests recorded high concentrations of oxygen with no significant variations from the beach sand controls (t-test, $P>0.05$). Overall, this study showed that nests constructed with a portion of recycled glass cullet offer a nesting environment that is equal in its developmental parameters as the natural beach sand. Worldwide, the nesting beaches of sea turtles are under the constant threat of erosion, which ultimately results in the loss of nesting habitat. By revealing that recycled glass cullet is a biologically viable, sea turtle friendly nesting substrate, this research can help pave the way for a new method in beach protection.

INCIDENTAL ARTESANAL BY-CATCH OF GREEN TURTLES IN THE GULF OF VENEZUELA: IDENTIFYING ITS IMPACT AND PRIORITIES AREAS FOR MITIGATION EFFORTS

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The Gulf of Venezuela (GV), a center of artesanal and industrial fishing, is thought also to be an important feeding area for several species of sea turtles. Unfortunately, incidental bycatch and

illegal hunting of turtles also appear to be high, by both industrial operations and indigenous Wuayuú fishers. The most heavily affected species in the GV is probably the green turtle, although evidence for the distribution and severity of impacts is presently anecdotal. Between 1998 and 2006 we collected data about artesanal fisheries activities in the western coast of the GV: Net type, time of exposition, size of fishing fleet, geographic coordinates and depth of capture localities, numbers of turtles captured, size and sex (when was possible). We determined that approximately 900 - 1,000 turtles/year area captured, 2) the main capture areas for green turtle were Castilletes, Porshoure, Tapuri y Parashiou, 3) the months with more capture were between April and August; 4) Subadults were more common, but adults (females) also frequents, some with tags from Costa Rica, Panama and Isla de Aves. These results show that the rate of green turtles captured in the GV is high, and serious conservation programs (nationally and internationally) in this feeding area should take into consideration. This artesanal fisheries should be monitored and mitigation measures put in place to avoid or minimize the probable damage to the Caribbean Green turtle populations.

STATUS OF THE HAWKSBILL AT THE BEGINNING OF THE 21ST CENTURY

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The latest IUCN Red List assessment of global hawksbill (*Eretmochelys imbricata*) populations conducted in 2006 reveals that the species continues to endure major threats in much of its range, especially in the Indian and Pacific Oceans and along the mainland Caribbean coast. Hawksbills nest in some 60 of the 108 countries in whose waters they occur. Historic and recent published accounts indicate extensive declines in all major ocean basins over the last 100 years due to overexploitation of breeding animals and eggs at nesting beaches and juveniles and adults in foraging areas. Trade in tortoiseshell was the driving force behind much of this take. Volume of international trade has declined significantly in the last 10-15 years; but several major reviews on international trade produced in the past five years indicate that it remains active and menacing, especially in southeast Asia and the Americas. Destruction of nesting habitat, especially for tourism, is a tremendous problem for this most tropical sea turtle. Loss of coral reef foraging habitat and beach erosion due to climate change are other major concerns, as are incidental capture in fisheries and marine pollution. The analysis, based on quantitative estimates of rates of population change over time, uses recent data obtained from researchers around the world as well as older information. The contribution of historically large but now depleted populations was considered using quantitative data, old naturalist's records, and historic egg collection and tortoise shell trade statistics. While researchers may never fully know the extent of hawksbill declines during the last century, old records are invaluable. In an exhaustive review of the Caribbean, McClenachan *et al* (2006) estimate that 20% of historic nesting sites have been lost entirely, and 50% of the remaining nesting sites have been reduced to dangerously low levels that threaten the species with ecological extinction. Much of the global decline occurred in the 20th century, driven by intense international trade that in 1970 involved 46 importing and exporting countries. Most shell went to Japan which imported shell from an estimated 650,000 hawksbills during 1970-1992. Exploitation lessened in the late 1970s and during the 1980s as CITES came into effect globally. In 1993, Japan banned all imports; but the industry's infrastructure remains intact, and Japanese domestic sales continue today. Since publication of the last assessment for IUCN (Meylan and Donnelly, 1999), population decline has continued at many sites including some of the world's most important remaining rookeries--

i.e., eastern Mexico, NE Australia, Indonesia, and Seychelles. With protection, however, some small or remnant populations have stabilized, and a few are increasing. Increases are particularly apparent at certain protected islands in the Caribbean and Indian Ocean. Unfortunately, protected nesting sites represent a minority of total nesting habitat currently used by hawksbills. Public awareness is at an all time high and international and regional agreements are helping to address the issues at government level; but effective enforcement on the ground is still lacking at many sites.

COMPARISON OF FOUR DIFFERENT TECHNIQUES TO PREVENT MAMMALIAN PREDATION OF OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) NESTS ON PEJEPERRO BEACH, OSA PENINSULA, COSTA RICA (EASTERN PACIFIC)

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Sea turtle nest predation on isolated beaches without human influence or the influence of introduced species like dogs, pigs, etc… comes from natural sources; however when predators become too numerous, this natural predation can become a threat. A pilot experiment was conducted in Pejeperro Beach, Costa Rica, from July to September 2006 to assess the effectiveness of four techniques in preventing predation by white-nosed coati (*Nasua narica*) and northern raccoon (*Procyon lotor*) on olive ridley sea turtle (*Lepidochelys olivacea*) nests. Pepper and human urine were used to mask the smell of the eggs and 1 m^2 and 0.25 m^2 flat chain-link screens were placed over the nests to prevent access by digging. Fifty nests were marked, 10 for each technique and 10 more as controls; 25 nests of the total were left In Situ (IS) and the other 25 were relocated on the beach (RB). Nests with 1 m^2 screen and with pepper were the least predated (6% both n=18) and had the longest mean incubation periods (46.1 ± 15.65 days, mean ± SD) and (39.2 ± 15.66 days) respectively. Fewer RB nests were predated than IS nests. Urine and 1 m^2 screens were most effective at preventing predation by *P. lotor*, and pepper was most effective for *N. narica*. *Procyon lotor* only predated IS nests. Future studies to evaluate the raccoon and coati populations in the area are highly recommended.

EFFECTS OF OFF-ROAD VEHICLES ON THE NESTING ACTIVITY OF LOGGERHEAD SEA TURTLES IN NORTH CAROLINA, USA

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Loggerhead sea turtles face many anthropogenic nesting threats including beach armoring, beach nourishment, artificial lighting, commercial fishing, beach vehicular driving, and pollution. Most potential threats have been thoroughly evaluated, but there remains a dearth of information about the effects of beach vehicular driving on nest success. Several factors were evaluated to determine the effect of driving off-road vehicles (ORVs) on nesting activity. To compare driven and non-driven beaches, data on beach slope, sand compaction, beach width, sand color, sand grain size, moisture content, incubation temperature, and pedestrian activity were collected during the 2005 nesting season at Cape Lookout National Seashore, Cape Hatteras National Seashore and Pea Island Wildlife Refuge, North Carolina, USA. Data

collected in the 2000 to 2005 nesting seasons were assessed to determine differences in incubation period and the percentages of false crawls between ORV and non-ORV beaches. ORV use was found to be a significant factor in determining nesting laying. False crawls were more likely to occur on ORV beaches. The light intensities for 300-500 nm were found to be a significant factor in determining the occurrence of a nest or false crawl. A T-test for light intensities for 300-500 nm found greater light intensity on non-ORV beaches. Incubation period was estimated to be an average of 2 days longer for ORV beaches. This is estimated to cause a decline of 20% in production of female loggerhead turtles at these locations. None of the beach and sand characteristics accounted for this difference. More nests were relocated on ORV beaches than non-ORV beaches. However, nests on non-ORV beaches were subject to higher rates of inundation by the sea. Emergence success of hatchlings in Cape Hatteras was reduced by more than half by overwash and approached zero with washout. The greater occurrences of false crawls on ORV beaches may cause the nesting turtle to expend additional energy. This energy could be put into egg production or growth. Cape Hatteras and Cape Lookout need to further evaluate this effect and take action to mitigate it. ORV use could be stopped completely, subject to limit permitting, mileage reduced, discontinued during nesting season, or prohibited during nighttime hours. The habitat quality of non-ORV beaches was inferior to the beaches designated for ORV use. The issues of overwash, washout, and light intensity should be considered when selecting an area for ORV use or as a nest relocation site. Areas with high historic nesting percentages and low incidence of overwash and washout ought to be designated as non-ORV. The possible skewed sex ratios present a risk for a recovering population. ORV use should be discontinued in order to correct sex ratio.

THE CONSERVATION MOSAIC: A MODEL FOR MULTINATIONAL MARINE CONSERVATION

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The conservation mosaic is a model program for social change and the protection of highly migratory species. The goal is to reduce poaching and bycatch of endangered sea turtles. Preliminary results indicate positive changes in partner communities, increased numbers of sea turtles on nesting beaches and foraging grounds, and an emerging “sea ethic.” Over the past decade we have developed this approach to sea turtle conservation in the Californias (U.S. and Mexico) through the integration of three strategies: 1) facilitate the growth of a diverse international NETWORK of fishermen, students, teachers, activists, researchers, funders, managers, indigenous community members and other coastal citizens. 2) draw on these relationships to understand threats, generate new KNOWLEDGE and develop practical solutions. 3) empower local leaders to facilitate COMMUNICATION and sharing of these solutions and knowledge through an array of resonant media. The novelty, simplicity and effectiveness of our methodology is based on in an integrated, innovative approach informed by regular evaluation and monitoring. We have adapted and exported the conservation mosaic model to community-based projects focused on leatherback turtle conservation in Indonesia and shark conservation in the eastern Pacific, among other projects. However, the model should prove useful across the range of conservation and social change issues. (This paper is Part one of a 4-part series of papers/posters...the other three parts highlight in detail each of the three components of the conservation mosaic model and provide detailed case studies related to the work of the Grupo Tortuguero in the ETP).

MANAGEMENT OF SEA TURTLE NESTING ON HIGHLY URBANIZED BEACHES IN BROWARD COUNTY, FLORIDA: TO RELOCATE OR NOT TO RELOCATE?

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Since 1981, intensive nest relocation has been used as the primary tool to minimize hatchling disorientation by coastal lights in Broward County. It has always been recognized that nest relocation is a highly invasive, undesirable management tool but it was thought to be a necessity because only 5 of the 8 cities have lighting ordinances in place and at least 70 percent of Broward County beaches are very brightly illuminated. In 2006, with the partial enforcement of coastal lighting ordinances, this policy was changed by mandate of the Florida Fish and Wildlife Commission. No enclosed or open beach hatcheries were used and many more nests were left in situ. Preliminary evaluation of the disorientation incident reports from highly developed Fort Lauderdale, Lauderdale by the Sea, and Pompano Beach indicate that the number of disoriented hatchlings ranged between 16,532 and 19,255 in 2006. In 2005, estimated range was 7334 to 9400. Accounting for disoriented hatchling tracks that reached the water, the estimated number of missing hatchlings ranged from 13,020 to 14,447 in 2006 and from 5,198 to 6,382 in 2005. These numbers may be underestimates because hatchling tracks are often indistinct and are easily removed by rain and wind. Of the 45 nests left in situ on the Fort Lauderdale strip, 22 disoriented. Thirteen of these disorientations were inside cages. While the new management procedures may have contributed to the disorientation loss of about 8000 more hatchlings than in 2005, the new protocol also appear to have increased live hatchling production rates of relocated nests, possibly due to wider nest spacing and shorter relocation times and transportation distances. Based on comparison of the increases in overall live hatchling production rates of in situ and relocated nests from 2005 to 2006, we estimate that the new relocation protocol may have contributed to a 12 percentage point increase in the production of relocated nests this year. Comparison of the estimated hatchling production of all nests in 2006 with the projected hatchling production if the old procedures had been used, suggests that the new methods may have contributed to the release of an additional 18,500 hatchings. This compares favorably with the increased loss estimate above. Further reduction of beachfront lighting, from increased enforcement of lighting ordinances and education, has the potential to greatly reduce hatchling disorientation losses and reduce the need for relocation even further.

FACTORS AFFECTING DISTRIBUTION AND NESTING BEHAVIOUR OF MARINE TURTLES ALONG THE AMANSURI COAST IN GHANA

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In Ghana three species of Marine turtles are currently found to nest along the coast. These include, the leatherback, olive ridley and green turtles. This study was undertaken as a follow up to a previous study that assessed the effectivenes of conservation education in achieving the conservation of marine turtles along the Amansuri Coast in the Western Region of Ghana. We evaluated the effect of parameters such as beach development, sand texture and sanitation along the beach on the distribution and nesting activities of turtles, and how this logistically fit

into the level of awareness by local communities. The data used was collected over three years. Preliminary results show that the major factor influencing the distribution and nesting behaviours is beach development and low level of awareness of the importance of marine turtles.

THE REAL RIDDLE OF THE RIDLEY: SHOULD WE CONSERVE ARRIBADA NESTING POPULATIONS? SOLITARY NESTING POPULATIONS? BOTH?

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Olive ridley sea turtles are best known for their distinctive reproductive behavior of synchronized mass nesting known as the arribada. Hundreds to tens of thousands of ridleys may emerge synchronously from the ocean in just a few days to nest in close proximity. Arribadas occur at only a few beaches worldwide in the eastern Pacific, western Atlantic and northern Indian Oceans. However the nesting range for the olive ridley extends far beyond these select beaches. For example, in the eastern Pacific, arribadas occur annually at several beaches in Mexico, Nicaragua, Costa Rica and Panama from June through December. During the same time, solitary olive ridleys emerge individually to nest along nearly the entire coastline from Mexico to Colombia. Very little is known about this behavioral polymorphism. The study of the arribada phenomenon has dominated most aspects of research on this species and comparatively little attention has been given to the solitary nesting strategy. This is reflected in the literature wherein solitary nesting is not even mentioned in most review papers despite the fact that its extent was well known and described many years ago. Recognizing these different phenotypes, and acquiring data on the abundance, status of, biology and ecology of each is critical to managing and recovering the species. Nearly all of the research, population censuses and conservation efforts have been directed toward arribada nesting populations. But focusing attention on just a few nesting populations is a risky strategy and sea turtle conservation programs need to study and protect both large and small nesting populations within a region. This talk will provide a summary of our knowledge of these two nesting strategies, discuss the significant life history and genetic differences between them, its potential impact on population growth of the species and it will underscore the need to conserve solitary nesting ridleys as well as arribada nesting ridleys.

COMMUNITY-MANAGED SEA TURTLE MONITORING AND PROTECTION ON MOHELI, UNION OF THE COMOROS

Chris Poonian, Cheikh Moussa , and Hamada Issoufi
C3-Comores, Moheli, Union of the Comoros

Community-based management enables local stakeholders to take responsibility for their own natural resources through direct participation in decision-making, surveillance and monitoring. This flexible approach can be valuable when tackling fundamental socioeconomic factors affecting conservation efforts and can compensate for limited scientific data. Mohéli, one of the three islands of the Union of the Comoros is among the top ten green turtle (*Chelonia mydas*) nesting sites in the world with over 5000 females nesting annually. There is also evidence that the island's water serve as juvenile habitat for green and hawksbill turtles (*Eretmochelys*

imbricata). However, effective turtle conservation is adversely affected by existing ecological, cultural, socioeconomic and political conditions, and poaching is a serious problem. C3-Comores has initiated an environmental awareness program in Hoani, a village in the North West of Mohéli and site of a principal nesting beach, neglected by previous conservation efforts on the island. Three voluntary community ecoguards have been trained to patrol beaches, participate in turtle monitoring and promote further awareness-raising. Four ecoguides were also trained to provide turtle-watching tours to encourage community conservation of natural resources through increased income from ecotourism. The results of the initial training were overwhelming, and turtle poachers were caught and convicted within weeks; this led to direct financial benefits for the community, who received a percentage of the fines. A regional conservation centre has now been established in Hoani, to provide information to local communities and tourists, and for the sale of artisanal crafts and souvenirs. C3-Comores has also extended the program to neighboring villages and has implemented a sustainable low-cost community turtle monitoring strategy for the whole island, which will be entirely managed by local communities in the future. This study has shown that motivated local communities can effectively monitor and manage sea turtle populations. However, the long-term sustainability and development of such programs must inevitably depend on the generation of alternative income to maintain community motivation. C3-Comores is a collaborative initiative between Community Centered Conservation (C3), Mohéli Marine Park on Mohéli and AIDE on Grande Comore. C3-Comores gratefully acknowledges the support of the BP Conservation Program and IOSEA Year of the Turtle 2006.

VOLUNTEER PROGRAMS: A TOOL FOR CONSERVATION

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One of the biggest challenges that research and conservation projects face in nesting beaches is effective and efficient coverage of the beach, especially when dealing with impacts such as hunting for nesting females or excessive collection of eggs. Also, when the objectives demand a full coverage of the beach, it is necessary people and mechanisms, to ensure the coverage of 100% of the nesting events. To comply with this objective, many projects have implemented volunteer programs, that on the other hand also aid to install social and economic processes that allow a decrease of the anthropogenic impacts. In Gandoca beach, the volunteer program has been an essential tool; the funds generated by the sale of services such as room and board by the local community (among other services) has resulted in incomes to the local community of at least 7 times more than the value of the eggs in the black market, while there has been a decrease in the poaching of nests by 97% and hunting has been reduced to 0%. These type of programs also promote community organization, public awareness, socialization of the income, diversification of the sources of income and the participation of women in decision making pertinent to the development of the community. Programs such as the one in Gandoca, with sustained activity since 1992, prove that it is possible to develop synergy between scientific work and generation of income through mechanisms of control and training.

TRADE IN MARINE TURTLE PRODUCTS IN THE DOMINICAN REPUBLIC

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A marine turtle product availability survey with a focus on hawksbill shell items was undertaken by TRAFFIC from March 17-22, 2006 in the Dominican Republic. A total of 7 sites were visited with large quantities of hawksbill shell items found to be offered for sale in street stalls, souvenir shops, markets and jewelries. A total of approx. 414 shops and stalls were surveyed, with 249 of these offering hawksbill products for sale. In Santo Domingo, which was found to be the main trading spot and distribution center for these items in the country, over 95% of the shops surveyed exhibited a number of items from finger rings to elaborated pieces with gold and amber/stone applications. Vendors readily offered a 20-30% discount on any purchase with the possibility of a better deal if several items were bought. Some of the vendors claimed to have their own workshops were these products were elaborated. Other marine turtle products, such as turtle oil was also documented for sale, with anecdotal information indicating the use and trade of meat as well. Results show, that the findings mentioned in TRAFFIC's "Swimming against the Tide" report from 2001, which indicate an existing trade and availability of marine turtle items in this Caribbean country, is still an issue of concern.

TRADE IN MARINE TURTLE PRODUCTS IN COLOMBIA

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A marine turtle product availability survey with a focus on hawksbill (HB) shell items was undertaken by TRAFFIC from March 23-29, 2006 in Colombia. A total of 3 locations in the Departments of Bolívar, La Magdalena and La Guajira (4 sites in Cartagena, 2 in the Santa Marta area, and Riohacha) were visited, with hawksbill shell items found to be offered for sale in crafts markets, souvenir shops, and street vendors. A total of approx. 223 shops/vendors were surveyed, with 60 of these offering hawksbill products for sale. Products were generally offered in established shops and stalls, by vendors (either in the old city or along the beaches), and through informal "sidewalk artisans". The old city in Cartagena is where most of the HB shell items for sale were found. Information gathered indicates that restaurants along beaches in the Cartagena area offer turtle dishes by request, but only during the season, and are not openly offered in the menu. In El Rodadero, a beach town mostly frequented by national tourists, and very close to Santa Marta City, a total of 87 shops were surveyed, 28 of which had HB shell items for sale. 13 souvenir shops were found and surveyed in Santa Marta, 4 of which offered HB shell products for sale. Rio Hacha presented an interesting situation. With an ongoing marine turtle project in a protected area nearby (Parque Nacional Los Flamencos), and several signs promoting marine turtle conservation in the area; the local government was mentioned to be quite strict in the prohibition of any marine turtle sell or use, consequently products are not openly offered to tourists either as crafted shell items or for food in restaurants.

EVALUATING SEA TURTLE NESTING DATA WITH GEOGRAPHIC INFORMATION SYSTEMS

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Since 2001, all sea turtle crawl locations in Boca Raton were recorded as latitude and longitude points using inexpensive hand-held GPS's (global positioning satellite). Starting in 2004, crawl data was directly recorded in pocket PC's fitted with GPS receivers running ESRI "ArcPad" software. Data collected with the pocket PC's is consistent with data collected since 1988 and recorded in MS Excel spreadsheets so there is no change in the data collected, only how it is collected. Direct entry of data into the pocket PC's virtually eliminated transposition errors that were common when the positions were recorded in field notebooks, then entered in office notebooks, followed by entry into the main computer. Using ESRI ArcGIS 9.1 with the spatial Analyst extension, any aspect of collected data can be visualized on aerials either as discrete points or as density maps where the higher concentration of points is shown as areas of darker color ramping down to lighter colors in less dense areas. Density maps make interpretation of complex data easier to understand by members of the general public, which helps correct lighting or many other beach issue effecting sea turtle nesting. Higher concentrations of false crawls and little nesting are found in such problem areas clearly delineated on the density map. In Boca Raton, a City Park experienced a 75% drop in crawls in 2004 which persists. This lack of activity in an unlit City Park representing nearly ¾ mile of beachfront is most likely due to sky glow from the cities west of the beach. Evidence is shown by the presence if an "island" of activity in front of a set of three 80 foot high Australian Pine Trees whereas, the rest of the dune in the Park is low and even. Loggerhead nesting is seen to cluster in front of tall beachfront condominiums, a phenomenon first reported by Salmon *et al* (1995). Although nesting in Boca Raton has been declining in recent years, an area that retains nesting densities of the past 16 years is in front of a very wide and tall condominium south of the Boca Raton Inlet. The density maps show consistent activity directly in front of this condominium from year to year. An oblique view using Pictometry ™ clearly shows the amount of beach shaded by this building. Many other aspects of the collected data can be viewed with this technology such as renourished beach areas, predatory mammals, and analysis of false crawl types (such as below the high tide line false crawls). Because nests in Boca Raton where shown to have high levels of pesticide in nests that also had a large number of unhatched eggs (Alva *et al*, 2003) analyses were made of the locations of nests with greater than 50 unhatched eggs. Inundated nests were not considered in these analyses. Surprisingly in 2006, a large concentration of these nests was found in and area of low nesting with high public access, showing that this technology can open even experienced eyes to new problems.

DATA ACTUALIZATION OF STRANDED SEA TURTLES FROM JANUARY 2005 – JULY 2006 IN TABLAZO BAY, ZULIA STATE, VENEZUELA

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In Venezuela, the five species of sea turtles: *Chelonia mydas*, *Eretmochelys* imbricada, *Caretta caretta*, *Lepidochelys olivacea*, *Dermochelys coriacea* are threatened by human actions. Maracaibo system in Zulia state is considered the most important area of *C. mydas* feeding in the whole country. The target of the present study was to update the data of stranding sea turtles on the coast of the Tablazo bay in the Maracaibo system during January 2005 – July 2006 period. A total of 29 field trips of 2 or 4 days were conducted, these trips included: a journey by foot along the coasts, fisherman interviews, observing fish unloading zones and inspections of fishing boats altogether with the National Guard. A total of 24 dead turtles were found, they belonged to 4 species: (1) *Lepidochelys olivacea* (3) *Caretta caretta*, (19) *Chelonia mydas*, (1) *Eretmochelys* inmbricata and 2 young *C. mydas* capture by the fishermans, these were caught alive and they were attended by the authors in the vertebrate zoology laboratory of Zulia University, and helped by the specialized medical personnel of Veterinarian Policlinic of the School of Veterinary Sciences of Zulia University, Centre of Investigations for the Marine Turtles Conservation (CICTMAR) and the Environment Ministry and Natural Resources (MARN). All the specimens were released in the National Park “Archipielago Los Monjes” helped by Republic Army, Naval Base “Mariscal Juan Cristostomo Falcon”. The main cause of death was incidental capture in fishing nets and hunting for commercial trade and food purposes.

COMMUNITY BASED TOURISM TOWARDS TURTLE CONSERVATION A CASE STUDY USING A PARTNERSHIP APPROACH

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The communities of Matura, Grande Riviere, Fishing Pond and Great Courland Bay, Tobago in collaboration with the Forestry Division and BHP Billiton Trinidad & Tobago have pooled their resources to develop a Tourism Plan. This proposal was developed with a vision to make T&T a Premiere Turtle Tourism Destination using the leatherback turtles as a flagship species. This initiative was based on the following 3 principles & philosophies: 1. Four community groups: Nature Seekers, Grande Riviere Nature Tour Guide Association, Fishing Pond Turtle Conservation Group and Black Rock Tobago will pool their strengths to support turtle conservation nationally. The main strategy is the development of the Turtle Village Trust to promote the leatherback turtles as a flagship species for economic, social and environmental growth of the area. 2. Broad scale development to the northeast area facilitating the development of Community Tourism as a tool to increase the economic standards of the area. This will be done by developing the cultural and natural attractions of the area, using the Leatherback turtles as the catalyst involving the local community as the main driver in this effort. 3. This project was initiated to address challenges that individuals & organisations face in the area – a. One of these challenges is un-sustained funding for conservation activities. Annually,

community groups need to seek grant funding from the limited sources available in the country to continue projects that are similar among the groups, b. Additionally, where these communities are located has the highest incidence of poverty in T&T due to limited training, employment and other opportunities in the area. Thus any skilled or technical workers normally leave the communities for outside opportunities, c. Groups also lack the resources to acquire and finance quality management. As a result, the ability and time to apply for grants, developing research proposal and organization management is not within the scope of all these groups. It was the premise that the Trust will be a feasible alternative to these community organisations for hiring staff in high cost areas, such as Marketing, tourism development, fund raising, writing research proposals etc. that could not be financially sustained by CBO's, d. The lack of infrastructure to operate compounds the weaknesses of these groups as there are few organizations with office space to work from.

SEA TURTLE CONSERVATION ON THE OSA PENINSULA, COSTA RICA

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In 2005, Friends of the Osa (FOO) began the Osa Sea Turtle Conservation Program, the first technical project to continuously monitor and protect populations of olive ridley, Pacific green, and leatherback sea turtles that nest on the Pacific beaches of the Osa Peninsula in Costa Rica. In addition to using standardized research and conservation methods, we participate in education and training with local communities. As a result of these efforts, we recorded 2,211 nesting attempts during the 2005 nesting season, including 2,188 nesting attempts by the olive ridley and 23 nesting attempts by the Pacific green. The average curved carapace length and crawl width (olive ridley: length = 66.5 cm ± 3.7, width = 74.5 cm ± 10.5; Pacific green: length = 94.6 cm ± 10.5, width = 89.5 cm ± 11.1) indicate that these are mature populations. The majority of nesting activity took place between 20:00 and 02:00 hours. The olive ridley and Pacific green laid 97.0 (± 18.2) and 80.5 (± 27.5) eggs respectively. Of 2,212 emergences of adult turtles onto the beach, 1,894 (86%) were successful nesting attempts and 318 (14%) were false crawls. To contribute to the recovery of turtle populations, we relocated 223 nests from unfavourable sites to a different part of the beach and placed 263 nests inside protected hatcheries. 1,408 nests were left in situ after nesting measurements were taken, and 620 of these nests (44%) were depredated. Of these 620 depredated nests, 82.9% were eaten by wild animals (raccoons and coatis), 12.9% were poached by humans, and the remaining 4.2% of cases were unknown. Poaching was less common than in previous years, although natural predation may be an increasing threat to sea turtles in this region. It is possible that unusually high predation rates by coatis may be influenced by the hunting out of large cats that control coati populations. Hatcheries successfully increased hatching rate by reducing predation and poaching. Of the 257 nests and 22,942 eggs placed in protected hatcheries, 19,028 hatchlings emerged. In the hatchery, there was 90.6% hatching success and 89.4% emergence success, compared with 93.5% hatching success and 92.2% emergence success on the beach. The temperature range of nests in the hatchery varied from 23˚ to 35˚C, with an average of 29˚C (± 0.76). On the beach, nest temperatures ranged from 23.1˚ to 32.8˚C, with an average of 27.7˚C (± 1.2). In conclusion, the results indicate that the beaches monitored in this project have one of the highest sea turtle nesting rates on the Pacific coast of Costa Rica (excluding Nancite and Ostional). Ongoing monitoring in coming years will establish whether these populations are declining or increasing. Size measurements and tagging of adults will describe population dynamics and age structure. Long-term efforts in conservation, education, and scientific

investigation will be essential for understanding, protecting and managing these turtle populations.

THE LONG-TERM IMPACT OF THE 2004 TSUNAMI: IMPLICATIONS FOR MARINE TURTLES AND THEIR HABITATS

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Though nearly two years have passed since the 2004 tsunami, there is still little clarity on its long term environmental impacts. This is largely because attention has been focused largely on its direct physical impacts. Similarly, reports on marine turtles have looked at impacts on nesting beaches. These reports definitely provide a useful compilation of the short term impacts of the tsunami itself. Studies of sociological impacts have also documented fairly thoroughly loss of lives and livelihoods, damage to houses and boats, etc. Subsequent to studies of physical impacts, many commentators have spoken of the tsunami of assistance, the tsunami of non-government organizations, the tsunami of developmental aid and organizations. Which of these will have the most impact on the coast and its environment? For example, large scale planting of Casuarina as a bioshield has been initiated along the coast without a careful analysis of whether such plantations are indeed beneficial in the long term. Coastal features such as sand dunes which may be critical to coastal integrity have been given scant attention, and used for reconstruction or plantations. Similarly, many boats have been replaced after the tsunami and the proportion of mechanized and motorized boats may actually increase. Given that the fisheries and marine habitats were already detrimentally affected by bottom trawling, these actions may further aggravate both ecological and livelihood issues on the coast. In both cases, marine turtles or their habitats are directly impacted; loss of sand dunes and beaches affects the nesting grounds of olive ridley turtles, and an increase in mechanization will result in an increase in incidental mortality in trawl and gill net fisheries. Environmental and socio-ecological issues on the coast clearly preceded the tsunami. It is against this background trend that one must assess the impacts of the tsunami and responses to it. To address issues of environment sustainability, the UNDP launched the 'Post-Tsunami Environment Initiative', a project jointly executed by the Nature Conservation Foundation (NCF), Mysore, the Ashoka Trust for Research in Ecology and the Environment (ATREE), Bangalore and the Citizen, consumer and civic Action Group (CAG), Chennai. This project aims to understand coastal vulnerability and resilience in the face of such natural disasters within the Indian context, establish participatory monitoring systems, critically analyse developmental policy, and develop management models for key ecological sites along the coast. Marine turtles have served as a flagship for coastal and marine conservation; here also, they can be used to bring attention to important habitats, as well as to modify or mitigate certain post-tsunami development plans. Future research and detailed review based on primary and secondary biological, legal and sociological information is required to guide policy changes, accompanied with monitoring along the coast. Long term impacts of interventions, especially for species such as marine turtles, needs to be carefully evaluated before implementation. Coastal conservation and management, both within and outside the

context of the tsunami, needs to take into account a full range of issues if it is to be successful in the long term.

NAVIGATING FLORIDA'S WATERWAYS: BOAT-RELATED STRANDINGS OF MARINE TURTLES IN FLORIDA

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The Florida Sea Turtle Stranding and Salvage Network (FLSTSSN) has documented over 23,000 dead or debilitated sea turtles (i.e., strandings) in Florida from 1980 through 2005. Data were collected by individuals permitted by the Florida Fish and Wildlife Conservation Commission (FWC) and were verified and entered by FLSTSSN coordinators with the FWC. Potential sea turtle mortality factors were sometimes visually apparent with the most common of these being propeller wounds. From 1980 through 2005, over 4,000 sea turtle strandings (including almost 500 live turtles) were documented with propeller wounds. The percent occurrence of propeller wounds among sea turtle strandings each year increased from about 10% in the early 1980's (average of about 50 per year) to almost 30% in the most recent five-year period (average of about 300 per year). By species, the percent occurrence of propeller wounds was 20% for green turtles (*Chelonia mydas*), 17% for leatherbacks (*Dermochelys coriacea*), 15% for loggerheads (*Caretta caretta*), 12% for Kemp's ridleys (*Lepidochelys kempii*), and 7% for hawksbills (*Eretmochelys imbricata*). In 2005, boat registrations in Florida surpassed one million. Most (54%) boats were registered in southeast or southwest Florida (Brevard County through Pinellas County, the southern half of Florida) where most (87%) of the sea turtle strandings with propeller wounds were found. The highest percent occurrence of propeller wounds in stranded sea turtles by county (2000-2005) were found in Palm Beach (42.7%), Martin (41.6%), Broward (39.3%), Miami-Dade (35.2%), Lee (24.1%), St. Lucie (23.5%), Indian River (22.5%), Hillsborough (21.7%), Brevard (20.6%), and Hernando-Levy (19.5%).

SEA TURTLES & STAKEHOLDERS: A PILOT MANAGEMENT PROGRAMME AT THE CONTROVERSIAL SEA TURTLE NESTING BEACH OF DAPHNI, ZAKYNTHOS, GREECE

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Conflict over habitat use between the needs of endangered wildlife and stakeholder interests is a global conservation issue. The Zakynthos National Marine Park (ZNMP) in Greece was established in 1999 to protect an important Mediterranean loggerhead sea turtle (*Caretta caretta*) breeding habitat at Laganas Bay, while promoting ecologically sustainable activities for affected communities, in a region with a firmly established mass-tourism industry. Daphni is one of six loggerhead sea turtle nesting beaches found in the ZNMP. Annually, Daphni beach holds

on average 11% of the ZNMP region's total nesting effort. Across two decades of monitoring, data collected by the NGO ARCHELON – the Sea Turtle Protection Society of Greece indicated that whenever the illegal businesses at Daphni operated without any form of regulation, a noticeable reduction in sea turtle nesting numbers was recorded at this beach, with nesting effort falling below average. In 2006, the Management Agency of the ZNMP attempted to forestall further degradation of the sea turtle nesting habitat at Daphni through initiating a pilot management programme. The programme aimed to improve nesting conditions for loggerhead sea turtles while simultaneously allowing stakeholder businesses to operate under specific guidelines, i.e. operation during daylight hours only and the incorporation of sustainable activities. The ZNMP presence at Daphni resulted in (1) reclamation of sea turtle nesting habitat lost to beachfront development (2) protective legislation being enforced throughout the nesting period, (3) quantitative monitoring of loggerhead sea turtle nesting activity and associated environmental factors, (4) the introduction of public awareness activities to this area. An increase in nesting numbers was recorded at Daphni beach in 2006, which resulted in it representing 14.5% of total loggerhead nesting effort in the ZNMP during the current season. While a range of parameters may have contributed to this increase, it may at least be partly attributed to the improvement of nesting conditions at Daphni in 2006. Hence, the case study of Daphni indicates that conservation of a sea turtle nesting habitat may co-exist with proper regulation and sustainable operation of stakeholder businesses.

SEA TURTLE CONSERVATION IN MATURA

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Trinidad is the most southerly isle of the Caribbean and is a globally important nesting site for endangered leatherback sea turtles. Matura, located on the east coast of Trinidad, represents one of the three major nesting beaches in Trinidad. In the 1970's and 1980's,the local community hunted nesting turtles on this beach. To manage this problem a conservation partnership between the local communities and the government wildlife agency was prompted. This collaboration led to the formation of community-based organizations known as Nature Seekers in Matura, dedicated to conserving sea turtles while promoting Community Tourism in the area. After years of growth, the organisations have extended their work to include Public Education. During this time the activities of the communities attracted and transformed sea turtle hunters and their children into conservationists, who are now some of the strongest members of the team. Volunteers patrol the beaches on a nightly basis to protect the nesting turtles. In addition important scientific data are collected such as tag numbers, measurements, physical condition, weather conditions etc. An intensive tagging program has been in operation for the past few years, initiated in Matura. The conducting of tours to view the nesting process of the turtles and to provide sea turtle related education was done both at local and national levels. The Community collaborated on many research projects conducted by scientists from international organizations and universities (such as the Satellite Tracking of Turtles done this year by Scoot Eckert). This project supports the involvement of the local communities in natural resource management and it allows them to realize the value of the natural environment surrounding the community, the economic potentials associated with tourism activities, as well as the goal of sustainable livelihoods. This presentation shares a community's experience in community-based conservation.

METAL PROFILES USED AS ENVIRONMENTAL MARKERS OF GREEN TURTLE (*CHELONIA MYDAS*) FORAGING RESOURCES

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The Baja California Peninsula, Mexico serves an important role for feeding and developing sea turtles. High concentrations of metals detected in green turtles (*Chelonia mydas*) from Magdalena Bay prompted an investigation into the sources of metals in the region. We compared metal concentrations in sea turtle tissues with plant species found in their stomach contents, and with the same species of plants collected inside a sea turtle refuge area known as Estero Banderitas. Differences in the metal concentrations between marine plant species were minimal. Principal components analysis of the percent contribution of individual metals to the overall metal signature of each plant or tissue sample generated three principal components that explained 80.7% of the total variance in the data. When plotted relative to the first and second principal components, the plant samples collected within Estero Banderitas formed a grouping at the left side of the plot while the green turtle tissue samples and the plants from the stomach contents formed separate groupings. The plants in the stomach contents contained greater percent contributions of Cd and Zn than the plants collected inside the bay, while Pb and Mn contributed more to the metal profiles in the bay samples. The metal profiles in the sea turtle tissues more closely resembled the stomach contents than the same species of plants collected within Estero Banderitas, and suggest that sea turtles collected inside Magdalena Bay are using foraging resources outside of the Estero Banderitas region. This work supports the suggestion that metal profiles can be used as "environmentally acquired markers" to determine sea turtle feeding areas and aid in conservation efforts to establish adequate protection for these species based on improved understanding of the extent of sea turtle foraging areas.

NEST RELOCATION ON FLORIDA'S URBAN BEACHES: WHEN LESS IS MORE

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The sandy Atlantic coast beaches along Broward County's twenty-four miles of shoreline typically support 1800 to 2600 loggerhead (*Caretta caretta*) nests, up to 255 green turtle nests (*Chelonia mydas*), and 16 to 40 leatherback turtle nests (*Dermochelys coriacea*) each year. The same stretch of beach also supports some of Florida's famous resort cities, including Fort Lauderdale, Hollywood, and Pompano Beach. To protect hatchling sea turtles from the negative effects of urban lights, Broward County implemented a massive nest relocation program. All nests found along most of the approximately 24 miles of sandy beach were transported to a few localized areas, with the majority of nests moved to the north end of the County. While implemented with the best intentions, there were logistical difficulties associated with locating, transporting, and reburying such a large number of nests during the five to six month nesting

season. Clustering nests in relatively few areas resulted in the expected problems of predation, both on the beach and in the water off the beach, contamination of beach sands, decreased hatch and emergence success. Due to a lack of efforts to enforce local lighting ordinances, relocated nests were still subject to inappropriate light levels. Recently, the County has worked with state and federal government staff on reducing the scale of nest relocation. As part of this effort, more nests were left in place on darker sections of beach; nests in more brightly lit areas were still relocated but to an adjacent beach with less lighting and not to hatcheries. Local municipality staff increased efforts to ensure compliance with local lighting ordinances, while local property owners worked to improve their lighting.

EVALUATING LOCAL SPATIAL NESTING IMPACTS WITHIN AND ADJACENT TO A BEACH NOURISHMENT PROJECT, JUNO BEACH, FLORIDA, 1999-2002

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Beach nourishment often results in measurable changes in sea turtle nesting behavior for nesting seasons immediately following the project, including documented reductions in nesting emergences. To date, most nesting inventory evaluations of beach nourishment impacts compare total emergence or nest counts from the project area to 'control' areas or other natural beaches geographically removed from the nourishment project. Using detailed global positioning system (GPS) coordinates for each documented emergence in the 1999-2002 nesting seasons from Juno Beach, Florida, we apply spatial statistical techniques to describe and compare local emergence patterns within and adjacent to a nourishment project conducted between the 2000 and 2001 nesting seasons. More specifically, we compare the spatial intensity of emergences (number of emergences per unit distance) between the two years prior and the two years after the nourishment project. We report pre-/post-nourishment comparisons for all emergences, nesting emergences, and non-nesting emergences for both loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) turtles. The detailed location data and statistical approach not only identify locally varying reductions in all emergences (nesting and non-nesting) per unit distance in the nourishment zone for both species, but also reveal different species-specific increases and decreases as one moves north and south to areas immediately adjacent to the nourishment zone. Loggerhead emergences are significantly reduced in the two-year post-nourishment period compared to the two-year pre-nourishment period for a continuous interval beginning approximately 2,000 feet north of the northern end and ending approximately 5,000 feet north of the southern end of the approximately 15,000 foot nourishment zone. That is, moving from north to south, the observed interval of significant reduction begins before entering the nourishment zone and ends prior to reaching the end of the zone. In addition, significantly increased loggerhead nesting intensities are observed to the north (for areas further than 3,000 feet north of the nourishment zone) and also to the south (beginning coincident with the southern border) of the nourishment zone. While based on fewer observed emergences than for the loggerhead data, green turtle nesting largely follows a similar pattern but with significant reductions beginning somewhat closer to the northern end of the nourishment zone while still ending approximately 5,000 feet north of the southern end of the nourishment zone. No significant increases were observed north of the nourishment zone for green turtles but, as with loggerheads, we observe significant increases beginning immediately south of the nourishment zone. Importantly, the results for both species reveal significant reductions in both nesting and non-nesting emergences in the two years following the nourishment project suggesting an impact on behavior prior to emergence from the ocean, in

addition to any behavioral modifications due to the experiences of the nesting turtles as they emerge on the newly reconstructed beach. While we focus on results from Juno Beach Florida, we also briefly present similar results for Jupiter Beach, indicating consistent general patterns of emergence reductions within the nourishment zone accompanied by similar increases in areas adjacent and to the immediate south of the nourishment zone.

CONSERVATION STATUES OF THE NATIONAL GANGKOU SEA TURTLE RESERVE IN CHINA

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The National Gangkou Sea Turtle Reserve (NGSTR) in Guangdong Province currently is the unique nature reserve for sea turtles in China. NGSTR was called Sea Turtle Bay by local citizens, which is located in the east of Renping Peninsula, Guangdong Province, between Da Ya Bay and Hong Hai Bay. The whole area of NGSTR is 18 km^2. NGSTR was founded by Guangdong Province, China in June 1985, and upgraded to national reserve status in Oct 1992 by the State Council. The State Council authorized the Ministry of Agriculture, China to manage NGSTR. In 2002, the Reserve was included in international important wetland sites by the Ramsar Convention (the Convention on Wetlands of International Importance, especially as Waterfowl Habitat). In July 1993, it acceded to Biosphere Reserve Net of China National. In October 2003, Guangdong Provincial Fishery Administration was authorized to establish the Fishery Administration Station in NGSTR. NGSTR biodiversity is abundant, about 1300 living creatures are found. Annually from June to October, sea turtles swim to NGSTR for nesting and breeding. NGSTR have already succeeded to protect nesting sea turtles from 1985 to 2005 with 1,184 sea turtle emergences, 665 nestings, resulting in 75,319 eggs, and 62,188 sea turtle hatchlings. Of these, 53,203 sea turtle hatchlings were released. Since 1986, NGSTR conducted research on artificial hatchery techniques for green turtle nests. Satellite tracking was conducted by NGSTR in 2001. Swimming routes show that sea turtles can swim across Taiwan channel to Japananese coastal areas. During 2002-2003, NGSTR made use of a beneficial microorganism (EM) to increase sea turtle hatching rates from 40% to 80%. For public awareness, NGSTR Set up a sea turtle multi-function demonstration center, a rescue center, a specimen building, etc. With respect to education facilities, NGSTR built "the hands to hands global village for Chinese young children" and "Guangdong Province teenager education Base of science and technology ", which hold various environmental protection summer camp activities. NGSTR also invites people to participate in exhibitions on the protection of sea turtles. All of these activities help to raise public awareness on the protection of endangered wildlife. However, there are some problems for NGSTR.(1)The funds are short, much protection and management work can't be finalized;(2) lack of surveys on sea turtles and biodiversity; (3) Fishing by-catch affects sea turtles migrating to NGSTR; (4)The reserve scope is too small, only 18 square kilometers, it needs to be extended. To secure the future of sea turtles in China, the following recommendations are offered: surveys to identify critical habitat and better document population trends; the development of a long-term Action Plan to guide conservation and management efforts; enhance international, regional and national co-operation; improve public awareness and participation; stronger measures are needed to protect habitat; a science-based plan to restore populations is needed, effective mitigating of major threats is needed; and the reduction sea turtle by-catch by fisheries.

AN OVERVIEW OF OLIVE RIDLELY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) MASS NESTING, ARRIBADA, BEACHES WORLDWIDE

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Mass synchronous nesting, termed arribadas, are unique to members of the sea turtle genus *Lepidochelys*. The olive ridley sea turtle (*Lepidochelys olivacea*) is known to currently nest in arribadas on at least 10 beaches worldwide: Gahirmatha, the Devi River Mouth, and Rushikulya (India); La Escobilla and Morro Ayuta (Mexico); La Flor and Chacocente (Nicaragua); Nancite and Ostional (Costa Rica); and Isla de Cañas (Panama). This study reviewed existing information on nesting activities and trends, monitoring efforts, legal protection, major threats, and local community use (direct and indirect) of olive ridley sea turtles at known arribada beaches. Nesting is increasing at Ostional beach and stable at Escobilla beach; trends at the other beaches are either inconclusive or indicate that numbers of nesting females are declining. Local inhabitants at Ostional, Isla de Cañas, La Flor, and Chacocente utilize sea turtle eggs under some sort of controlled harvest. Comparative studies at the different beaches are needed with standardized monitoring methods to better determine nesting trends. Current harvesting procedures at both La Flor and Chacocente should be reevaluated and modified, as current levels of egg harvesting and poaching are not sustainable.

SATELLITE TRACKING OF INTERNESTING LEATHERBACK TURTLES IN A MARINE PROTECTED AREA

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The leatherback turtle (*Dermochelys coriacea*) is a globally distributed species and is subject to fisheries bycatch throughout its range. Focused protection within pelagic foraging habitats is difficult to achieve but may be more tractable when populations are concentrated near breeding grounds. We use satellite telemetry to describe patterns of habitat utilization during the internesting period (mean ± SD) 10.2 ± 1.7 days for leatherback turtles (n = 5) nesting at Mayumba National Park in Gabon on the Equatorial West African coast (South Atlantic). The National Park includes critical nesting grounds and a Marine Protected Area (MPA) to 15 km offshore. Turtles dispersed widely (mean maximum displacement 82 km, range 21 to 166 km) from the nesting beach, spending two thirds of tracking time outside of the protective confines of the National Park which includes a fisheries exclusion zone. This propensity to disperse is likely

to increase the chance of deleterious interactions with fisheries in the region. Patterns of habitat utilization indicate the need for wider spatial scale planning on the West African continental shelf to enhance protection of leatherback turtles while seasonally occupying these habitats in great numbers for breeding and nesting.

COMPARING THE IMPACT OF NATIVE AND INTRODUCED PREDATORS ON GREEN TURTLE (*CHELONIA MYDAS*) HATCHLINGS IN THE GALAPAGOS ISLANDS, ECUADOR

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This study was undertaken to compare the impact of predation by native and introduced species on green turtle (*Chelonia mydas*) hatchlings at four study sites in the Galapagos Islands, Ecuador. In the Galapagos Islands, as in many isolated island locations, some introduced species have flourished in the absence of natural predators putting a number of native species at risk of extinction. Four study sites were examined: Quinta Playa (QP) and Bahia Barahona (BB) on Isabela Island, Las Bachas (LB) on Santa Cruz Island, and Las Salinas (LS) on Baltra Island. The selected sites are four of the main turtle nesting beaches in the Islands. Data were collected opportunistically during day and night surveys of nesting beaches. When hatchlings were observed emerging from nests, number of hatchlings and predators present were recorded. Seventeen predator species were identified, including five invasive species: feral pigs, house mice, black rats, feral cats and dogs. A native predator, the lava gull (*Larus fuliginosus*), an endemic species listed as vulnerable on the IUCN 2006 red list, was also encountered. Observation of the emergence of a total of 3230 hatchlings suggested that approximately 57% of emerging hatchlings suffer predation before reaching the sea. Approximately 93% of this predation was carried out by native species, confirming the importance of green turtles in the diet of native fauna. The remaining 7% of beach predation was carried out by feral pigs and cats, with the former particularly affecting study site QP. While the current impact of introduced species on hatchling survival appears to be low, the importance of continued monitoring is stressed to advise future management plans of introduced species in each green turtle nesting site. Expansion of monitoring to other nesting sites in the Galapagos is also recommended to assess the problem of predation by introduced species throughout the archipelago.

Ecology and Evolutionary Biology

DIET AND ECOLOGICAL TRANSITION OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN THE CENTRAL MEDITERRANEAN

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In the central Mediterranean, loggerhead turtles (*Caretta caretta*) frequent both the southern shallow waters part of the African shelf and the northern deep waters part, closer to Sicily, Italy. In these two areas they are incidentally caught by trawlers and drifting longlines, and are supposed to be in the neritic and oceanic stage respectively. In order to assess the size at which the transition from the oceanic to the neritic stage occurs, we analyzed food items from 76 turtles ranging 25-80 cm CCLn-t, caught by longliners, trawlers, or found floating at sea and brought to the WWF's Turtle Rescue Centre in Lampedusa Island, Italy, in the period 2001-2005. Samples consisted in 29 stomach contents obtained through necropsy of dead animals and 130 feces from 47 turtles. Food items belonged to 19 Classes of 12 Phyla. Whenever possible, the items were identified at the species level, with a total of 69 species of which 49 are reported among *Caretta caretta* food items for the first time. Both animals and plants were represented, although plants were probably ingested incidentally. Gastropoda, Crustacea and Echinoidea were the three most common Classes, occurring in 59%, 59% and 51% of the turtles respectively. As expected, all the turtles caught by trawlers had ingested benthic preys, and 25% of them had fed upon pelagic prey items too, indicating they fed through the whole water column. Although specimens caught by drifting longliners (fishing in deep waters) were expected to feed upon pelagic prey items only, we found benthic preys in 63% of turtles from which feces or stomach contents were collected (n=27). Even if we conservatively assume that other 12 turtles in which no stomach contents were found or which did not defecate in reality had fed upon high digestible pelagic prey items leaving no residuals, the overall proportion of turtles with benthic prey items would be still high (44%; n = 39). Even turtles in the smallest range (e.g. 25-30 cm) had ingested benthic prey items, although the occurrence is higher in turtles above 40 cm. These results suggest that in the study area loggerhead turtles have an exclusively pelagic diet at a size below the size range of our sample. This indicates a very early trophic use of neritic grounds in addition to the oceanic areas, suggesting that small juveniles move across a wide area including both neritic habitats (where they find benthic prey items) and oceanic habitats (where they are caught by longlines). This lack of habitat and area separation in most part of the juvenile class may have implications for conservation that should be considered.

GENETIC ANALYSIS OF THE *ERETMOCHELYS IMBRICATA* POPULATION OF GUATEMALA

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We present the results of the first genetic analysis of the hawksbill population of Guatemala. We collected eight tissue samples of nesting females at the Caribbean coast of Guatemala to get DNA sequences of the mitochondrial D-Loop. We obtained PCR sequences with the Allard 1994 oligonucleotides LTCM1 y HDCM1 that produces a fragment of 550 bp. The sequences were aligned with Clustal software to identify polymorphic positions that were confirmed with re-analysis of samples. With this, haplotypes we determine the composition of the Guatemalan Hawksbill nesting females related to the sequences already published by the use of a parsimony analysys. We also show the historic effective population size based on the genetic diversity values.

WHAT DO HITCHHIKERS EAT? THE DIET OF *PLANES CYANEUS* AND THEIR ASSOCIATION WITH LOGGERHEAD AND OLIVE RIDLEY TURTLES OFF THE PACIFIC COAST OF BAJA CALIFORNIA SUR, MEXICO

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In the Pacific Ocean, both loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles host a variety of epifauna, including a species of grapsid crab, *Planes cyaneus* (Dana, 1851). This study examines the ecological role of sea turtles as hosts using *Planes* as a model interacting species. Although this relationship is currently being studied in the Atlantic, little is known about the diet of *P. cyaneus* and their association with sea turtles in the Pacific. In Bahia de Ulloa, Baja California Sur, Mexico, 87 loggerheads and 14 olive ridleys were examined for crab presence. A total of 85 crabs were collected from both species of turtles sampled. Previous studies have indicated that *Planes* species may be foraging on the epibiotic organisms that are commonly found on sea turtles, but the diet and ecology of these crabs is poorly understood. Because olive ridley turtles have much lower abundance and diversity of both epi-flora and -fauna than loggerheads, we hypothesized that crab abundance would be lower on olive ridleys due to food limitation. However, a higher proportion of crabs were found on olive ridleys (50%) than on loggerheads (42%). In order to understand this discrepancy, we analyzed the number of crabs per turtle, percent cover data from turtle carapace photographs, and diet of crabs via stomach content sampling. Social structure of crabs found on turtles was also studied. Female crabs had significantly longer carapace lengths than males and 57% were ovigerous. Most of the crabs present on turtles were found in male-female pairs or as singletons with more than two crabs per turtle rarely occurring.

METAPOPULATIONS, POPULATIONS, SUBPOPULATIONS, AND CONNECTIVITIES: ANALYSIS OF THE COMPLEX POPULATION STRUCTURE OF NORTH ATLANTIC LOGGERHEADS

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North Atlantic loggerheads have a complex life cycle that spans decades and a spatial ecology that encompasses terrestrial, neritic, and oceanic habitats. Our understanding of this complexity has increased with the incorporation of recent stable isotope data and new genetic information. Our objective is to evaluate the North Atlantic loggerhead population within the context of current metapopulation theory and to explore a novel method to quantify the strength of connectivities among rookeries and foraging grounds. We approach these questions with analyses of new mtDNA haplotype frequency data for rookeries and foraging grounds (both oceanic and neritic). The frequencies of the two most common mtDNA haplotypes, which when combined account for approximately 92% of individuals sampled, represent a classical cline north to south along the SE USA. We discuss the problem of assigning rookery sources when the rookeries exhibit a clinal change. In addition, we test whether the oceanic developmental stage is genetically unstructured and whether there is juvenile homing for the neritic foraging populations. A Bayesian model is applied that allows us to analyze multiple oceanic and neritic foraging grounds simultaneously with respect to source rookery contributions. The results of our study have both theoretical and conservation implications. We discuss the conservation implications of our metapopulation analyses and the clinal composition of rookeries.

POPULATION STRUCTURE OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) AT ROOKERIES AND FORAGING AREAS IN GRENADA, WEST INDIES, BASED ON MITOCHONDRIAL DNA SEQUENCES

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Ongoing analyses of mitochondrial DNA of hawksbill sea turtles, *Eretmochelys imbricata*, within the Caribbean region have yielded information on the patterns of the evolutionary process and migratory behaviour of these animals. One of the greatest contributions of molecular studies has been the capacity to identify individual populations and estimate their contributions to aggregations in marine habitats. In order for accurate estimates to be made, all possible source populations need to be characterized. However, to date several Caribbean habitats and foraging areas remain uncharacterised in terms of mtDNA haplotypes. A mtDNA d-loop analysis of the hawksbill at rookeries and foraging areas in Grenada and the southern Grenadine Islands has revealed new information about the haplotype compositions of those populations that include haplotypes previously unreported from other colonies. Individuals at foraging sites originate in

various regional rookeries, some as far as Mexico. Given the fact that there is legal harvest of sea turtles in Grenada, as well as in several other Eastern Caribbean territories, understanding the genetic composition of rookeries and foraging grounds in these islands together with information on the level of impact on individual populations will help to direct and focus future conservation efforts throughout the Wider Caribbean.

GENETIC PROFILING OF CAPTIVE CURAÇAO SEA TURTLES

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Sea turtles are a widely distributed and critically endangered species, and for conservation it is important to have knowledge about their population structure. In particular, the migratory behaviour between foraging and nesting areas is essential. For three species of sea turtles; the green turtle (*Chelonia mydas*), the hawksbill turtle (*Eretmochelys imbricata*) and the loggerhead turtle (*Caretta caretta*), several locations were genetically analysed to reconstruct these behaviours by linking haplotypes from nesting and foraging areas. In this study an extra sampling location, the area around the island of Curaçao in the Netherlands Antilles, is considered. 35 tissue samples from the three species were collected from the captive sea turtles from the Curaçao Sea Aquarium. Archive studies and interviews were used to find that the green and hawksbill turtles from the aquarium both represent the Curaçao foraging population and the loggerhead turtles represent two nests of the Curaçao nesting population. For every species a specific region of the mtDNA hypervariable D-loop was sequenced and all individuals were haplotyped according to previously published sequences. Among 15 individuals of green turtles 3 haplotypes were identified, among 9 hawksbill turtles 3 haplotypes and among the two loggerhead nests 2 haplotypes were identified. Genealogies of the haplotypes were estimated and with their geographical distribution two different nesting populations could be distinguished for each species. For the loggerhead turtle, Curaçao is, geographically as well as genetically, a transitional area between the two populations. The other two species, both foragers from Curaçao, are genetically mixed with individuals originating from the different nesting populations. Findings from this study confirm the existence of genetically mixed foraging populations. In the overall reconstruction of the population structures of the three species, this new location can be added, but for effective conservation more information is necessary and thus more sites need to be studied in the future.

EXPLORING THE ORIGIN OF LOGGERHEAD SEA TURTLES IN THE SOUTHWESTERN ATLANTIC OCEAN BY MITOCHONDRIAL DNA ANALYSIS

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Sea turtles have extended and complex life histories, and are able to cover great distances during their migrations. The loggerhead (*Caretta caretta*) life cycle consists of developmental stages which can be segregated spatially and temporally. In the Southwestern Atlantic Ocean, the waters of Uruguay are an important foraging and migratory habitat for immature and mature loggerhead sea turtles. In general, juvenile loggerheads inhabit offshore waters, while mature turtles are present along the continental shelf. These turtles are taken as bycatch in the industrial fisheries that operate in the area; the pelagic longline fleet operates over the shelf break and oceanic waters, and the coastal bottom trawl fleet operates over the shelf, at no more than 50m depth, mainly in the Rio de la Plata estuary. In order to characterize the haplotype composition, possible natal origins, and dispersal behavior of loggerhead turtles incidentally captured by these fisheries, we carried out preliminary genetic analyses. Following DNA extraction, we sequenced a 340 base pair fragment of the mitochondrial DNA control region. Sequence editing and alignment revealed three haplotypes previously described for loggerhead turtles. All of the loggerheads caught in coastal bottom trawl fishery were large, classified as adults or medium to large juveniles, and shared the single “D” haplotype (n=10). This haplotype is only found among sources in Brazil, the rookery closest to Uruguay. In contrast, the animals caught in longlines were smaller (mostly small and medium juveniles), more genetically diverse, and some were traceable to distant rookeries. Three different haplotypes were revealed in the longline sample (n=10): Haplotype “B” present among rookeries in the USA, Mexico and Greece; Haplotype CC-A34 found only in the Pacific, and Haplotype “D”. These results suggest that larger turtles may forage closer to their birthplace in Brazil, while some smaller turtles from distant rookeries may disperse and utilize southern Atlantic waters during their developmental stages before returning to their natal rookeries. Correspondingly, the coastal bottom trawl fishery may primarily affect turtles breeding in Brazil, while populations as distant as Australia may be impacted by longline activities. Marine turtles are highly migratory and often cross national borders throughout their life cycles. Therefore activities in one jurisdiction can affect the status of the species in another. This study furthers our understanding of the distribution and migratory behavior of loggerhead turtles in the southern Atlantic and confirms the importance of international cooperation in managing these species. Further research is needed, and monitoring of Uruguayan fisheries should continue in order to provide the information necessary for devising appropriate international conservation measures.

USING MTDNA AND MICROSATELLITES FOR ORIGIN ASSESSMENT IN MARINE TURTLE FEEDING GROUNDS

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We used mitochondrial DNA (mtDNA; n=584) and seven microsatellites (nDNA: n=169) to assess the origin of the juveniles inhabiting several feeding grounds in the western Mediterranean and the eastern Atlantic. Both markers revealed deep genetic structuring within the western Mediterranean.

THE LEATHERBACK TURTLE, *DERMOCHELYS CORIACEA*: A MODEL TO TEST HYPOTHESES OF AGE RELATED REPRODUCTIVE STRATEGIES

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Life history data derived from long-term studies of nesting turtles is crucial in developing effective conservation programs. The identification of age-related reproductive strategies is particularly important for the conservation of long-lived species such as sea turtles. The leatherback turtle, *Dermochelys coriacea* was chosen as a model to test hypotheses of age-related reproductive strategies because it displays indeterminant growth and has the highest absolute reproductive output of all reptiles. The 'relative reproductive rate' hypothesis predicts that older individuals in a population will have increased reproductive success through increased reproductive output, while the contrasting 'senescence' hypothesis predicts that reproductive output will decrease in the older individuals in a population. To test these important hypotheses of life history traits, we compared reproductive output between new recruit (neophyte) and remigrant turtles by analysing 8 years of nesting data from 1998 to 2006 from a population of leatherback turtles at Las Baulas National Park, Costa Rica. It was assumed that an untagged turtle first seen between 1998 and 2006 was a new recruit to the population

(because saturation tagging began in 1993) and also that any turtle with a PIT tag was a remigrant turtle. This assumption was made because the frequency of the remigration interval for all turtles that had nested since 2003 (ten years after PIT tagging commenced at Playa Grande) showed that only 11% of turtles had a remigration interval of greater than 5 years. Therefore, the number of years since a turtle was PIT tagged was used as a proxy for age, because if each turtle nests for the first time at approximately 9 years of age, then a turtle that has been tagged for a greater number of years will be older than a turtle that has been tagged for a lesser number of years. Remigrant turtles when analysed as a group were larger and had higher reproductive output than new recruit turtles. However, when the number of years that a turtle had been tagged was used as a proxy for age, there was no significant change in reproductive output as the number of years that a turtle had been tagged increased. These results supported neither the relative reproductive rate hypothesis nor the senescence hypothesis. Instead, nesting experience between the first nesting season and any subsequent season may be an important determinant of reproductive output rather than age. However, it is also recognised that increases or decreases (senescence) in reproductive output due to age may not be detectable in this study, because although the data were obtained over a 15 year period, it is still less than the expected reproductive life-span of a leatherback.

MULTI-YEAR EVALUATION OF HATCHLING SEX RATIOS OF HAWAIIAN GREEN SEA TURTLES

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Hawaiian green sea turtles represent an isolated population of sea turtles. They possess temperature-dependent sex determination (TSD) which can result in a variety of hatchling sex ratios. Thus, hatchling sex ratios are of conservation and ecological interest. French Frigate Shoals (FFS), part of the Hawaiian Islands National Wildlife Refuge is an atoll where approximately 90% of Hawaiian green nesting occurs. The purpose of this study was to predict hatchling sex ratios produced on East and Tern Islands at FFS based on both nest and beach temperature data from 1998-2005. Data loggers were placed into nests and in beach locations at mid-nest depth (approximately 45 cm) to monitor temperatures. Sex ratio predictions were based on the average temperature during the middle third of incubation. The nest temperature data suggested relatively cool temperatures compared to green turtle populations in other areas of the world. The sand temperatures were also relatively cool. These data suggest that either male sex ratios predominate or that the Hawaiian green turtle has evolved a lower pivotal temperature in its TSD. We have recently been addressing these hypotheses. Gonadal histology was employed to verify the sex of hatchlings that were found dead in nests after all of the live hatchlings emerged from the 2004 nesting season at FFS. The kidney and gonad tissue were preserved and processed using standard paraffin histological procedures. Each gonad was then examined using microscopy to determine if it was an ovary or a testis. Both male and female hatchlings were identified from FFS during 2004. Additionally, we are currently evaluating the pivotal temperature experimentally in laboratory incubators. The results of these studies will determine if Hawaiian green turtles have evolved a lower pivotal temperature than other populations of green turtles to coincide with cooler nesting beach temperatures.

SEA TURTLE BYCATCH AND TERRESTRIAL ECOLOGY: A REVIEW OF THE INTERACTIONS BETWEEN STRANDINGS, SCAVENGERS, AND TERRESTRIAL ECOSYSTEMS

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Sea turtle mortality results in the occurrence of carcass strandings on coastlines all over the world, the extent of which is established from international stranding networks and research efforts. For example, the Sea Turtle Stranding and Salvage Network reports 16,879 strandings on the shorelines of all states between Texas and Maine between 1998-2002 (STSSN). In addition, various research studies are underway in an attempt to understand the leading causes of mortality in sea turtles, including fisheries observing, PIT tagging (Spotila *et al*. 2000), satellite telemetry (Hays *et al*. 2003), and carcass assessment (Panagopoulos *et al*. 2003; Koch *et al*. 2006; Balazs 2006). Studies suggest the deployment of gillnets, longlines, trawls, and hook and line gear as the main cause of sea turtle mortality. As strandings accumulate on beaches, coastal ecosystems are the recipient of this resource allocation. The terrestrial implications of sea turtle strandings have yet to be studied; therefore, this preliminary review is a compilation of data regarding scavenger and stranded turtle interactions, obtained through literature review and personal communication with field researchers. Among other species, black vultures (Coragyps atratus), turkey vultures (Cathartes aura), ghost crabs (Ocypode quadrata), dogs (Canis lupus familiaris), fire ants (Solenopsis invictiva), crocodiles (Crocodylus sp.), coyotes (Canis latrans) (Nichols, pers. obs.) and black bears (Ursus americanus) have all been observed feeding on stranded turtles (eg: J.P. Martinez, pers. comm.; P. Plotkin, pers. comm.; S. Murphy, pers. comm.; M. Lamont, pers. comm.). At some locations, the majority of strandings are due to anthropogenic causes, and an unnatural accumulation of carcasses on coastlines may have an ecological effect. For example, an increasing number of scavengers in coastal areas may affect ecosystem equilibriums by altering species interactions or through the reallocation of resources. Future studies in this theme should be considered in order to understand the ecological relationship between scavengers and stranded turtles, and to distinguish any resulting ecosystem impacts.

COMERS AND GOERS: LONG-TERM FREQUENCY ANALYSIS OF BARNACLES FROM LOGGERHEAD SEA TURTLES AND UNDERWATER OBSERVATIONS OF ACTIVE GROOMING BY HOST TURTLES

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For ten seasons (1997-2006) data have been collected at Wassaw Island, Georgia that reflect the percent occurrence of each barnacle species hosted by turtles annually. These data - the first of its kind reported for sea turtles or any epibiont host – are reported here. Our data are also the first on the composition of barnacle communities from individual turtles over multiple nesting seasons. These data demonstrate that individual turtles consistently utilized the same marine habitats (pelagic v. benthic marine v. estuarine benthic), and likely home-range, during

each nesting season they were sampled. Frequency data are also used to demonstrate the periodicity of some barnacle species and how multi-seasonal epibiont surveys are necessary to adequately catalogue the epibionts of any turtle population. We also present data on the sudden disappearance of epibiota from nesting turtles that had previously (one nesting event prior) hosted dense aggregations of epibionts. We combine these accounts with photographic observations and data collected at Gray's Reef National Marine Sanctuary of fouled turtles actively grooming beneath limestone ledges – leaving scrape marks on the carapace similar to those observed from 'clean' loggerheads on the nesting beach. We discuss the length of grooming bouts and describe the biotic and abiotic factors associated with grooming sites. Grooming mechanisms (facultative, passive or active) are also described and compared.

LOGGERHEAD SEA TURTLES AS BIOTURBATORS IN MARINE ECOSYSTEMS

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The northern Adriatic Sea is one of the most important foraging habitats for loggerhead sea turtle (*Caretta caretta*) in the Mediterranean. Its shallow continental shelf, favorable sea temperatures and rich benthic communities constitute feeding areas for loggerheads in neritic stage. While searching for prey, loggerheads actively dig and mine through the seafloor, ingest seafloor sediments and mix substrates. The sea floor of the Adriatic shelf is covered by muddy and sandy sediments of terrigenous origin and inorganic remains of benthic organisms, like shells of bivalves and gastropods. In order to examine ecological role of loggerheads in nutrient mixing and cycling in marine ecosystem, we qualitatively and quantitatively analyzed mollusc component in the diet of 50 loggerhead turtles (mean CCLn-t: 42.5 cm, SD: 11.7) found dead in the northern Adriatic Sea (Slovenia and Croatia) in 2001-2004. We preformed detailed identification and quantification of bivalve and gastropod fragments and sub-fossil shells. In total, we recorded 99 mollusc taxa. Most taxa belonged to gastropods (55) and bivalves (41), which were found in 88% of analyzed turtles. Majority of identified gastropod and bivalve species were small (shell length < 2 cm) and of sub-fossil origin. Due to the small size and low energetic value, shells of these species (e.g. *Bittium reticulatum*, *Turritella communis*, *Corbula gibba*) most likely do not present selected prey of loggerheads, and were probably eaten incidentally while digging through benthic sediments. By such feeding strategy, loggerheads actively mix sediments, enable aeration and contribute in nutrient cycling. Large proportion of sub-fossil shells found in our samples emphasizes the role of loggerheads as bioturbators in marine ecosystems. *Acknowledgements*: Participation at the 27th Symposium on the Biology and Conservation of Sea Turtles was made possible by an international travel grant from the following organizations: Disney Animal Kingdom, Western Pacific Regional Fisheries

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THE POTENTIAL IMPACT OF CLIMATE CHANGE ON LOGGERHEAD SEX RATIOS IN THE CAROLINAS – HOW IMPORTANT ARE NORTH CAROLINAS MALES?

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We investigated the potential effects of forecast climate change on the loggerhead sea turtle at a breeding location at the northerly extent of the range of regular nesting in the USA. We recorded sand temperatures and used the relationship between sand and local air temperatures, along with local historical air temperatures in North Carolina, to examine past sex ratios and predict future sex ratios under scenarios of warming. There were no significant temporal trends in estimated primary sex ratio evident over the study period (1980-2005) and estimated mean sex ratio was 58% female. Long term mean annual air temperatures in North Carolina have decreased significantly over the last 64 years, although a recent warming pattern has been observed, with 10 of the last 12 years warmer than the long term average. There were no temporal trends in phenology over the study period but earlier nesting and longer nesting seasons were related to warmer sea surface temperature. We modelled the effects of incremental increases in mean air temperature of up to 7.5°C, the maximum predicted increase under modelled scenarios of climate change that would lead to 100% female hatchling production and lethally high incubation temperatures, causing reduction in hatchling production. We used previously published data for populations of turtles in more southern parts of the USA, which are currently highly female biased, to model the same increases up to 7.5°C. These southerly populations are likely to become ultra-biased with as little as 1°C of warming and experience extreme levels of mortality if warming exceeds 3°C. The lack of demonstrable increases in air temperature in North Carolina in recent decades, coupled with primary sex ratios that are not highly female biased, means that the male offspring from North Carolina could play an increasingly important role in the future viability of the loggerhead turtle in the Western Atlantic.

INVESTIGATING TROPHIC STATUS OF OLIVE RIDLEY TURTLES (*LEPIDOCHELYS OLIVACEA*) IN THE EASTERN TROPICAL PACIFIC USING STABLE ISOTOPE ANALYSES

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Little is known about the diet of olive ridley turtles due to the difficulty of sampling this pelagic species. A more practical method to address dietary questions has become the application of stable-carbon (δ13C) and -nitrogen (δ15N) isotope analyses. This approach supplements information obtained through standard diet study techniques such as esophageal lavage and fecal analysis. Since dietary information is integrated into consumer tissues over extended time periods, stable isotope analysis can provide a better understanding of consumer's overall trophic status versus other techniques that only give snapshots of recently consumed foods. The focus of this project was to determine the trophic variability within and among maturity and sex classes of olive ridleys captured in pelagic habitats of the Eastern Tropical North Pacific (ETNP). Skin samples were collected from 32 individuals during a NOAA research cruise to the ETNP in 2003. Turtles were assigned to a maturity class based on their size (straight carapace length) relative to mean nesting size. Males were identified based on the presence of a differentiated tail. Samples were dried, lipid extracted, and analyzed for stable-carbon and -nitrogen isotope ratios. δ13C signatures were similar among juveniles (-15.3 ± 0.3), adult males (-15.1 ± 0.2) and apparent females (-14.9 ± 0.2). δ15N signatures were also similar among classes: juveniles (13.3 ± 0.2), adult males (13.3 ± 0.3) and apparent females (13.6 ± 0.3). There was no significant difference in δ13C or δ15N among groups; therefore, we grouped all animals to determine potential prey groups and overall trophic status. The δ15N range (11.4 to 15.8‰) was compared with values of potential prey items collected during additional NOAA cruises in the ETNP and from published literature. Invoking the mean of published diet-tissue discrimination values for nitrogen (Δdt15N) in marine turtle skin (+2.2‰) suggests that olive ridley prey in the ETNP have δ15N values ranging from 9.35 to 13.77‰. Olive ridley turtles may therefore feed on a variety of pelagic organisms possessing δ15N within this range, such as jellyfish (δ15N = 10.5‰), squid (δ15N = 11.5‰) and crustaceans (δ15N = 11.32‰). Moreover based on published δ15N values for primary consumers (zooplankton) in the ETP, olive ridley turtles examined in this study occupy a trophic level of 2-4 and are considered to be polytrophic consumers. These findings will facilitate conservation of the species since juveniles and adults can be managed as a single foraging unit. Continued isotope analyses and trophic studies will also address specific recommendations for research outlined in the NMFS Recovery plan for olive ridley turtles.

GENETIC STRUCTURE OF NORTH ATLANTIC LOGGERHEAD SEA TURTLES: INSIGHTS FROM EXPANDED MITOCHONDRIAL ANALYSES

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In the Atlantic Ocean, the Cape Verde Islands and the southeastern United States are important nesting areas of the globally endangered loggerhead sea turtle (*Caretta caretta*). These turtles also occur in coastal waters of the Canary Islands and North America. The linkages among loggerhead sea turtles occurring in these areas are a focus of our ongoing genetic research. Elucidating relationships among populations throughout a species´ range is important for conservation purposes, and for understanding their biology. In studies using previously available mtDNA control region primers, the CC-A1 haplotype was commonly found at our study sites. In the present research, we examine the utility and applications of newly designed primers that amplify a longer segment of the mtDNA control region (Abreu *et al*. 2006), particularly in distinguishing among these CC-A1 haplotypes. To this end, we analyze control region sequences (804 bp) from adult females nesting at Cape Verde (n=50) and Georgia USA (n=20), and from individuals sampled in the waters of the Canary Islands (n=30) and North Florida USA (n=24). The number of haplotypes, haplotype diversity (h), nucleotide diversity (Pi), haplotype frequencies and fixation indices (Fst) were obtained and compared with results using shorter sequences. We discuss new insights into population connectivity from the analysis of the longer mtDNA sequences.

LONGER MTDNA SEQUENCES RESOLVE LEATHERBACK STOCK STRUCTURE

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Genetic studies using the hypervariable control region of the mtDNA have been instrumental in ascertaining population stock structure and phylogeography for sea turtles. Data on sequence variants and their frequencies at rookeries provide a baseline for conducting mixed stock analysis on foraging grounds, or for assigning stock origin for sea turtles caught incidentally in fisheries. In the case of leatherbacks however, lack of variation detected in the mtDNA control region has limited its utility in such studies, with only three haplotypes detected among Atlantic leatherback populations based on 496bp sequences (Dutton *et al*. 1999). These nesting populations are characterized by one ubiquitous haplotype (DC1), and it has not been possible to distinguish the leatherback rookery in South Africa from Caribbean rookeries which are fixed for this haplotype. We re-sequenced samples that had been identified as DC1 from these rookeries using new mtDNA primers that amplify 800 bp of the control region, providing an additional 304 bp of new sequence data for analysis (Abreu-Grobois *et al*. 2006). We identified three new haplotype variants among the old DC1 haplotype that allowed previous ambiguities to be resolved, including distinction of the South Africa nesting stock from the Florida stock. These findings provide impetus for a global re-analysis of leatherback rookeries; we discuss

implications for re-interpretation of phylogeography, and applications of these new data for resolving previous ambiguities in stock ID of strandings and fisheries bycatch.

POPULATION STRUCTURE OF LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN THE ADRIATIC SEA

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The Adriatic Sea is an important feeding habitat for loggerhead sea turtles in the Mediterranean. Its shallow northern and central waters host one of two of the most extensive neritic habitats in the basin, whilst the southern Adriatic is considered oceanic habitat. Analysis of tag returns showed that at the adult female level, the Adriatic is frequented by loggerheads belonging to regional nesting stocks, predominantly to the Greek reproductive population. In the case of juveniles, it has been hypothesized that Adriatic developmental habitats may be shared by turtles of regional and Atlantic origin. To asses genetic structure and natal origin of loggerheads in the Adriatic Sea, we sampled 116 turtles with CCL ranging from 8.5 - 84.5 cm (mean CCL = 42.9, SD = 14.7) found in Croatian and Slovenian waters and analyzed mitochondrial DNA control region sequences. Most of the turtles in this study were juveniles (111 ex) with CCL < 70.0 cm. We detected eight distinct haplotypes. Six were previously reported from the Mediterranean (Cc-A2, Cc-A3, Cc-A6, Cc-A26, Cc-A29, Cc-A32), whilst the remaining two are new and can not be assigned to a rookery of origin. Based on Bayesian mixed stock analysis results, we discuss natal origin of loggerheads in the feeding habitats of the Adriatic Sea and their implication to conservation, fishery management in particular.

LONGER MTDNA SEQUENCES UNCOVER ADDITIONAL GENETIC VARIATION AMONG NORTH PACIFIC LOGGERHEADS

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Genetic analysis has revealed two major nesting stocks for Loggerheads in the Pacific; a northern hemisphere stock with nesting sites in Japan and a southern hemisphere stock with nesting sites in Australia (Bowen *et al*. 1995). Studies to date using mtDNA have confirmed that juvenile and adult loggerheads encountered across the North Pacific belong to the Japanese genetic stock. Currently, three distinct haplotypes have been identified in the North Pacific based upon 350 base pairs (bp) of mtDNA sequence. Haplotype A, common in the southern hemisphere stock is relatively rare in the Japanese nesting stock, while haplotype C represents 10% of the Japanese animals sampled, and haplotype B is the most common and makes up 89% of the Japanese nesting stock (Hatase *et al*. 2002). MtDNA analysis was performed on 250 genetic samples which are routinely collected from loggerheads in the eastern Pacific foraging

areas (including the eastern tropical Pacific and Baja California, Mexico), stranded animals in the eastern Pacific (mainly Mexico), and fisheries by-caught animals in the eastern and central Pacific. Sequencing analysis was performed using new mtDNA primers designed to target 800 bp of the control region which includes the original 350 bp region (Abreu-Grobois *et al*. 2006). Based on analysis of the longer 800 bp fragment, we have identified at least 3 new haplotype variants among the individuals identified as B haplotypes with the shorter (350bp) sequence. We will also use the longer sequence to detect further variation among individuals identified as having haplotypes A and C. These findings suggest the potential for detecting finer scale population sub-structuring among nesting populations. Given that some nesting populations appear to be increasing while others remain depleted, ability to improve detection of relative contribution rates from nesting populations to loggerhead aggregations and among fisheries bycatch is relevant to conservation and management of this species in the Pacific.

ADAPTING TO CLIMATE CHANGE: A CASE STUDY OF THE FLATBACK TURTLE, *NATATOR DEPRESSUS*

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Flatback turtles, an ancient lineage of hard-shelled turtle, are survivors of climate change across geologic time. How a present day, marine turtle population might respond to climate change is explored using our extensive current knowledge of this species along with sea level changes and climate change since the ice ages. Flatback turtles have made radical changes in distribution of their nesting beaches, foraging areas and migratory pathways in response to sea level rise and loss of "traditional" nesting beaches over the last 10,000 years. Today's (Holocene) N. depressus distribution (nesting beaches, post-hatchling dispersal, benthic foraging by immatures and adults, breeding migrations) lies totally within the previous ice age (Pleistocene) land mass of Australia-New Guinea. Some of the nesting beaches occur up to 1,1000km inland of old ice age beaches. Associated with these changes in distribution were selective pressures that drove changes leading to development of new genetic stocks with associated differences in biological characteristics. Tropical beaches during summer in present day (Holocene) northern Australia are too hot to be suitable turtle eggs incubators (The Guinea effect). N. depressus populations illustrate two different but parallel adaptive responses. On the east and west coasts of Australia, today's summer nesting populations have a southern (cooler) nesting distribution. Across northern Australia where a southward shift in nesting distribution was not an option, the population(s) is selected for winter breeding. Both breeding distributions provide beach temperatures suitable for high incubation success within beach temperature ranges yielding suitable male:female hatchling ratios. This difference in timing of breeding by different populations implies underlying selection for physiological differences in the endogenous breeding cycles within the respective populations. Where summer & winter breeding populations have sympatric adult foraging areas, it leads to reproductive isolation of these populations. With breeding isolation, comes the potential for genetic differentiation and for developing fixed differences in other biological parameters between populations (adult female CCL, eggs per clutch, size of eggs and hatchlings).

INTERPRETING PATTERNS IN NEST SITE CHOICE OF INDIVIDUAL HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) WITHIN AND AMONG SEASONS

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The Jumby Bay Hawksbill Project is a saturation tagging study which takes place on Long Island, Antigua, and has been ongoing since 1987. Here, we use long term nest site data to assess patterns in individual clutch placement within and among seasons. We test for nest site fidelity as defined by distance to high tide line, distance to vegetation edge, and distance parallel to the shore. Additionally, we calculate within season repeatabilities for individual nest site choice to test the prediction that repeatabilities, which (over)estimate heritability, vary from year to year in the same population. We discuss how variation in beach characteristics between seasons, and between nesting beaches, may impact nest site patterns in hawksbill turtles, and if those features have value as predictors of nest site specificity in a given year.

EVOLUTIONARY RELATIONSHIPS OF SEA TURTLES: A MOLECULAR PHYLOGENY BASED ON NUCLEAR GENES

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The taxonomy, phylogenetic affinities, and evolutionary history of widely distributed and generally endangered sea turtles are insufficiently understood. There remains some disagreement, for example, as to how many species, or subspecies, constitute a “green sea turtle”. In the past, the placement of taxa such as the flatback (Natator depressa) and the hawksbill (*Eretmochelys imbricata*) has been questioned. In addition, the exact phylogenetic position of sea turtles within Cryptodira has not been irrefutably recovered, and the monophyletic relationship of sea turtles bears further investigation. Previous research addressing some of these questions focused primarily on mtDNA and morphological analyses. In this study, we analyze approximately 6200 bp of DNA from five nuclear genes in the seven widely recognized sea turtle species, as well as in Eastern Pacific “black” turtles, to determine whether they represent distinct evolutionary lineages. Further, we rigorously test the monophyly of all sea turtles, and resolve their phylogenetic position by analyzing 12 taxa of cryptodire turtles, which represent all major lineages of this suborder. We use current methods to estimate divergence dates of nodes in the resulting cladogram using minimum ages of available fossil taxa as calibration points. In this approach, we estimate the timing of dispersal and vicariance events, and identify their links to other geologic and climatic episodes. We analyze our dataset using various phylogenetic methods and a total evidence approach, and compare our results to those of previous studies. Additional and previously uncharacterized mitochondrial markers will

also be considered in future efforts. Clarifying taxonomic issues is the first step in systematically characterizing organisms, and determining the precise position of sea turtles with respect to other Cryptodires helps elucidate their biogeographic origins. As well, incorrect taxonomy has had severe repercussions for conservation in other reptiles, underscoring the importance of investigating these issues to inform conservation prioritization in sea turtles. Our findings to date are presented in this poster.

AN ASSESSMENT OF THE CHARACTER OF SEA TURTLE HABITATS IN SOUTH COAST KENYA

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Three sites along the south coast of Kenya i.e. Msambweni, Funzi and Bodo were studied with an overall objective of characterizing the existing sea turtle nesting and foraging habitats. The methodology employed for this study included use of overlays interpreted from remotely sensed data, participatory approaches and a stratified sampling design. Estimation of cover and species composition among sea grass communities was accomplished using a structured sampling design protocol described by Saito and Atobe (1970). A 50 × 50 centimeter quadrat subdivided into 25, 10×10 centimeter sectors were placed on the substratum within sampled areas. A total of 21 transects were laid resulting in over 500 quadrats. Ten (10) beach stretches measuring 5.84km were identified in both Funzi and Msambweni. Msambweni beaches had a higher index of human pressure than Funzi beaches. The mean temperature range at a depth of 10-30cm was higher for the Funzi hatchery when compared with samples from Funzi beaches (t= 2.7, p0.05). Seagrass cover ranged from 1.3-44.23% but there were no significant differences (p>0.5) between sites. Most of the sampling stations were dominated by *Thelassodendron ciliatum*, *Thalassia hemprichii*, *Siringodium isoetifolium*, and *Halodule* uninervis. A two-factor ranking exercise identified fisheries, sea urchins and pollution as the most immediate threats to sea turtle habitats within the study sites. During the survey period 67 green turtle nests were sighted in Funzi and Msambweni beaches and a total of 32 mortality cases were reported.

CHARACTERIZING THE FORAGING ECOLOGY OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) USING STABLE CARBON AND NITROGEN ISOTOPE ANALYSIS OF EGGSHELLS

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Stable isotope analysis is a useful tool for discerning information regarding an animal's foraging ecology. Isotope signatures of prey items are integrated into consumers' tissues in a characteristic manner, and in the case of nesting females, eggshell isotopic signatures can provide insight into the trophic status and foraging locations of the adult females. By sampling

eggshells from nesting beaches, researchers are given a unique, wide-range perspective that might not be obtained by sampling turtles directly in their foraging areas. Leatherback turtle eggshells were collected from 26 different nests on two nesting beaches in the Western Pacific in 2003 (22 nests from Jamursba Medi, Papua, Indonesia, and four nests from Lababia, Papua New Guinea). Habitat samples, including particulate organic matter, jellyfish, krill, and small fish, were collected with dip nets and bongo tows in the Central Pacific and Western Pacific during two different NOAA research cruises. δ13C and δ15N values were ascertained for all eggshell and habitat samples. It was found that δ13C values were very similar for all Jamursba Medi eggshell samples (-13.2 ±1.2‰). However, δ15N values showed an apparent dichotomy with 62% of the eggshells in the 9.2‰-10.8‰ range and 38% in the 12.5‰-14.5‰ range. Comparing these values with the δ15N values of habitat samples analyzed here and elsewhere as well as with data on Pacific-wide nitrogen fixation/denitrification patterns, we believe that these two δ15N groupings represent animals foraging in the Western Pacific and Eastern Pacific, respectively. These data are consistent with satellite telemetry data and suggest that δ15N isotope analysis can be an effective, non-invasive method to gain knowledge about turtle foraging locations that may prove useful in conservation efforts. *Acknowledgements*: SP gratefully acknowledges travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service, provided through the Symposium Travel Committee.

DOOMED EGG RELOCATION: A BENEFICIAL CONSERVATION STRATEGY?

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Sea turtles lay eggs on dynamic beaches, and their clutches may be deposited in areas that are vulnerable to tidal inundation or erosion. As a conservation strategy to increase hatchling production, the relocation of such doomed eggs to less vulnerable areas is used around the world. Rescuing doomed eggs may impose artificial selection that maintains traits favoring poor nest placement and in the long run would be unfavorable to the conservation of sea turtles. Conversely, if individual turtles are inconsistent in their nest placement and tend to scatter nests, then doomed egg relocation may be a valuable conservation strategy. During the 2005-2006 loggerhead turtle nesting season at Mon Repos beach, Queensland, the perpendicular distance from the original site of egg deposition to the dune post baseline was measured for in situ and relocated clutches. Using the same technique, tidal inundation and storm erosion lines were mapped to monitor what would have been the fates of relocated clutches if they had not been moved. These data allowed us to designate each nest by known females as successful or unsuccessful. Unsuccessful nests were distributed across the population with a high proportion of individuals showing inconsistency in nesting success. In addition, nesting success was positively correlated with experience, as measured by the number of past breeding seasons. Moving eggs vulnerable to tidal inundation and erosion saves the progeny from a large percentage of the population, as well as progeny from individuals who may in subsequent years nest successfully. Our results support the hypothesis that doomed egg relocation in this population will contribute positively to its conservation.

LUNAR ILLUMINATION AND ITS IMPACT ON SEA TURTLE NESTING

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Comprehensive nesting surveys between 2000 - 2002 documented more than 1000 nesting events over three years in Teopa Beach, Jalisco, Mexico. These events are alligned with recorded lunar illumination and statistically analyzed for patterns of peak nesting periods. Our study suggests a negative correlation between lunar illumination and nesting, whereby challenging the idea that peak nesting occurs during the full moon. Here we report that this alternative relationship between moon and sea turtle nesting holds true for several additional years (1994 - 1999), and thus has major implications for better resource management of conservation efforts.

LIMITED EXCHANGE OF IMMATURE LOGGERHEAD SEA TURTLES BETWEEN ADJOINING MEDITERRANEAN BASINS REVEALED BY TAGGING AND STABLE ISOTOPES

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We used traditional tagging and stable isotope analyses to assess whether immature loggerhead sea turtles (*Caretta caretta*) exchange freely between the northern and the southern regions of the western Mediterranean, as delimited by the 37.8 isohaline. Dispersal modelling on the basis of previous satellite tracking revealed that 112 days were needed to ensure independency between tagging and recapture locations in the western Mediterranean and, hence, only 28 of the 36 turtles recaptured for this study were considered for further analysis. Although they were recaptured on an average of 390 days after being tagged, only 2 of 28 were

recaptured in a basin different from the original one, a value much lower than that expected if barriers to dispersal did not exist.

MULTI-YEAR COMPOSITIONAL STABILITY OF A SUBADULT LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) FEEDING GROUND

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Sea turtle feeding grounds are potentially unique mixtures of individuals from various nesting populations. Determining the composition of these feeding grounds is an important tool for effective species management. While several studies have evaluated individual feeding ground compositions, relatively few have investigated their long term stability. Here we present a multi-year mixed stock analysis of loggerhead sea turtles (*Caretta caretta*) from subadult feeding grounds along the Atlantic coast of the United States from northern Florida to North Carolina, an area previously recognized as containing a genetically distinct nesting area. We use mtDNA haplotype data for individuals captured over 3 years, from 2000 to 2002, to estimate the contribution of natal beaches to this feeding assemblage.

MULTIPLE PATERNITY ANALYSIS OF *LEPIDOCHELYS OLIVACEA* FROM OAXACA STATE, MEXICO

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Molecular tools can give us some information about the biology of sea turtles. Here, we show an example related to their mating systems, which can be polyandrous or monogamous. The multiple paternity (MP) phenomenon has been verified in the olive ridley *Lepidochelys olivacea* with values up to 92 % in Costa Rica (Jensen *et al*. 2006) and values of 20 % (Hoekert 2002) in Suriname. This may be due the population nesting behavior (single females vs arribadas) as suggested by Jensen *et al*. (2006). La Escobilla beach in Oaxaca México is one of the most important nesting beaches for the olive ridley turtle were arribada behavior is present. Here we show a MP analysis of this nesting population. The analysis was carried out with two microsatellite loci of 103 samples of embryonic tissue gathered from four nests. We use PARENTAGE software (Emery, 2001) in order to infer the maternal and paternal genotypes for each hatchling. MP was found in 100% of the sampling nests, with a minimum of two and a maximum of four paternal genotypes involved in the fertilization of the progeny. There is not just one paternal genotype involved in the fertilization of progeny from more than one female. This high MP support the Jensen suggestion.

SPATIAL DISTRIBUTION AND TEMPERATURE EFFECTS ON HATCHING SUCCESS IN LEATHERBACK TURTLE *DERMOCHELYS CORIACEA*: IMPLICATIONS FOR CONSERVATION

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The leatherback turtle, *Dermochelys coriacea*, is Critically Endangered according to IUCN, and has a higher embryonic mortality than that of other sea turtles. A better understanding of patterns and causes of embryonic mortality is therefore necessary for developing effective conservation strategies. I examined the influence of distance to high tide line, mean incubation temperature, section- and zone of the beach on hatching success in Tortuguero, Costa Rica to evaluate the desirability of nest relocation. Hatching success was positively correlated with distance to the high tide line; nests below the high tide line have significantly lower hatching success. Mean incubation temperature is positively correlated with hatching success due to low survival at low minimum temperatures. Estimates of effects of distance to high tide line and mean temperature from a known fate model in MARK were reversed, probably because washed out nests do not meet data requirements and are excluded. The known fate model also shows that developmental stage significantly affects risk of embryonic mortality. The strong effect of distance to high tide line indicates that relocation of nests below the high tide line at Tortuguero may improve hatchling recruitment. The inconsistency with the known fate model suggests that there might be conflicting weaker selective forces that favour a more seaward nest placement. The negative effect of low temperature could possibly be coupled with weather conditions; storms and heavy rains accelerate the erosion process and increase risk of wash out or wash-over. The high embryonic mortality during the first developmental stage could partly be due to infertility, and an effect of badly placed nests dying during the first days of incubation.

BOTTOM-UP AND CLIMATIC FORCING ON THE GLOBAL POPULATION OF LEATHERBACK TURTLES

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There is a clear dichotomy in the nesting population trends of Atlantic, Indian, and Pacific leatherback turtles. Nesting beach monitoring has shown an increase or stability among females in the Eastern Atlantic (EA), Western Atlantic (WA), and Western Indian (WI) while those in the Eastern Pacific (EP) have been declining precipitously. In the Western Pacific (WP), some populations have been practically extirpated while others have shown some evidence of decline. Increases in the WA have been attributed to higher recruitment rates from nesting beach

protection, which has also been in place at some of the major beaches in the EP yet population recovery has not occurred. Incidental leatherback mortality among coastal gillnet fisheries is suggested to be the major source of anthropogenic influence on adult survival. While these fisheries exist in all basins, they have not affected populations in the Atlantic and Indian. One theory to explain this paradox suggests that leatherbacks in the Pacific may be resource limited but this has yet to be tested. Here we explored the foraging and nesting ecology of leatherbacks worldwide to determine differences in resource quantity and reproductive output (RO). Leatherbacks are foraging specialists relying on large patches of gelatinous zooplankton that can occur at areas of high primary production (PP). Vitellogenesis among female sea turtles is dependent upon their level of fat reserve, which is a function of foraging area condition. We reviewed long-term satellite tracking data from post-nesting females at the major rookeries to designate foraging areas in the Atlantic, Indian, and Pacific. We then calculated monthly PP at these areas using satellite-derived chlorophyll-A, sea surface temperature, and photosynthetically active radiation data over a period of 8 years. Finally, we reviewed nesting data from the major rookeries in each basin to calculate egg production. Post-nesting females among all populations migrated to systems of high PP driven by coastal upwelling, equatorial upwelling, and strong wind-driven vertical mixing along coastal shelves and temperate pelagic zones. We focused our comparison on the WA and EP populations given their extensive data sets. Mean PP among all foraging areas of WA females was significantly higher than those of the EP ($P << 0.0001$, $n = 100$). Moreover, the RO of WA females was twice that of EP females. The total yearly PP of the WA foraging areas was almost 150% greater than those of the EP. A harmonic analysis showed that all of the foraging areas had seasonal PP except those in the EP where the El Niño Southern Oscillation (ENSO) caused interannual variability. Our results suggest that Atlantic and WI populations are recovering or are stable in the face of continued anthropogenic mortality due to a higher RO derived from temporally consistent, high quality foraging areas. We conclude that the combined effects of natural oceanic fluctuations and their response to anthropogenic climate warming have exacerbated the EP population's sensitivity to fishery mortality thus explaining their rapid decline rate despite continued beach protection.

EVALUATION OF THE POWER OF MICROSATELLITES AND THEIR POTENTIAL FOR PATERNITY ANALYSES: A STUDY OF THE CAPE VERDE LOGGERHEAD TURTLE POPULATION

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The Cape Verde loggerhead population is one of the largest nesting populations, comparable with those of Florida and Oman. Previous studies indicate that the frequency of multiple paternity is highly variable in marine turtles, depending on the species studied and nesting location. The factors involved in such differences are still debated. This study will examine the fine-scale paternal contribution of the Boa Vista Island (Cape Verde) nesting population, evaluating the power of the number and combinations of the microsatellite markers used to detect multiple paternity and the number of potential fathers. Mothers and offspring from 15 nests collected in 2004 at Boavista Island will be analyzed using two to eight variable microsatellite loci and different combinations of the best sets of markers inferred from their individual and combined exclusion probabilities (Gerud 1.0, Jones 2001). Our hypothesis is that the probability of detecting different fathers varies with the number of loci, but also with the combinations included in the analysis. This study propose that care may be taken when

estimating and comparing multiple paternity frequencies, because results must be biased, not only depending on the species or population under study, but also depending on the level of polymorphism, the number and the combinations of the loci used.

FINE-SCALE PATERNITY STUDY OF A LOGGERHEAD FROM CAPE VERDE: WITHIN AND BETWEEN SEASONS

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Genetic analyses of reproductive strategies (multiple paternity and sperm storage) are promoting important information to define the criteria and the measures of conservation of many species, such as the level of genetic variability and effective population size. Furthermore, the knowledge of the mating system is particularly relevant for the protection and recovery plans of sea turtles. The population of common turtle, *Caretta caretta* of the Archipelago of Cape Verde is one of the greater nesting populations of the Atlantic, together with those of Florida and Oman. During the nesting season, loggerhead sea turtles nest on a particular beach, generally laying their subsequent clutches on the same area. In this study, 15 mothers and offspring's were collected in the island of Boa Vista during the peak of the annual 2004 nesting season, to investigate fine-scale multiple paternity. All female turtles were tagged with metal rings and microchips for identification. For one of the females (named Hortensia), we were able to detect five nests in the same nesting season (2004)and one more nest in 2006. For each of the nests, 27 hatchlings were randomly selected immediately after their emergence. A biopsy of a rear marginal scute was done and samples were stored at room temperature in 70% ethanol until DNA extraction is donned. This study will address the following questions: (1) Is multiple paternity common in the loggerhead sea turtle population of Boa Vista? (2) Is the frequency of multiple paternity and the contribution of the multiple fathers homogeneous in the consecutive nests of one female through the nesting season? (3) Is there any evidence of sperm storage between subsequent nesting seasons? Little is known of the courtship behavior and breeding structure of sea turtles, nor of the migratory conduct of *Caretta caretta* males implicated in mating groups. This study will try to resolve these questions for loggerhead sea turtles in Boa Vista Island.

MARINE TURTLE POPULATION SURVEY DURING THE NESTING PERIOD 2002-2003 IN TOGO AND BENIN

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Four species of sea turtles have been identified along the Togolese and the Beninese coasts: green turtle (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), olive ridley (*Lepidochelys olivacea*) and leathearback (*Dermochelys coriacea*). The nesting beach survey and the observations around fishing places have allowed us to record 222 individuals and 117 nests

during the nesting period running from September 2002 to February 2003. Of the four species, two *L. olivacea* and *D. coriacea* were found to nest on the beach unlike the two others *C. mydas* and *E. imbricata*. However, juveniles of *C. mydas* and *E. imbricata* were regularly found in this area.

DEVELOPMENT OF 15 NOVEL PRIMERS AMPLIFYING TETRANUCLEOTIDE MICROSATELLITE LOCI IN LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)

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Population structure, as indicated by nuclear DNA loci, is low among southeastern United States loggerhead (*Caretta caretta*) rookeries relative to population structure inferred from mitochondrial DNA. The development of additional highly polymorphic nuclear DNA markers and analysis of larger sample sizes may be required to detect any existing subpopulation structure. We describe the development of novel primers amplifying 15 tetranucleotide microsatellite loci from the loggerhead sea turtle. The primers were tested on samples collected from 30 females nesting along the Georgia coast in 2005. The primer pairs developed in this study yielded an average of 13.9 alleles per locus (range of 10 to 21), average observed heterozygosity of 0.91 (range 0.79 and 1.00), and average polymorphic information content of 0.88 (range 0.84 to 0.92). The combined panel of markers is sufficiently powerful to yield theoretical probabilities of identity of 1.46e-25 (PID) and 2.63e-8 (PID (SIBS)). Total exclusionary power with both parents unknown is 1.000000. We collected over 600 skin biopsies from females during the 2006 nesting season. Samples represented rookeries from the Florida panhandle to the North Carolina coast, including Cape San Blas, Casey Key, Keewaydin Island, Juno Beach, Archie Carr National Wildlife Refuge, Canaveral National Seashore, Cumberland Island National Seashore, Wassaw National Wildlife Refuge, Cape Romain National Wildlife Refuge, and Bald Head Island. We will discuss nuclear population structure within and among these areas and present estimates of individual relatedness within rookeries.

APPLICATION OF A BIPHASIC GROWTH MODEL TO DESCRIBE GROWTH TO MATURITY IN THE HEAD-START KEMP'S RIDLEY SEA TURTLE

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Age and growth rates in sea turtles are generally poorly understood as their long migrations and utilization of multiple habitats make such studies difficult. The Kemp's ridley sea turtle (*Lepidochelys kempii*) is one exception to this generality. Because its population declined to very low levels from 1947 through the 1960s, Kemp's ridley was listed as an endangered species in 1970, and a 'head-start' experiment was initiated in 1978 as an ancillary part of the Kemp's Ridley Restoration and Enhancement Program, conducted jointly by Mexico and U.S. agencies. The purpose of the experiment was to captive rear and reintroduce Kemp's ridleys into the wild, in part as an effort to preserve the species in case all other conservation efforts failed. This experiment resulted in the release of 22,255 yearling Kemp's ridleys comprising the 1978-1992 year-classes. To date, close to 1,000 of these turtles have been 'recaptured', including strandings (dead or alive), captures, and directly observed nesters. Recoveries were from both the Atlantic and the Gulf of Mexico. For this analysis, we restricted the data set to include only recoveries from the Gulf of Mexico. Of those recoveries, 228 had their carapace lengths measured and could be assigned to a year class, making this a unique set of size-at-age data for sea turtles. To analyze the size-at-age data, we first fit a Loess smoother to observe the trend. This showed a generally linear trend up to about 50 cm straight carapace length (SCL) and 4 yr of age followed by an asymptotic curve similar to those observed in fish populations. We then fit a new growth model that has been developed to better describe indeterminate growth in fishes (Lester *et al*., 2004, Proceedings of the Royal Society of London B 271:1625-1631). Because of the difference in energy allocation pre- and post-maturation, it has been suggested that the von Bertalanffy growth curve cannot describe lifetime growth and the new model, the biphasic von Bertalanffy growth model, divides growth into these two compartments. The biphasic model described the data well; however, rather than the shift between phases occurring at maturity as in fish, the break occurs earlier, potentially marking the subadult stage when gonadal maturation begins which can be several years prior to first reproduction. For the head-started Kemp's ridley, the model indicates that the average shift between the growth compartments occurs at 4.3 yr of age and at 52.2 cm SCL, and we suggest that this marks the beginning of a subadult stage for this species. The information we have learned from this unique dataset will likely increase our general understanding of sea turtle growth rates.

GENETICS: A TOOL TO INFER STRUCTURE OF GREEN TURTLE POPULATIONS (*CHELONIA MYDAS*) IN THE SOUTH-WESTERN INDIAN OCEAN?

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We assessed the genetic structure of green turtle populations, *Chelonia mydas*, in the South-Western Indian Ocean (SWIO) by sequencing the control region of mtDNA and using 6 microsatellite loci. About 800 samples (females, males, juveniles and hatchlings) have been analysed, from 15 sites of SWIO. Both nesting and foraging zones have been selected. The preliminary results revealed a new haplotype and allowed us to identify 2 Management Units (MUs) of important interest for the conservation of green turtles. Thus, Reunion green turtles constitute a very specific population. Furthermore we examined the influence of Atlantic green turtle populations on genetic structure and composition of SWIO populations. Confrontation between results from mtDNA and microsatellites allowed us to have a more complete vision of the global population structure in our zone. Our results provide useful elements for management and conservation of green turtle in SWIO, and so they would participate in the global conservation of this species. Finally, this study shows that genetics constitutes a useful tool for population structure study, especially in association with other techniques like satellite telemetry and tagging campaigns. Acknowledgements: CT gratefully acknowledges the assistance of a travel grant by Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service, provided through the Symposium Travel Committee. Financial support was provided by European Community and “La Région Réunion” through a FEDER grant (convention DEAT3/2005 1045) and a PhD grant for the first author. Financial and technical support was also provided by the Agriculture and Forestry Administration of Mayotte. The TAAF, the French Navy, Météo France, the SEF Turtle Team and the “Jardin Maoré” Hotel of Mayotte Island, Nosy Iranja Lodge (Madagascar), the association for the economic development of Itsamia and the “Parc Marin de Mohéli” (Comoros archipelagos) provided useful technical assistance, especially during sampling. We thank CIRAD organism and personnel for their technical and scientific support during genetic analyses. Special gratitude to all training students and personnel who provided us samples and technical assistance making this work possible.

OCCURRENCE OF MTDNA HAPLOTYPES OF LEATHERBACK TURTLES ON THE BRAZILIAN COAST

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The population of leatherback sea turtle (*Dermochelys coriacea*) nesting in Brazil is restricted to very few individuals, regular nesting is found only on the coast of the Espírito Santo State. Although these animals are seen spread out along Brazilian waters, some concentration is observed on the south and southeast coast. To understand the relationship between leatherbacks from Brazil and elsewhere we analyzed long mtDNA sequences. Here we present research data produced in cooperation with LBEM, Projeto Tamar-Ibama, NEMA and PETROBRAS/CENPES as part of the project "Mamíferos e Quelônios Marinhos". Control region sequences of mtDNA were generated either from leatherbacks caught incidentally by fisheries in Brazilian waters (n=7), or stranded on beaches in the Rio Grande do Sul State, in south Brazil (n=45) and on nesting areas (n=11). High quality sequences of 711 bp long were generated and analyzed in two steps, using the complete data set or only 496 bp sequences to compare with data available in literature. When shorter sequences were analyzed, 5 distinct haplotypes were defined by 5 polymorphic sites, as compared to 7 haplotypes defined by 9 polymorphic sites, found for the 711 bp comparisons. Comparing the 496 bp haplotypes with published data, we observed for the first time along the Brazilian coast, the presence of two individuals of a haplotype found previously only in Solomon Islands (Dc 9); one individual with haplotype Dc 4, usually found in Costa Rica, and three individuals with haplotype Dc 3, frequently found in Trinidad. Genetic diversity indexes for the nesting population were similar on both analyses ($h = \pm 0.182$ and $\pi = \pm 0.00147$) with only 2 haplotypes (Dc 1 and Dc 3). For stranded and incidentally caught leatherbacks, the genetic indexes were (496 bp; $h = 0.369$ and $\pi = 0.00138$) with only 5 haplotypes and (711 bp; $h = 0.498$ and $\pi = 0.00159$) with 7 haplotypes. An important conclusion of this research is that haplotype Dc1 (496 bp), the most common haplotype found to date in Atlantic leatherbacks, has been divided in 3 different haplotypes using 711 bp sequences. With this new insight we may be able to better understand the population relationship among and within different rookeries and the leatherbacks found on the Brazilian coast. We thank Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service for the Travel Grants.

UNIDIRECTIONAL INTROGRESSION BETWEEN *ERETMOCHELYS IMBRICATA* AND *CARETTA CARETTA* ANALYZED BY PCR-RFLP

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The hawksbill turtle, *Eretmochelys imbricata*, occurs in tropical seas of the Atlantic, Indian and Pacific oceans. It is considered critically endangered by the IUCN and in Brazil, due to fisheries, killing and egg collecting, there are few hatchling sites left. The loggerhead turtle, *Caretta caretta*, is distributed in the Atlantic, Indian and Pacific oceans and tropical waters of Mediterranean. It is considered endangered by the IUCN and by the Brazilian environmental agency Ibama. Hybridization between these two species has been known for many decades from morphology studies. Recently we used mitochondrial DNA (mtDNA) analysis to detect hybrids on Brazilian nesting beaches and feeding grounds. In this study, we aimed to investigate the hybridization process between *E. imbricata* and *C. caretta* though analyses of three autosomal markers. Here we present research data produced in cooperation between LBEM, Projeto Tamar-Ibama, and PETROBRAS/CENPES as part of the project "Mamíferos e Quelônios Marinhos". A total of 42 individuals from Bahia State in Brazil, with morphology more similar to *E. imbricata* and bearing a *C. caretta* mtDNA, and 120 individuals identified as *E. imbricata* by morphology and mtDNA were analyzed with these autosomal markers to detect likely *C. caretta* genomic ancestry in this population. In all individuals tested, three anonymous regions of nuclear DNA were amplified by PCR with primers previously described to *Chelonia mydas*, and the inter-specific variation was identified using one or two restriction enzymes. Among 42 previously detected hybrids, four (15.1%) showed both specific alleles of *E. imbricata* in at least one locus, but no hybrid presented both *C. caretta* alleles in any locus. Furthermore, another eleven hybrids, with incomplete genotyping, have also occurred in 4 individuals with at least one *E. imbricata* homozygous locus. Additionally, in the 42 hybrids 52.4% of the alleles belonging to *E. imbricata* and only 47.6% to *C. caretta* were observed. These data indicate some introgression between parental species and hybrids due to the existence of hybrids of generations >F1. It would also indicate a likely bias to preferential mating with *E. imbricata*. This unidirectional introgression can be an evidence of the incapacity or failure in meeting of F1 female hybrids to mate with males of the parental taxa *C. caretta*. This apparently unsuccessful introgression with *C. caretta* could be due either to the low mating success of this species with hybrids or low survival/fecundity of >F1 hybrids with *C. caretta*, since all hybrids analyzed were females in oviposition. It is interesting to note that F1 female hybrids with *C. caretta* mtDNA are result of the mating of a female *C. caretta* with a male *E. imbricata* and we do not observe any evidence of opposite gender pairing. Likely, this hybridization process can be biased by the gender of the parental species, and can be an important factor in introgression. The hybridization observed in sea turtles can be due to the inexistence of pre and post-zygotic barriers allowing interbreeding. The detection of this intensive hybridization process and the sex biased introgression can direct differential management strategies for conservation of this species in Brazil.

EGG COMPONENTS, EGG SIZE, AND HATCHLING SIZE IN LEATHERBACK TURTLES

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Relationships between egg size, egg components, and neonate size have been investigated across a wide range of oviparous taxa. Differences in egg traits among taxa reflect not only phylogenetic differences, but also interactions between biotic (i.e., maternal resource allocation) and abiotic (i.e. nest environment conditions) factors. We examined relationships between egg mass, egg composition, and hatchling size in leatherback turtles because of the unique egg and reproductive characteristics of this species and of sea turtles in general. Albumen comprised nearly two-thirds of egg mass and explained most of the variation in egg mass, whereas yolk comprised only one-third. Additionally, leatherback albumen dry mass was ~16% of albumen wet mass. Whereas hatchling mass increased significantly with egg mass (n = 218 clutches), hatchling mass increased by only approximately 2 g for each 10 g increase in egg mass and was approximately 10-20 g greater than yolk mass. Taken together, our results indicate that albumen might play a particularly significant role in leatherback embryonic development, and that leatherback eggs are both capable of water uptake from the nest substrate and also possess a large reservoir of water in the albumen. Relationships between egg mass and egg components, such as variation in egg mass being largely explained by variation in albumen mass and egg mass containing a relatively high proportion of albumen solids, are more similar to bird eggs than to eggs of other non-avian reptiles. However, hatchling mass correlates more with yolk mass than with albumen mass, unlike patterns observed in bird eggs of similar composition.

SEA TURTLE CONSERVATION ON THE WESTERN COAST OF GHANA

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The Amansuri Marine Turtle Conservation Project (AMTCP) located on the Western Coast of Ghana started in October 2001 along a six kilometer (6 km) stretch of beach. This project identified by the Ghana Wildlife Society (GWS) was extended to cover 76 km stretch of coast from the Amanzuri River estuary in Ghana to New-Town on the Ghana – La Cote Devoire border in January 2002. The objective of this project is to conserve turtles in all the coastal communities in the Project area and use it as a tool to promote eco-tourism and socio-economic development. It is envisaged that this project will lead to an increase in turtle populations in the Western Region of Ghana, and the development of a Turtle and Whale Watch potential as a contribution to the socio-economic development of the project area. This objective is gradually being achieved through conservation education in schools and communities in the project area as well as through community consultations and meetings, film shows, open forum and regular visits to sea turtle meat markets to create awareness on the need to conserve sea turtles as well as the laws banning the trade in turtle products in Ghana. Achievement made so far includes: • High level of awareness on sea turtle conservation in the project area has been created. This is shown by a 50% decline in raided turtle nest from January 2004 to December 2005, • A Marine Turtle Task Force (MTTF) made up of 10 local people has been formed • Good cooperation from community members on sea turtle conservation. For example, two (2) migrant fishermen who raided turtle nests were arrested by community members in the 2005 nesting season and handed over to an MTTF member. • A micro-credit scheme has been set-up to support MTTF members. • The project during the 2005 nesting season, recorded the activities of a Hawksbill turtle (*Eretmochelys imbricata*) a species thought to be extinct from the coast of Ghana. The Soft-shell turtle also called the Pig-nose turtle (*Carettochelys insculpta*) was also recorded during this period. This might be an indication of decreased exploitation in the project area. It is envisaged that there would be a complete stop or drastic reduction in the exploitation of sea turtles by the end of the second phase (2004 – 2007) of this project and the development of a Sea Turtle and Whale watch program would have been fully completed.

THE NEW GEORGIA SEA TURTLE CENTER: A COMPREHENSIVE EDUCATIONAL CURRICULUM FOR ALL AGES

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The new Georgia Sea Turtle Center (GSTC) on Jekyll Island will open to the public on June 16, 2007 — it will be the first sea turtle rehabilitation center on the Georgia coast. The GSTC's mission is conservation through rehabilitation, research, and novel educational experiences designed to yield environmental action. The facility and programs have been designed from the ground up to integrate a spectrum of educational opportunities for all ages. Using the loggerhead sea turtle as a flagship species of Georgia's highly prized coastal habitats, a staff of ten professional educators will lead programs for students of all ages. Programs Include: Pre-

Kindergarteners and their Parents- Through the GSTC's "Hatchlings" program, preschoolers and their parents participate in age-appropriate nature programs throughout the year. Standards-based fieldtrips and outreach visits are also available for local preschool and parents' groups. K-12th Grades- Public courses for elementary students include "Eco-Explorers" ecology programs and nature-themed holiday camps. Middle and high school students can also volunteer through the GSTC's unique environmental action club, "Seas the Day." Through partnerships with local, state, and other conservation agencies, the GSTC works to introduce these young people to the fields of marine science. Educators from elementary to high school can choose from a range of field-based trips and outreach visits, all correlated to exceed state and national standards for learning-- Over thirty engaging marine education courses allow students to explore the marine ecosystem through hands-on activities and experiential learning. Environmental action is emphasized in every class, using real-world applications and encouraging ecological problem solving. Each program has been individually tailored to meet best practices in environmental education, as evaluated by local teachers and education administrators. Additional teacher resources include GSTC professional educator workshops and portable Teacher Resource and Curriculum Kits (TRACKs), which supply local schools with interactive curriculum guides on sea turtle biology, conservation, and the marine ecosystem. Undergraduate, Graduate, Veterinary and Adult students- Internships and service-learning opportunities are in place for college and veterinary students, and throughout the summer sea turtle nesting months, seasonal technicians (undergraduate/graduate students) help to monitor loggerhead nesting activity and educate the beach-going public. Through our Scientist for a Day workshops, Nighttime Turtle Walks and early morning Hatchling Walk programs, whole families can actively assist with the GSTC's ongoing research, while Elderhostel programs offer continuing education for retirees. Finally, adults of all ages are encouraged to join the GSTC's extensive volunteer programs where they may guide sea turtle walks, assist with animal care and husbandry, and participate as interpretive docents within the facility. General Visiting Public- The facility itself is constructed to immerse the visitor in the rehabilitation process with a true "behind the scenes" experience via a public passage way through the working veterinary hospital. In addition to sea turtle natural history and conservation efforts, the GSTC's fixed, interactive exhibits highlight action-based ideas, activities, and opportunities for individual involvement.

TRAINING WORKSHOPS FOR FISHERMEN IN MOROCCO

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In 2005-2006, we organized 2 training workshops for 54 fishermen at Tangier and Casablanca port. Through these workshops we tried to educate the fishermen about turtles and data collection techniques and also further strengthen our collaboration with them to collect data on accidentally captured sea turtles. Children of the fishermen also participated in these workshops. Drawing competitions were held for the children who then received prizes. Other workshops are being planned along the Atlantic Moroccan coast in Agadir, Laâyoune and Dakhla.

TARGETING THE FUTURE: CREATING AND IMPLEMENTING A SEA TURTLE EDUCATION PROGRAM FOR HIGH-SCHOOL STUDENTS

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Although public education and outreach programs have been crucial in engaging resource users in sea turtle conservation in Canada, the success of these initiatives amongst established members of the fishing community is tempered by a range of factors, including literacy, level of education, peer pressure, and entrenched attitudes toward conservation. Educational outreach in coastal grade schools since 1998 has helped mitigate some of these factors, but it became clear to us that the best avenue for reaching a relatively fresh audience that had first-hand opportunities to conserve leatherbacks at sea was to address high-school students. Not only do they represent the upcoming generation of resource users, but many already work as helpers in their families' fishing enterprises. High-school students are a challenging audience in their own right, and attempts to engage them in school-related activities that they consider "cool" enough for their attention, and that meet curriculum needs while promoting the conservation of sea turtles require careful planning. The Canadian Sea Turtle Network developed a high-school outreach program designed to teach students basic sea turtle biology, engage them in philosophical discussion about the intrinsic importance of endangered species, demonstrate the difference local action makes in conserving sea turtles, and encourage them to think critically about the role they and their communities play in protecting sea turtles in Canada. In its pilot year, the program targeted four coastal community schools in Nova Scotia, Canada, reaching more than 150 students. Program feedback was collected from both teachers and students, with students surveyed both at the beginning and end of the program period. Post-program evaluations indicated a marked increase in all areas, including students' understanding of sea turtle biology and factors contributing to species decline, students' interest in sea turtle conservation, and students' knowledge of ways in which resource users can directly contribute to conserving marine turtles at sea. Our findings suggest that programs such as this one may be key to reaching the next generation of resource users in a context that allows a thorough exploration not only of the scientific facts about sea turtles and the threats they face, but also of the responsibility of the fishing industry to act as stewards of the marine environment. The authors would like to thank the 2007 Symposium on Sea Turtle Biology and Conservation Travel Grant, and the generous donations from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service and US Fish and Wildlife Service which have made participation in this symposium possible.

TOWARDS ESTABLISHING A GEORGIA SEA TURTLE LEARNING COMMUNITY

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Starting its 17th year of integrating "Conservation, Research, and Education," the St. Catherines Sea Turtle Conservation Program has put 100,177 hatchlings into the sea, hosted 202 interns, 180 of whom are K-12 teachers who have taught over 198,152 school children during the 16 years of the program. Research outcomes have included definition of loggerhead nest morphologies common to Georgia, development of a Rapid Assessment Tool for Sea Turtle Nesting Habitat, the conceptualization of an ancient doublet island to St. Catherines (named Guale Island), the discovery and definition of an ancient Cretaceous sea turtle nest in the Fox Hills Formation southeast of Denver, Colorado (the first fossil sea turtle nest ever described!), instituted educational reform in field-based, experiential inquiry learning, and completed many smaller research projects. The Program provides content and pedagogical enhancement for 14 K-12 teachers each summer in a 10-day class, including a 7-day residential internship on beautiful St. Catherines Island, Georgia. Students are mentored by colleagues and taught by a cadre of scientists and educators to broaden their knowledge of stewardship of the Earth through conservation of threatened and endangered loggerhead sea turtles nesting on the sandy beaches of St. Catherines Island. Interns are presented with a holistic scientific education in a real-world field setting where they gain hands-on experience and build a learning community around charismatic sea turtles. The course of study includes four and three-credit University courses (GSU 5740 and GSU 5741), helping students re-certify with PDU credit, college credit, or build toward an advanced degree. Expected outcomes include the design and execution of an endangered species teaching unit, the accumulation of free, natural history teaching materials for each teacher's classroom, and unforgettable experiences documented by digital photography. The Georgia learning community has included an interesting component of veterinarians taught through the EnviroVet Program, participation of veterinarian students, and collaborations built in the learning community. Field lectures on sea turtles have been presented for five years to the world-wide participants in the EnviroVet Program of the University of Illinois at Urbana-Champaign. Three masters degree students have used the sea turtle program as a basis for theses. Liaisons with the St. Catherines Wildlife Survival Center has led to development of a Sea Turtle Outreach Internship at the College of Veterinary Medicine at the University of Georgia. Tangible outcomes have included development of web-based resources, a Handbook for Sea Turtle Interns, publication of web-based lesson plans, and education leading to the establishment of other sea turtle programs. Intangible outcomes have included the education of nearly 200,000 students in sea turtle conservation. An informal learning community has been built using mentoring from year to year, but has lacked the coherence of established lines of communication to link annual cohorts beyond the participation of mentors. This deficiency will be alleviated by construction of the Georgia Sea Turtle Rehabilitation and Education Center to pull the past and future participants in this and other Georgia programs together.

SEA TURTLES IN THE CLASSROOM: AN ACTIVITY GUIDE CORRELATED TO SOUTH CAROLINA STATE EDUCATION STANDARDS

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Many different factors have contributed to the decline of sea turtle populations around the world, but almost all of these factors have one attribute in common—they are human-induced. Therefore, the majority of conservation plans for sea turtles include a strategy for public education and outreach. From a sea turtle management and conservation standpoint, there are two main goals of public education: the first is to make people aware that they have an impact on the survival of sea turtles, and the second is to provide people with accurate knowledge about sea turtles. Once these two objectives have been met, people can then make informed decisions concerning their behavior towards sea turtles, evaluate and choose among management options, and participate meaningfully in local and national policy discussions. The South Carolina Aquarium's "Sea Turtle Rescue Program" sponsors outreach activities in support of public education. With an aim to expand these activities to embrace formal curricula designed for elementary school children, I [EC] developed a sea turtle activity guide designed to implement the state of South Carolina education standards for children ages 9 to 12. The guide provides students with knowledge of sea turtles, as well as the causal factors in population declines, and seeks to cultivate an informed citizen by communicating information to young people concerning the impact various human behaviors have on sea turtle survival. By gaining this knowledge early in life, the hope is that students will make more environmentally informed decisions about their own behavior(s) as they mature. The activity guide consists of six sections: Introduction to Sea Turtles; Adaptations; Life Cycle; Nesting; Sea Turtle Rescue and Care; and Conservation and Policy. Each section includes five activities, resulting in a total of 30 activities created using a standard lesson plan format. Each activity features a title, focus question, activity synopsis, time frame, key terms, objectives, standards, background, materials, procedures, and assessment. Selected activities were classroom-tested at the aquarium during the summer of 2006. Hard copies of the activity guide will be distributed to the aquarium, to South Carolina educators, and, in partnership with the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), to Caribbean educators. In addition, an on-line version will be available on both the South Carolina Aquarium's website and at WIDECAST's website.

ROLE OF EDUCATION AND AWARENESS IN SEA TURTLE CONSERVATION; A CASE STUDY FROM GOA, INDIA

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Out of the 105 kms of coastline of Goa in the West Coast of India, 8 kms in the Morjim in the north and Galgibaga and Agonda in the South are the known nesting ground of olive ridley turtles. The Centre for Environment Education (CEE), Ahemedabad, a National Institute mandated for environmental education, initiated a Turtle Conservation Education project in 2001 targeted at school students and teachers, tourists and enforcement organizations. Between 2001 to 2006 the following activities have been conducted: a. Seven three day teacher training workshop to orient teachers on the issues related to turtle conservation and conservation

education methods; b. Twenty-five slide shows on sea turtle conservation, activities like quizzes, essay competitions, and clay modeling have been made availaiable to the students; c. Students in Galgibaga and Agonda, with the help of the local community and Forest Department, guarded nests and put up signs indicating 'save our sea turtles' during the years of 2003-04; d. Four one day turtle fairs involving about 500 students and 40 teachers from the nesting areas were conducted in which students displayed posters, signage and performed a skit on "The Importance of Sea Turtles'. A film 'Ridleys Last Stand' was screened for the students and general public. Rallies in the village were instigated to create awareness about sea turtles; e. A teachers manual 'Turtles in Trouble' and a set of 10 posters were prepared under the project and have been distributed to all the schools along the coastline of Goa. The education awareness programmes have reached more than 400 teachers and 5000 students in Goa and they have become aware and sensitive to the issues related to sea turtle conservation. Students along the Goa coast are now reporting turtle poaching, nestings, or the occurrence of dead turtles on the beach to their teachers. Two turtles, one with both the fore flippers injured, were found and were rescued by the locals and later released in to the deep sea with the help of Goa Forest Department and Indian Coast Guard. Four meetings with the villagers and two meetings with the owners of make-shift tourist shacks on the beach were held to discuss their role in sea turtle conservation. A one day multi-stakeholders consultation was organized to develop short term and long term strategies for turtle conservation in Goa. The Goa Forest Department has now set up a Sea Turtle Information Centre and displays posters, manuals and other materials developed by CEE. CEE also helps the department in conducting educational activities and other conservation issues. Information on the number of nests on the beach and probable dates of their hatching are displayed during the nesting season as information for tourists and visitors. Several interested tourists came to see the hatchlings on the day of hatching. Every year more than 2000 foreign tourists visit the sea turtle information centre. *Acknowledgements*: I thank Ms. Meena Raghunathan, Ms. Sanskriti R. Menon for their continuous support and encouragement and Shri B. C. Choudhury for his guidance. Thanks to Goa Forest Department, Turtle Volunteers and Directorate of Education for their support in implementing the project. I am extremely thankful to Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, US Fish and Wildlife Service and Ford Foundation for their financial support to attend the symposium. I also thank the Programme Committee of the Sea Turtle Symposium for giving me opportunity to attend.

DEVELOPMENT OF THE TURTLE AWARENESS AND PROTECTION STUDIES (TAPS) PROGRAM ON ROATAN, HONDURAS

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Sea turtles of the Caribbean are highly threatened. Turtle population declines in the region can be attributed to habitat degradation from coastal development, increasing marine pollution, removal of eggs and females from nesting beaches, and the capture of juveniles from foraging areas for human consumption. In Honduras, turtle populations are compromised by these and other wide-spread factors, yet levels of awareness regarding the plight and status of sea turtles among locals, visitors, researchers and the conservation community are surprisingly low. This, in part, may stem from a lack of published research coming from Honduras. One area of the

country that especially facilitates initial opportunities for research, and engaging local communities and visitors in awareness is the island of Roatan. For this reason, we have initiated a series of national research and outreach efforts under the Protective Turtle Ecology Cooperative for Training, Outreach and Research (ProTECTOR). These initial efforts have been organized as the Turtle Awareness and Protection Studies (TAPS) program based on Roatan in the Bay Islands of Honduras. With cooperation from the local community of Oak Ridge, the Reef House Resort and Projecto Manejo Ambientales de Isla de Bahia (PMAIB), the TAPS program commenced in February, 2006 with the study of 24 'reclaimed' sea turtles, of which 83% were juvenile hawksbill turtles, *Eretmochelys imbricata*, and 17% were juvenile green turtles, *Chelonia mydas*. Since commencement of the program, temporarily captive turtles have been monitored for health and growth, showing mean growth rates of 0.27 cm month-1 for *E. imbricata* and 0.1 cm · month-1 for *C. mydas*, based on curved carapace lengthmax. Detailed measurements are among the data collected and stored in the TAPS Geographical Information System (GIS). The GIS designed to support the TAPS projects, is focused on the use of maps and globes to represent locations of turtles and track their migrations. It will also have the ability to compare location information with environmental parameters, such as sea surface temperature and current direction. Juvenile turtles are likely to stay 'local' for many years, with home ranges along the coasts of Roatan. This remains to be determined and will be mapped with points and polygons as more information and data are collected. The TAPS Turtle Adoption Program, established in June of 2006, helps to facilitate and build on turtle awareness efforts and provides a sustainable form of outreach beyond the immediate community. This program offers opportunities for individuals to contribute to the TAPS research efforts in Honduras, affording one source of financial support that supplements national and international grant funding. Projects under development include mapping nesting beaches of the Bay Islands, a two-year nesting beach monitoring program, long-term female tagging, determination of home ranges for juvenile hawksbill and green sea turtles by radio telemetry, satellite telemetry, determination of growth rates for wild-caught juveniles, and mapping historical versus current distributions. A top priority of the TAPS program is to provide scientific data that is currently lacking, to local area managers of endangered species and to the international conservation community.

PLAYA JUNQUILLAL: SOLUTIONS FOR UNPROTECTED LEATHERBACK NESTING SITES

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WWF'S Pacific Leatherback Conservation Project has been in effect since December 2004. With the support of the community of Playa Junquillal (10°09'42"N, 85°48'32"E), Guanacaste, Costa Rica, the Project protects the nesting sites of three threatened marine turtle species: The giant leatherback (*Dermochelys coriacea*), the black turtle(*Chelonia mydas* agassizi), and the Olive Ridley (*Lepidochelys olivacea*). Although there are only 300 residents living in Junquillal, the rapid influx of tourism and development in the area, which has doubled in the last two years, has created a new set of challenges for both the Project and the community. The light pollution on the beach has considerably decreased the number of successful nests. For generations, it has been the local custom of residents in Junquillal, and other nearby communities, to consume turtle eggs. Until December 2004, 100% of both the olive ridley and the black turtle, and 75% of the giant leatherback nests were poached. To protect the threatened turtles, the Project has implemented various solutions to increase the hatching levels such as transplanting nests, constructing a hatchery, and involving community participation. Among the strategies used in

this process of conservation are as follows: a) creating activities that involve the participation of foreign and local residents in turtle conservation, such as informative talks, workshops that promote responsible management of the environment, popluar recreational activities, (soccer championships, festivals, and dances), beach clean-up, nest monitoring, hatchery construction, and the releasing of hatchlings, b) informing residents and visitors about project activities by widely distributing a bilingual newsletter, posting educational signs on the beach that mark and name each nest, and distributing hatching calenders throughout the region, c) raising the social consciousness about the urgency of protecting the threatened turtles through an ecological educational program in Junquillal and nearby communities, d) augmenting the local pride in the community by helping them appropriate the project through, por example, organised teams of local teenagers who monitor and protect the turtle nests, e) stimulating a model of eco-tourism for the community, and encouraging an exchange between experienced eco-tourism community leaders from other areas of Costa Rica, f) offering an alternative source of income to reduce the consumption and selling of turtle eggs by teaching related arts and crafts, organising homestay programs for visiting students, and training locals as eco-guides, g) promoting the cooperation between involved institutions such as the Development Association, other local community groups, municipal authorities, and national environmental agencies. From December 2005 to May 2006, WWF's Pacific Leatherback Conservation Project and the community of Junquillal have eliminated 80% of the light pollution problem, and reduced the poaching rate of the olive ridley to 2.6% and the leatherback and black turtle to 0%. The teens that once relied on the eggs for their livelihood now constitute the team of monitors that patrol the beach and protect the nests. In the last year, they have ensured that 10,000 baby turtles have successfully hatched and been released into the ocean.

THE ROLE OF PUBLIC EDUCATION IN FUNDING SEA TURTLE CONSERVATION

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It is a well known fact that public education is a critical component of long-term sea turtle conservation programs. But, can education in a tourist environment also help generate sufficient funding to support the educational staff and economically support sea turtle conservation programs in under-funded areas of the world? The focus of this study is to document and quantify the tourist's attitudes towards and willingness to financially donate to international sea turtle conservation programs after receiving an educational tour of a non-profit sea turtle rehabilitation facility in the U.S. Additionally, the study will quantify the tourist's reception of beach management techniques that may adversely affect their beach experience. This study will be conducted between May 2006 and January 2007 at Sea Turtle, Incoporated (STI) on South Padre Island, Texas. Funded solely by donations, the mission of this organization, founded in 1977, is to: 1) rescue and rehabilitate injured sea turtles for return to the wild, 2) educate the public about sea turtles and their marine environment, and 3) support sea turtle conservation programs with volunteer labor and financial donations. Sea Turtle, Inc. is able to generate sufficient funding to support its educational staff and interns, save funds for a 3,000 sq.ft. addition, provide scholarships, and assist with funding for conservation programs in Texas, Tamaulipas, MX, Michoacan, MX, and Sri Lanka. Sea Turtle, Inc. has also funded a research project in Costa Rica and small educational projects in Tamaulipas, MX, and Roatan, Honduras. Therefore, from our experience, we hypothesize that when tourists are given an educational tour, using injured or non-releasable sea turtles and additional displays, they become openly more generous financially and enthusiastic in their support for saving sea turtles and beach

management techniques that support sea turtle habitat. By way of exit surveys, this study will quantify this hypothesis. Furthermore, the results may encourage other conservationists in a tourist environment to utilize more education as a potential for generating additional funds or to ease the way with management of beaches to facilitate optimum conditions for turtles and marine life while minimizing the negative effect on tourism.

COGNITIVE EFFECTS IN THE POPULATION OF FISHERMEN IN THE ZAPARA ISLAND BY THE EDUCATIVE MANAGEMENT OF THE GTTM-GV

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Zapara Island belongs to the Insular region of the Zulia State, it's characterized by its natural wealth and exotic landscapes as well as the hospitality and vibrant personality of its inhabitants. Pertaining these to the indigenous ethnic group Añú or Paraujanos that through transculturization process have tried to maintain the essence of their culture before the different urban demands which they are put under. This island is one of the populations of work of the GTTM-GV to be in direct bonding with the Gulf of Venezuela and because historically in this island the marine turtles have been frequent personages for the nutritional and economic sustenance, which increases the risk of extinction of these animals. Due to the 8 years of investigation and educational work of the GTTM-GV in this Island, it is important to emphasize the permanent cognitive changes that they have been generated in the population of fishermen that lives there. This investigation was made through qualitative investigation, using the phenomenological method for his process and the technique of interview structured like recollection of data. The sample of informants will be conformed by 8 fishing inhabitants of the island, arranged to offer the necessary information and to triangle these data into a history of events to accompany the obtained findings.

YOUTH NETWORKS AS A TOOL FOR SEA TURTLE CONSERVATION

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When protecting migratory organisms such as sea turtles, community empowerment and the construction of conservation networks are important aspects that can determine success. Involving youth in these projects can have a positive impact on conservation efforts, since they are stakeholders and will become the next fishermen, heads of households and professionals.

The future of coastal communities and sea turtles swimming in coastal waters is in their hands. When young people create a group that engages in conservation activities, they act as an example for other kids and youngsters in their community; they focus their energy and free time in activities that strengthen their personal development, their learning skills and their creativity. Additionally, they reinforce their identity adopting responsibilities inside their communities and expand their knowledge of the local natural resources. The North Pacific loggerhead turtles *(Caretta caretta)* are critically endangered. As they feed off the Baja California Peninsula, they are vulnerable to fisheries, getting caught in gillnets and hooks as by-catch or as target species for the black market. Pto. Adolfo López Mateos, Baja California Sur, México is a fishing community crucial for loggerhead conservation because loggerheads aggregate at unusually high densities within the reach of local fisheries. Inspired by Ocean Revolution (an international program designed by Wallace J. Nichols to empower youth in the protection of the oceans), the proCAGUAMA team empowered youngsters from López Mateos to create their own youth conservation group in the summer of 2006. The 8 founding members of the *Kguaboys* carried out a number of activities: they 1) established the group by choosing the name and logo which they painted on t-shirts; 2) created posters for a sea turtle nature center and 3) prepared short visit groups through it. They took part in the research activities of proCAGUAMA, participating in field investigation and learning about the field work done with loggerhead turtles to better understand and effectively share their concern for these organisms. They also wrote a song: "Come and Save It" (a call to protect the loggerhead turtles in their waters), performed during the Sea Turtle Festival. They created the KGUA-CLUB, a space to gather and plan their activities, and a place where they create crafts recycling trash, which they sell to fund their projects. By autumn 2006 the group boasted 14 members, a work agenda, and the momentum and resolution to operate on their own. These were some of the achievements the *Kguaboys* accomplished during last summer. Now they plan to visit kindergartens in their community to teach kids about the situation of loggerheads and visit other communities to teach what they have learned. The *Kguaboys* have inspired youth not only in López Mateos, but in neighboring communities including San Juanico and Punta Abreojos. A way of measuring the future impact of the *Kguaboys* will be the number of youngsters integrating the group and their capacity to continue operating independently. We expect long-term conservation gains by empowering young people to form local conservation groups and regional networks.

SEA TURTLE CONSERVATION EFFORTS ON THE SOUTH EASTERN COAST OF BANGLADESH

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The major sea turtle nesting rookeries along the south eastern coast of Bangladesh lies under the district Cox's Bazar that included offshore islands and the longest sandy beaches at the Teknaf peninsula. The entire coast along the offshore inlands and peninsula provides more than 120 kilometers of suitable nesting beaches that are under severe threats currently due to developmental pressure from tourism and other factors. Long nesting beaches remain unprotected hence posing failures of breeding success. As part of the sea turtle conservation effort of the NGO MarineLife Alliance, activities conducted in the 2005-06 are discussed in this paper. The activities included monitoring of nesting sea turtles, monitoring of dead turtles along entire coast, conservation of nests through hatchery practice and in situ conservation, awareness activity with grassroots people and particularly with fishermen and school education programs. Establishment of sea turtle information and education center, training of community

people and offshore fishermen, education program with primary & high school in the coastal areas that included a quiz and sea turtle drawing competition, sea turtle campaign, and festival in Cox's Bazar during the peak tourist season was a target activity. The awareness program included the main theme of the IOSEA YOT 2006 that facilitates the program with sea turtle mass campaign in Cox's Bazar town. As part of the sea turtle conservation activity community capacity building and awareness activity has been emphasized under the MarineLife Alliance sea turtle program. Within the schools programs mass enthusiasm observed among the primary and high school students. And still the program needs to be conducted by every conservation project. Fishermen and grassroots people needs to be educated regarding sea turtle facts and their role in the nature. Still there is a huge lack of basic knowledge that needs to be disseminated to fishermen & grassroots to facilitate conservation. We are extremely thankful to Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, Ford Foundation and US Fish and Wildlife Service for their financial support to attend the symposium.

PERSONAL MEANING MAPPING METHODOLOGY USED AT THE NORTH CAROLINA AQUARIUM AT PINE KNOLL SHORES TO INVESTIGATE THE IMPACT OF SEA TURTLE EXHIBITS AND EDUCATIONAL PROGRAMS ON VISITOR LEARNING

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The North Carolina Aquarium at Pine Knoll Shores (NCAPKS) is one of three state operated aquariums and is part of a division in the North Carolina Department of Environment and Natural Resources. The mission of the three aquariums is to inspire appreciation and conservation of North Carolina's aquatic environments. To educate visitors about sea turtles, the aquarium works with North Carolina Wildlife Resources Commission to rehabilitate loggerhead hatchlings. During rehabilitation and growth, these hatchlings are exhibited and used in educational programs to teach visitors about sea turtles, focusing on local loggerhead nesting sites and conservation issues. Goals of the NCAPKS are to inspire stewardship of sea turtles and their natural habitats and instill conservation of these animals. In an effort to assess the aquarium's ability to achieve these goals through the exhibits and programs, the personal meaning mapping methodology was used to qualitatively analyze the visitors' learning experience. The method has been designed by the Institute for Learning Innovation to assess learning in environments like aquariums. School groups and general visitors of all ages were interviewed before encountering a sea turtle exhibit or program at NCAPKS and again interviewed after making the journey through the facility. This information is compared to learn what impact these programs and exhibits have on the visitors and their frame of mind regarding sea turtles. Information learned from this study will be used to further develop, improve, and diversify the exhibits and programs to achieve the aquarium's mission.

STRENGTHENING SEA TURTLE CONSERVATION ON THE BAJA CALIFORNIA PENINSULA: EDUCATION, OUTREACH, AND COMMUNICATION

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The Grupo Tortuguero works with local communities to recover migratory sea turtle species and reverse declines of diversity, complexity and connectivity of ocean basins. The objectives of this project are: 1) to build a diverse network of fishermen, students, teachers, activists, researchers, funders, managers, indigenous community members and other coastal citizens.; 2) draw on these relationships to understand threats, generate new knowledge and develop locally-appropriate solutions and 3) empower local leaders to communicate the conservation message and share these solutions widely. One of the main challenges in the field of marine conservation is the progression from field research to knowledge to the modification of detrimental behaviors. Recognizing this, a comprehensive education, outreach and communications plan remains a major part of our conservation strategy. Based on our research and work in communities we implement solutions and share our findings widely through a variety of media outlets, educational programs, festivals, symposia and public meetings, with the goals of defining policy and modifying detrimental behaviors. Using the five species of sea turtle found on the Baja California peninsula (*Caretta caretta*, *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata* and *Lepidochelys olivacea*) as flagship species for environmental conservation, we are encouraging sensitivity and appreciation of local natural resources. We have developed a methodology to identify the main environmental challenges in the region, and have developed various activities such as cleanup campaigns, festivals, sporting events, and outreach using stickers, posters and t-shirts that have become a permanent message of conservation and protection of sea turtles.

SUN, SAND AND SEA TURTLES: EDUCATING NEVISIAN YOUTH AS A MANAGEMENT TOOL FOR THE FUTURE

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Historically, the Caribbean Sea was home to millions of sea turtles. Present day sea turtle populations throughout most of the region, including the island nation of Saint Kitts and Nevis, are severely depleted from what they were a century ago. While cooperative and collaborative action between Caribbean islands is crucial to the survival of migratory marine species, including sea turtles, conservation is most often undertaken at local levels. In order for communities to take action, and to ensure that these actions are rooted in the principals of sustainable use (whether that use be consumptive or non-consumptive), residents need to be more aware of the complexities of sea turtle biology and management issues. Because sea turtle conservation is a long-term challenge with generational solutions, it is important to educate those who will be accountable for the resolution of this problem in the future; the

children. During a 3 month internship with the Nevis Department of Fisheries and the Nevis Turtle Group, I created a summer camp, “Sun, Sand and Sea Turtles” for local children. The camp was initiated as a collaboration between the Four Season’s Resort and a local non-profit organization, The Nevis Turtle Group (NTG). The camp was free to local children (9-15 years old) and featured a 3–day curriculum. A gracious donation from the Four Seasons Resort provided the venue, snacks and registration fees for all participants. The program focused on the biology, threats (both man-made and natural) and conservation of sea turtles in the Caribbean Sea. Upon completion of the camp, 80 children were pronounced Junior Members of the Nevis Turtle Group, and invited to participate in nest monitoring efforts. As a result of educating Nevisian Youth, the NTG saw an elevated island-wide interest in sea turtle conservation, including increased participation of local adults in nighttime beach monitoring. Due to the overwhelming success of the camp, my master’s research will focus on the production of a detailed and multilingual curriculum guide. The guide will be available to any interested party, allowing “Sun, Sand and Sea Turtles” to be replicated throughout the Caribbean region.

SWOT REPORT II: THE STATE OF THE WORLD'S SEA TURTLES - LOGGERHEAD NESTING BEACHES

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Volume I of the *SWOT Report: The State of the World’s Sea Turtles* was published in early 2006, featuring leatherback nesting data from 2004 at nearly every leatherback nesting beach in the world. Expanding upon the "SWOT Team," the network of data providers who collectively documented these nesting sites, *SWOT Report (Volume II)* has as its centerpiece the loggerhead nesting beaches of the world, with nesting data from every available beach in 2005, as well as a second year of leatherback nesting data, also from 2005. Building upon lessons learned in developing Volume I, the SWOT Scientific Advisory Board refined the data-gathering procedures to allow for greater analysis of the nesting data presented in Volume II. Furthermore, as part of SWOT efforts to create a tool for global outreach and education, five small grants were provided to members of the SWOT Team network to conduct outreach and educational activities using *SWOT Report (Vol. I)*. These projects were located in Bangladesh, Guyana, Malaysia, and Sierra Leone and covered a wide range of communications themes including outreach to politicians and local communities. Of these five, the outreach project implemented by Conservation Society of Sierra Leone (CSSL)—-a workshop specifically designed around *SWOT Report (Vol. I)*—-stood out as an exemplary use of the publication as a means to examine the worldwide status of sea turtles and Sierra Leone's place within that global view. That project will be highlighted in this presentation as a successful outreach project and one of many possibilities for employing *SWOT Report* as an educational tool. This paper explores the merger of science with education and outreach under the SWOT initiative, presenting the findings of SWOT Report (Vol. II)’s collaboration on global loggerhead and leatherback nesting data, in addition to the results of the outreach and education campaigns that were based on *SWOT Report (Vol. I)*.

ENVIRONMENTAL EDUCATION AND COMMUNITY ENGAGEMENT FOR THE CONSERVATION OF SEA TURTLES

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Environmental Education (EE) in conservation projects is of great importance to bring about socially and environmentally transformations and to elaborate and apply effective measures to the conservation of biodiversity. It is the role of Environmental Education to ensure the transformation that will make life better now and in the future. It means, also, to look at nature with passionate eyes and to respect all forms of life, considering the interface and interdependence among all its elements. Therefore, the sea turtle project, carried out by the NGO NEMA in the Coast of Rio Grande do Sul/ Brazil, seeks to reduce the incidental capture and mortality of sea turtles, caused by indiscriminate fishing and dumping, by engaging the fishing communities of the municipalities of Rio Grande, São José do Norte e Torres located in the Rio Grande do Sul state in its conservative and educational practices. It is we believe that the maintenance of biodiversity depends more on communitarian engagement than on the current means of protection. In this effort, Environmental Education is being taught in local schools, during popular events, upon the boarding of the onboard watchers, in the interviews with fishermen and in the craft courses offered to their wives. The EE methodology applied relies on the arts, on the environmental sciences and on the psychophysical education to bring about and to value the reasoning, the intuition, the feeling, the imaginary and the symbolic elements that constitute every human being. This work also contributes by showing different ways of understanding and expressing life in the world, producing a critical understanding of reality and aiming at the building of environmental awareness and the participation of all in solving and preventing social and environmental conflicts. These actions are making possible the rescue of values and culture together with the motivation to critical thought, as well as the development of a systemic view of society and environment in these communities. The educational activities gave possibility to the insertion of diverse social, economical, political and cultural themes that are associated to ecology. Through its actions and the community engagement the project established partnership with many fishermen that, from then on, collected data about incidental capture; formed the Craftswomen group of Barra, located in a fishing community and composed by local women and family members, representing an alternative income to these families; emerged children's interest in the conservation of sea turtles and marine biodiversity. This project took a big step ahead in the conservation of sea turtles and in raising ecological awareness of the local fisherman and their families. Furthermore, it also indirectly contributed to the empowerment of these communities, their culture and their beauty.

S.E.E. TURTLES - ELEVATING MARINE TURTLES INTO THE RANKS OF TOP ECOTOURISM ATTRACTIONS

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Around the world, sea turtle conservationists have proposed the economic benefits of ecotourism as an alternative to the consumptive use of turtles (hunting, egg collecting and bycatch). Yet connecting tourists with conservation projects remains, for many, a challenge. While a few high profile beaches reap the rewards of income, jobs, and strong local support that ecotourism can bring, many ideal spots are overlooked while people look elsewhere for entertainment. Most turtle conservation projects lack training in marketing, resources to advertise, and the ability to reach the prized ecotourism market. The goal of this project is two-fold: to augment field conservation projects by increasing income for both local communities and for the local project itself; and to elevate sea turtles into the realm of top wildlife attractions while educating visitors on their threats and how to help. The initial sites will be chosen by several criteria including the benefit to turtle conservation; benefits accruing to the local community; the need for alternatives; basic tourism infrastructure; and the relative importance of the site for turtles. Initial sites under consideration include Baja Mexico, Costa Rica, the US Virgin Islands, Hawaii, and Florida. The Ocean Conservancy and its partners will reach this market by building interest through outreach to key travel and media outlets; providing information through our magazine, e-newsletter, and a central web site; and connecting people to responsible options through various outlets including tourism operators and partnerships with conservation groups. We have developed a set of criteria that we are using to assess the first sites that SEE Turtles will feature and will offer. The program will expand to offer diverse options in terms of sea turtle species, accommodations and infrastructure, geographic location (starting in the Western Hemisphere), and turtle activities (swimming, nesting, participation in research efforts if possible).

ADVANCING CONSERVATION THROUGH RESEARCH AND EDUCATION: A FOCUS ON THE SEA TURTLES OF PALMYRA ATOLL

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An effective and challenging way to advance biodiversity conservation is to conduct high quality scientific research and apply the work directly to protection efforts. As flagship threatened species, sea turtles are promising model organisms in this regard. We are therefore combining our ongoing sea turtle research and educational initiatives in an interdisciplinary approach to support marine conservation. At the Palmyra Atoll National Wildlife Refuge, we are studying the population biology and connectivity of sea turtles. Marine chelonians at this remote atoll, located about halfway between Hawaii and American Samoa, forage in a unique environment currently removed from pervasive anthropogenic influence. In our research, we are addressing questions of distribution and abundance, ecological interactions, habitat use, and connectivity to other populations. In turn, our work at Palmyra is being incorporated into educational materials produced by the Network of Conservation Educators and Practitioners (NCEP). The key goal of NCEP is to improve the practice of biodiversity conservation by improving training in

conservation. The initiative targets educators working with undergraduate and graduate students, and trainers working with conservation professionals in a variety of settings. One of the most important tangible products of NCEP is a series of multi-component modules, or resources for teachers and trainers in the field of biodiversity conservation. The modules include a summary document or synthesis of a key topic in biodiversity conservation, an easily modified classroom presentation, accompanying practical problem-solving exercises for the field and classroom, a teacher's guide to module use, and a collection of original scientific literature. The modules, available in several languages, continue to be provided free of charge to teachers and trainers in partnering countries, and increasingly, through the Internet (http://ncep.amnh.org). An important focus for NCEP has been producing modules on the marine environment, including materials on marine conservation biology, marine protected areas and networks, marine conservation policy, and international treaties for marine conservation and management. We have also created an interactive computer simulation exercise about marine reserves and local fisheries. In this presentation, we describe the innovative and diverse educational materials about sea turtles and their environments, including exercises and a case study, that are widely available, free of charge, as part of the NCEP initiative.

USE OF SHORT SURVEYS TO ASSESS THE IMPACT OF EDUCATIONAL PROGRAMS

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Since 2001, we have conducted projects on the conservation of endangered marine fauna. These projects address scientific research and outreach/awareness. The main objectives of the educational program are to increase the knowledge on marine conservation and promote conservation in stakeholders. The activities performed within this program include talks, workshops, etc. Our target audiences were authorities, fishermen, school children at fishing communities and local researchers. To assess the impact of these activities on these target groups, we conducted a survey before and after each activity. The surveys were based on a short, written questionnaire, containing 20 questions total. The theme of the educational talks was seabird, marine mammal and sea turtle conservation. Our study period was from August 2005 to May 2006. From the preliminary analysis of these surveys, we found that almost two thirds of the fishermen knew the concept 'threaten/endangered species' and three quarters knew the concept 'migratory'. Attendants were much more familiar with sea turtle conservation (85%) than with seabird conservation (59%). Also, most fishermen (85%) were willing to try the circle hooks as a mitigation measure to reduce turtle bycatch and to try de-hookers after these techniques were presented to them. The majority (92%) of fishermen responded that they were willing to try mitigation measures for seabird bycatch. Also, most fishermen replied that they would release sea turtles or seadirds from their fishing gears. The increase in correct answers to post-workshop questionnaires suggests that the talks were successful, at least in the short term, in their objective of raising awareness on marine fauna conservation issues. These surveys also proved useful in evaluating levels of knowledge of the different stakeholders groups and inquiring about possible fishermen conservation actions. Also, surveys suggest that fishermen (the most important audience) have had the least previous exposure to the issues discussed. We therefore recommend placing particular emphasis on fishermen as workshops and evaluations are continued in the future.

CONNECTING CULTURES TO SAVE A TRANSPACIFIC AMBASSADOR, THE LOGGERHEAD TURTLE

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[6] Grupo Tortuguero
[7] Hawaii Longline Association
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Endangered loggerhead turtles nest in Japan and mature in the waters of Hawaii and Mexico and thus require international, collaborative conservation measures. Reversing the decline of loggerhead turtles is a priority clearly articulated in US, Japanese and Mexican environmental policy, as well as by local, national and international NGOs and intergovernmental agencies. Unfortunately, efforts to protect loggerheads have been hampered by poor pan-Pacific coordination among agencies, organizations, scientists, and fishers. Because fisheries bycatch is the greatest known threat to loggerheads, it is clear that conservation action must be coordinated in all three countries. Fisheries conservation initiatives in Mexico and Hawaii and nesting beach protection in Japan have resulted in reduced turtle mortality, but loggerhead turtle bycatch remains problematic in some fisheries. Preliminary social research indicates that fishers can be motivated to take conservation action by their appreciation for turtles' transpacific migrations and consequential vulnerability. We have assembled a pan-Pacific team from the U.S., Japan, and Mexico to share their knowledge towards understanding the cultural, social, and economic conditions that threaten loggerhead turtles in each country and for developing joint solutions to this shared problem. Through international exchange and capacity building, we are empowering fisher leaders and policy makers from Mexico, the US, and Japan to convey the transpacific migration and vulnerability of loggerhead turtles to other fishers and their families in bycatch hotspot communities. A delegation of Mexican, Japanese and US fishers, conservationists and scientists traveled to Japan, Mexico, and the US (this Symposium) to: 1) gain a pan-Pacific conservation perspective by experiencing trans-Pacific traveling loggerhead turtles in Japan; 2) share local bycatch concerns and develop solutions with international counterparts at the annual meeting of the Sea Turtle Association of Japan and at the annual meeting of the Grupo Tortuguero; 3) inspire and empower fishers to reduce bycatch by sharing the exchanges through community enrichment programs and a short documentary film; and 4) to share new knowledge of loggerheads to develop a tri-national conservation strategy to recover the North Pacific population.

SEA TURTLE JOURNEY: AN EDUCATIONAL LEARNING EXPERIENCE FOR 3RD GRADERS

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An educational kit was created by the South Carolina Department of Parks, Recreation, and Tourism at Edisto Beach State Park to educate and increase the awareness of third grade students with about the loggerhead sea turtle, *Caretta caretta*, which is the state reptile. Third graders were chosen to use this kit because it is within this grade that they are first exposed to life science. In addition, throughout the third grade year, they learn about the history, background, and symbols of South Carolina thus enriching their knowledge about their state reptile. This kit was designed during the 2006 turtle nesting season while working at Edisto Beach State Park. The kit is composed of six lesson plans, one per day, all of which follow South Carolina Curriculum Guidelines for third grade. They include: 1) pollution, 2) endangered species, 3) water life vs. land life, 4) sea turtle biology, 5) sea turtle hatching and reproduction, and a 6) capstone review day. The pollution lesson plan will give students an overview of what pollutants exist as well as the harmful effects they can have on marine life, turtles in particular. The endangered lesson plan not only gives an overview on the Endangered Species Act, but also explains the difference between endangered and threatened species. Water-life versus land-life provides the students with a look at the different adaptations needed for species to live in water as opposed to those that live on land. The sea turtle biology day will shed a light on the different sea turtles, basic anatomy, and geographic distribution. Sea turtle hatching and reproduction will follow a sea turtle from birth to when it lays its own eggs. These lesson plans incorporate not only Life Science Standards, but also Language Arts, Mathematics, Visual and Performing Arts, and Physical Education. At the culmination of the unit, the teacher will have the option of taking the students on a field trip to Edisto Beach State Park. On-site, they will have the opportunity to participate in a “Turtle Patrol” where they will search for, find, and excavate turtle eggs (ping pong balls). They will also determine suitable locations on the beach for turtle nesting using the knowledge gained from their unit as well as relate other lessons they have learned from the unit to this real-life experience. In addition, they will have the opportunity to visit the park’s Interpretive Center where they will gain additional hands-on knowledge about their state’s estuaries and different flora and fauna. The lesson plans for this kit are completed and should be tested during November 2006. They will be revised as needed. The finished products will be sent to schools in the spring of 2007.

SEA TURTLE EDUCATION FOR NEW HAMPSHIRE KIDS

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Students and teachers are motivated by the urgency of complex environmental challenges. Teachers are always looking for ways to make their teaching and connections with their students stronger, and to make learning more fun. Sea turtle education must be experiential, nurture interdependence, and must empower students to develop the judgment necessary to take responsibility for the conduct of their lives and the shaping of society. The Leatherback Sea Turtle A-Z Coloring and Activity book was designed to educate students, teachers, and the public about the importance of conserving the leatherback sea turtle which is endangered in

New Hampshire and worldwide. Threats that leatherback turtles face are similar to threats that all sea turtles face around the world. Kids can help sea turtles by learning more about them and ways they can participate in their preservation. Middle school students are curious and open-minded, ready to learn. This book encourages an awareness of the importance and relevance of sea turtle conservation in New England states. Nesting only occurs in tropical or subtropical states, but sea turtles spend most of their lives at sea. Their feeding and migration routes make them subject to many human-induced threats in New England waters and worldwide. It is important to provide students and their teachers with visionary innovative approaches to environmental learning that shape an ideology that respects the environment and questions the actions of others who don't. This book will be made available to the Contoocook Valley School District (Middle School's) free of charge, and be placed in local libraries reaching thousands of students, teachers, and community members in the Monadnock region of New Hampshire, USA. Teaching young students to be better stewards of the earth and its resources will help ensure that sea turtles will be around for future generations to enjoy. Additional grant funding will allow for wider distribution of this publication. *Acknowledgments*: I gratefully acknowledge travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service, provided through the Symposium Travel Committee.

TURTLES, TAMARINS AND TRASH: PROVIDING ECONOMIC INCENTIVES TO SUPPORT SEA TURTLE CONSERVATION EFFORTS WORLDWIDE

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Managing plastic waste is important to the survival of wildlife around the world; in many rural communities plastic bags are used and disposed of in a manner that negatively impacts wildlife. Thousands of endangered sea turtles die every year from ingesting plastic bags and the amount of litter on nesting beaches and associated with marine and coastal foraging grounds is staggering. To combat the challenge of plastic bag litter, we developed a program in Colombia to turn "trash" into products that could be sold in national and international markets. We trained a group of 12 women from a rural community in Los Limites to crochet using plastic bags which they collect, recycle, wash and sort. From these raw materials they create a colorful "eco-mochila," a crocheted tote bag constructed from 100-120 plastic grocery bags. More than 500,000 discarded plastic bags have been collected from rural communities, beach communities near Cartagena, and urban communities in Cartagena and Barranquilla to support this program. Eco-mochilas are sold in Colombia and internationally and the demand for these products has grown substantially since the project began in 2004. Recently we have partnered with the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) to expand this program with the aim of greatly reducing the amount of plastic bag litter found near sea turtle nesting beaches in Costa Rica, Panama and Nicaragua. We selected community leaders and artisans from communities involved in protecting sea turtles through a variety of local efforts. These individuals went to Colombia and trained with local artisans to learn the techniques of making eco-mochilas. Trainees also brought with them examples of indigenous crafts from their areas, so that each community learned a variety of new skills, enhancing their efforts to utilize otherwise discarded materials and to create much-needed local income. The program has been

a great success in that it not only enables communities to develop a product that provides a sustainable economic benefit but it also protects sea turtles by significantly reducing the amount of plastic bags in the environment. With the support of international sponsors such as Disney and WIDECAST in the creation of new markets, these communities reap ongoing benefits by their involvement in conservation efforts and have a direct economic incentive to keep the oceans and beaches free of plastic. Developing programs that reduce sea turtles exposure to plastics while empowering local people to learn new skills that provide them with a direct economic benefit is an example of how innovative solutions can be used to solve conservation challenges that positively impact impoverished communities and support the conservation of native biodiversity. Based on the success of this pilot effort, we will broaden peer-training opportunities to include dozens of communities involved with the protection of sea turtle nesting habitat throughout the Wider Caribbean Region.

Fisheries

RELATIVE ABUNDANCE TRENDS OF SEA TURTLES IN THE MAHI MAHI LONGLINE FISHERY OF COSTA RICA; 1999 – 2005

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Pelagic longline fishing is considered one of the main threats to the survival of sea turtles world wide. Estimating relative abundance of sea turtles captured during longline operations, as well as yearly trends, is critical to understanding the magnitude of the problem as well as the natural fluctuation of the numbers of turtles in the EEZ of Costa Rica. It is important to understand these fluctuations when performing research on gear modification to mitigate the impact of longlining on sea turtles, and comparing results between seasons. From 1999 to 2005, three separate observer programs, which included sample sizes of 77 sets with 39,284 hooks, 81 sets with 50,419 hooks, and 81 sets with 58,666 hooks, respectively.

NEW APPROACH TO SOLVE THE TURTLE/SHRIMP PROBLEM IN COSTA RICA

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Since May of 1996, the United States imposed an embargo on the importation of shrimp from nations that to do not protect sea turtles from drowning during commercial shrimp trawl operations. Since 1995, before the embargo, Costa Rica has been visited by National Marine Fisheries Service officers to perform technology transfer workshops and confirm efficient implementation of TED regulations. Furthermore, the local shrimp trawl industry, together with local conservation groups, developed modified TEDs specially designed for Costa Rican fishing conditions, called the Tico TED. Sinkey Boone, the inventor of the TED, visited Costa Rica in 2004 to work with the local fishermen and improve acceptance. Unfortunately, since 1999, Costa Rica has suffered three embargoes. On May 1 of 2006, the last embargo was lifted after one year, and Costa Rica was allowed again to export shrimp to the Untied States. However, shrimp trawlers are still commonly reported fishing within the waters of Marine Protected Areas designated as such to protect nesting turtles, such as the Ostional Wildlife Refuge and the Caletas-Ario Wildlife Refuge. During September of 2006, over 200 turtles stranded in Ostional. An evaluation by PRETOMA discovered that in spite of efforts by the Coast Guard to apprehend infractors, Fishery authorities were reluctant to impose any measures, such as canceling the fishing license, impunity reigning in the administrative process. Without government subsidisations the industry would perish, as shrimp is overfished, with catch rates dropping 7.7% yearly since 1985, reaching record lows in 2005-2006. We propose a serious reduction of up to 70% of the Costa Rican fleet, a prohibition for the remaining vessels to trawl in the Golfo de Nicoya and the Golfo Dulce, as well as one mile from the coasts. PRETOMA will build a Supreme Court Case to persuade government officers to take measures and regulate the shrimp trawl fleets, and Costa Rican consumers will be educated to consume artisinally caught shrimp.

HAWKSBILL BYCATCH QUANTIFIED IN AN ARTISANAL FISHERY IN SOUTHWESTERN DOMINICAN REPUBLIC

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Bycatch is a significant issue affecting fisheries management today and the incidental mortality of sea turtles in many fisheries is an important and often controversial conservation problem. Empirical data on the bycatch of turtles are lacking in artisanal fisheries. For 10 days we conducted informal interviews with fishers, fishing net surveys, searched for strandings, and deployed fishing nets to directly quantify turtle bycatch in an artisanal fishery from the Dominican Republic. Our study area was a major feeding ground for hawksbills turtles within a Caribbean UNESCO Biosphere Reserve with artisanal fishers soaking nets daily. We calculated a catch per unit effort of 0.03 turtles/h (SD ±0.04) and estimated an alarming bycatch rate of ~1 turtle/day from surveys and experimental fishing trials. We call for other rapid assessments that would aim to quantify turtle bycatch from artisanal fisheries to facilitate policy and management action protecting this critically endangered marine species.

PRELIMINARY ASSESSMENT OF THE IMPACT OF ARTISANAL FISHING ON SEA TURTLES ALONG THE CAMEROON COASTLINE (WEST AFRICA)

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Various human activities along the coast of Cameroon degrade the environment and threaten to deplete resources. One of the direct threats comes from the coastal fisheries sector. The coastal zone runs through three Provinces, namely the South, Littoral, and the South west. This represents almost 15% of the total population of Cameroon which has a growth rate varying between 2 and 6%, and their most important occupation is undoubtedly small-scale fishing. This study has been conducted to see the impact of artisanal fishing on sea turtles through surveys of fishermen and evaluation of carapaces. A total of 442 sea turtles were seen between 1999 and 2001. Fishing gear captured 400 turtles (90.5%) and 42 (9.5%) turtles were identified on the nesting beaches. The species observed included green turtles 166 (37.5%), olive ridleys 158 (35. 7%), hawsbills 110 (24.9%) and leatherbacks 11 (2.5%). These turtles were observed in Kribi 412 individuals (93.9%), Edea zone 20 individuals (4.5%), and Limbe area 10 individuals (2.3%). These results do not represent reality because certain areas like Edea and Limbe, which have intensive fishing activity, were not involved in our surveys due to the fact that this research was being confined to the Kribi area where the project is based. In conclusion, this study suggests that it is desirable to better organise fishing activity along the Cameroon coast because in 1995 there were 24,136 artisanal fishermen consisting of 4,149 (17.2%) Cameroonians, and 19,987 (82.8%) foreigners. This will help improve fishing techniques and permit the installation of patrol squads to survey the fisheries sector. These measures will be geared towards designing new policies for the management of the marine ecosystem in Cameroon.

PRELIMINARY SURVEY OF INCIDENTAL CAPTURE OF SEA TURTLES IN JAMAICAN FISHERIES

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There is limited information on the sources of mortality of sea turtles in Jamaican waters and no information on the extent of interaction with fisheries. We surveyed 127 Jamaican fishers in 5 locations during August and September 2006 to gain a preliminary understanding of sea turtle, marine mammal and sea bird bycatch in local fisheries. Eliciting information on prohibited activities such as sea turtle capture and the continuing opportunistic exploitation of turtles is often difficult and fishers were not directly surveyed regarding their fishing practices. However 27% of the 127 trawl, trap, and gillnet fishers interviewed about the timing, numbers, species and location of bycatch events, responded positively to the question of whether sea turtles were captured incidentally in fishing gear. Fish traps and gillnets ("china nets" and trammel nets) were gear types primarily identified in sea turtle bycatch, but this probably reflects the preponderance of those fishing gear in Jamaican waters. Our survey also suggests that juvenile hawksbills (3-20 kg) are caught in traps, while reports of bycatch of larger turtles were associated with the gillnet fisheries. This is the first study that specifically examines sea turtle bycatch in Jamaica and additional surveys incorporating a statistically robust sampling frame of fishers and their activities would aid in estimating bycatch levels. Since traps are the predominant fishing gear in the insular Caribbean, we recommend additional research to estimate the rate and size structure of hawksbills turtles caught in fish traps and coastal gillnets.

SEA TURTLES AND RFMOS: WORKING WITH REGIONAL FISHERY MANAGEMENT ORGANIZATIONS TO ASSESS AND REDUCE ACCIDENTAL SEA TURTLE FISHING MORTALITY

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The unintentional capture, injury and mortality of sea turtles (bycatch) by fishing fleets in national and international waters needs to be systematically addressed to arrest major population declines, such as the dramatic decrease in the southern Florida loggerhead nesting population. Growing global attention to the accidental capture of sea turtles and other non-target species by fisheries provides an opportunity for the sea turtle community to assist RFMO Secretariats and member states in assessing and addressing this problem. To date, the world's fishing commissions have established 16 Regional Fishery Management Organizations (RFMOs) to regulate and manage high seas fisheries. With the exception of several RFMOs whose regulatory areas are in far northern or southern latitudes, sea turtles can be expected to interact with the fleets of most RFMOs. Because there is an increasing awareness of the need to maintain ecosystem health, RFMOs are an excellent vehicle for promoting sea turtle bycatch reduction on a large scale. Bycatch reduction also should be facilitated by the fact that many countries which participate in RFMOs are members of multiple agreements. At its 26th annual symposium in 2006 in Crete, the International Sea Turtle Society passed a resolution calling on RFMOs to urge their members to adopt and implement the FAO's "Guidelines to Reduce Sea

Turtle Mortality in Fishing Operations" and resolutions to reduce bycatch. Subsequently, the Northwest Atlantic Fisheries Organization (NAFO) and the Southeast Atlantic Fisheries Organization (SEAFO) passed resolutions to collect data on sea turtle interactions; other RFMOs are considering similar action. These resolutions are the result of the commitment by governments and RFMO Secretariats to address the unintentional capture of sea turtles, thanks in large part to the pivotal role played by the sea turtle community over many years in raising awareness and generating government support. We should continue to catalyze action by other RFMOs. Research and much work lies ahead as these initial steps, as important as they are, will not resolve the bycatch issue. Once RFMOs adopt resolutions on sea turtle bycatch, the contracting parties must be encouraged to collect data and report their findings. Where interactions must be addressed, support may be needed for research and implementation of changes in fishing gear or fishing methodology. Member states will need to be convinced to couple international protections with identical safeguards within their EEZs. FAO deserves a great deal of credit for its work to reduce the bycatch of sea turtles and other non-target species and raise global awareness about this issue. Since hosting the technical workshop that resulted in the production of "Guidelines to Reduce Sea Turtle Mortality in Fishing Operations" in December 2004, FAO has turned its attention to developing materials on ways to implement them.

ALTERNATIVE METHODS TO SPATIALLY DISTRIBUTE FISHING EFFORT WITHIN THE HAWAIIAN LONGLINE FISHERY AND CORRESPONDING EFFECTS ON THE CALCULATION OF BYCATCH RATES

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Bycatch in longline fisheries has been recognized as a threat to many endangered populations of sea turtles. The precipitous decline of such populations as the Pacific leatherback (*Dermochelys coriacea*), has made the understanding of fisheries interactions a research priority for the sea turtle conservation community. The economic and social importance of the fisheries involved has also led to numerous studies that use or investigate the spatial distribution of longline fisheries effort to understand catch and bycatch rates. These analyses generally ascribe effort from an individual longline set to the point at which the gear is deployed or hauled. Typically, reported fishing effort summarizes these point values over large areas (>1˚). Although assigning kilometers of longline effort to a single point may be sufficient for large-scale summaries of general fishing effort, the accuracy of finer-resolution models, such as those associating local oceanographic effects with catch or bycatch rates, may be strongly influenced by the distribution method. In this assessment we look at alternative techniques (i.e. the use of centroids, polylines, and polygons) for distributing the fishing effort of the Hawaiian longline fleet. We analyze the effect of scale on the different distribution schemes and make recommendations regarding which methods for distributing fishing effort are appropriate based on the desired resolution of the parent model. This study is part of a larger bycatch assessment project jointly run by Duke University and Blue Ocean Institute (Project GLOBAL).

STRATEGIC PLAN FOR ELIMINATING THE INCIDENTAL CAPTURE AND MORTALITY OF LEATHERBACK TURTLES IN THE COASTAL GILLNET FISHERIES OF TRINIDAD AND TOBAGO

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Incidental capture in coastal gillnets is the largest single source of mortality to leatherback sea turtles (*Dermochelys coriacea*) in the Republic of Trinidad and Tobago. Unchecked, it threatens to undo several years of proactive conservation and innovative management by Government and by local NGOs. The entanglement problem also places a severe strain on the ability of fishers to operate economically, to the point that many are unable to fish during the sea turtle nesting season. Finally, because the nation supports the second largest nesting aggregation in the world, incidental capture and mortality to reproductively active females constitutes a major threat to this Critically Endangered (cf. IUCN) species on both Atlantic basin and global scales. To open a dialogue on these issues, and facilitate a stakeholder driven process of solution-making, a National Consultation was hosted by the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) and the Fisheries Division (Ministry of Agriculture, Land and Marine Resources) in February 2005. Invited participants included fishers, local and national NGOs, the government's natural resource management agencies, the Ministry of Foreign Affairs, and invited international fishing and conservation experts. The goal of the meeting was to review the problem of sea turtle bycatch in coastal gillnet fisheries along the north and east coasts of Trinidad where most leatherback nesting takes place, and to apply the shared expertise of the forum to devising a series of potential solutions suitable for field-testing and evaluation by fishers and natural resource management professionals. Twin objectives were proposed: (i) fishers must be better off economically as a result of any proposed solution to the bycatch crisis, and (ii) the incidental capture and mortality of leatherback sea turtles in coastal fisheries must cease. Participants acknowledged that no single solution would suffice. It was proposed that a series of investigations be designed to evaluate, under realistic field conditions, bycatch reduction options including: new hook-and-line baits; new fishing technologies or gear modifications to existing methods; and creative approaches to net avoidance. It was agreed that each testable would receive equal weight during the experimental phase, and that the results of each trial would determine subsequent experimental priorities. There was consensus that fishers be involved in the testing and development of each new method, with oversight and assistance by relevant experts, and criteria were devised to evaluate the results of such tests. New regulatory regimes, and in particular the implementation of time and area closures, were also discussed. Bycatch of endangered sea turtles in rural, poorly capitalized and largely artisanal fisheries is a serious issue throughout the world. Creative solutions that do not compromise the ability of low-income fishers to make a living are essential. The successful conclusion of the National Consultation ensures a multi-sectoral collaborative approach to the bycatch crisis in Trinidad, and provides a model for defining and achieving similar results elsewhere.

FIRST DATA ON COMMERCIAL FISHING IMPACT ON *CARETTA CARETTA* IN SOUTH SARDINIA (ITALY)

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The Cetaceans and Sea Turtles Rescue Centre "Laguna di Nora" (est. 1993) was the first of its kind established at the island of Sardinia. With this paper we present data recorded during 9 years of activity, from 1997 to 2005. We rescued 162 loggerhead sea turtles: 33% of the total *Caretta caretta* specimens were stranded turtles, 75% of them were dead animals. Besides, 39% of all specimens were directly caught as professional fishing bycatch, with an incidence of dead specimens of 6%. Trammel directly caught 86% of all loggerheads, while only 1 turtle was caught by bottom trawl net and only 1 by drifting longline. However, 40% of the specimens entrapped in trammel net showed a previous interaction with a longline gear (e.g. hook presence). Complete data on 111 specimens show that longline fisheries actually have a highly negative impact on *Caretta caretta* in this area, with a peak of catches at a size of 46-60 cm CCLn-t. With respect to hook location, 81% of turtles presented deep embedded hooks: 43% were found in the oesophagus, 12% in the stomach, 26% in the intestine. Generally, each specimen had no more than 1 hook.

LOGGERHEAD (*CARETTA CARETTA*) SEA TURTLE INTERACTIONS WITH THE VIRGINIA (USA) WHELK POT FISHERY

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The Chesapeake Bay and coastal waters of Virginia serve as an important foraging habitat for juvenile loggerhead sea turtles (*Caretta caretta*) between May and November. Each year, 200 to 400 sea turtle stranding deaths are recorded within Virginia's waters. The cause of death for many of these strandings cannot be determined. There are many active fisheries in the bay and coastal waters during these months that could potentially be a threat to sea turtles. Currently there is little to no data on sea turtle interactions with many of these fisheries. The whelk pot fishery is an example of a fishery that has no data on sea turtle interactions. Therefore, this research will examine the extent to which loggerhead sea turtles interact with the whelk pot fishery. In the past, the main prey item for loggerheads in the Chesapeake Bay was horseshoe crab (*Limulus polyphemus*). As the horseshoe crab population was depleted, loggerheads started to forage on other species such as whelk. Horseshoe crabs are used as bait in the whelk pot fishery and channel whelks (*Busycotypus canaliculitus*) are the targeted species. Therefore, the assumption could be made that loggerhead sea turtles are attracted to whelk pots, potentially becoming entangled in the bridle or buoy line. Several voluntary observer trips were conducted, setting pots in the lower Chesapeake Bay. Catch data for each hauled pot was recorded, and any evidence of sea turtle interaction documented. Preliminary results indicate that three different types of whelk pots resulted in similar CPUE's for whelks. There were no incidences of sea turtles caught as bycatch; however evidence of possible sea turtle interactions was present. Behavioral experiments were conducted in Galveston Texas using captive reared loggerhead sea turtles greater than 60cm CNT. Randomly chosen turtles were allowed to

interact with a randomly chosen whelk pot for 40mins. During the first forty trials, each baited pot type was tested ten times in its original bridle position. Ten trials were conducted using a non-baited pot. The next set of thirty trials tested each pot with the bridle position changed. To decrease the chance of startling the turtle, each pot was introduced to the water from a platform on the side of the tank. The buoy line went through a pulley system above the tank. Pots were slowly lifted and set into the middle of the tank. The buoy line was then tied off, leaving some slack in the line. For the final twenty trials, pot bridles were returned to their original position. Buoy lines were cut, leaving seven feet of line past the top of the bridle. Pots were set down in the tank on the side and then moved to the middle of the tank. The buoy was allowed to freely float in the tank. Preliminary results show that while sea turtles are attracted to and interact with whelk pots; they generally do not become entangled unless there is a lot of slack in the buoy line. Final, in-depth, results will be presented at the symposium.

THE SEA TURTLES OF CORISCO BAY (EQUATORIAL GUINEA, GABON); THREATS AND CONSERVATION POTENTIAL

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Corisco Bay is in the Gulf of Guinea, in the eastern Atlantic Ocean, located on the border between Gabon and Equatorial Guinea. This area hosts a unique ecosystem with high marine biodiversity. The availability of a high diversity of algae, corals and sponges makes it a feeding and developmental habitat for immatures and adults of green (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*). In addition, nesting of olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*) and green turtles has been reported. For several generations, the Benga tribe, traditional fishermen of southern Equatorial Guinea and northern Gabon, have been exploiting green and hawksbill turtles through directed capture. While in the past turtle hunting was primarily for local consumption, today a large number (300-500 individuals per year) are captured to supply the growing demand for turtle meat from the cities of Bata (Equatorial Guinea) and Libreville (Gabon). The sale price of juveniles and adults varies between 55 and 110 Euros (72-143 US Dollars). Turtles are transported illegally within the country and through border zones, with disregard for national and international legislation, including CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) of which these countries are signatories. We will present capture data from Corisco Bay for 1999-2006, including species diversity, seasonal abundance and size classes. It is vitally important to continue working with the local communities to change consumption habits and decrease commercial demand, providing long-term alternatives to direct capture and re-assessment of different marine resources.

BEYOND GEAR FIXES, BEYOND TURTLES: WHY PROTECTED SWIMWAYS SHOULD BE A HIGHER POLICY PRIORITY THAN FISHING GEAR MODIFICATION

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This presentation will discuss current fisheries management policy environment which largely favors the promotion of technological gear fixes to mitigate the impact of commercial fisheries, and argue that a preferred management priority should be international protected swimways. Specifically the presentation will highlight three different fishery management issues: Shrimp fishing in the coastal waters of Texas where the Kemp's ridley sea turtle nests, gillnet fishing off the US West Coast, and longline fishing in the Hawaiian Islands. In each situation, the presentation will examine the technological gear fixes that have been implemented, the problems with implementation, effectiveness and enforcement, the impact of the gear fixes on turtle populations and then compare these gear fixes with the impacts of fisheries closures in each of these waters. Beyond looking at the impact on the turtles, the presentation will compare the impacts of the gear fixes and the closures on other marine species, such as sharks and marine mammals. Additionally, the presentation will look at economic factors as well. The presentation will argue for a comprehensive management solution implementation that does not rely on a single tool (such as gear fixes) to address the broader issue of protecting endangered sea turtles and marine biodiversity. The presentation will conclude with recommendations to all policy makers to put time-area closures and international protected areas as a higher priority over gear fixes alone, as well as specific areas that could benefit immediately from time-area closures.

BEHAVIORAL RESPONSES OF LEATHERBACK JUVENILES (*DERMOCHELYS CORIACEA*) TO LIGHTS USED IN THE LONGLINE FISHERY

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The pelagic longline fishery is responsible for significant injury and mortality of sea turtles due to unintended capture as “bycatch”. The turtles can be entangled in the lines, accidentally hooked, or hooked in the mouth, throat or gut after consuming the bait. Contact between the turtles and fishing gear could in some instances be accidental, or a consequence of attraction to the gear, baits, or lights that are used at night to attract intended prey (swordfish, bigeye tuna, sharks) that feed during the dark period. Studies to date have been conducted on loggerheads (*Caretta caretta*) that are easily maintained in captivity, and which are known to consume the bait. These have revealed that the turtles are attracted to the gear, baits, and lights (colored lightsticks and battery powered electralumes). No comparable studies have been done with leatherbacks (*Dermochelys coriacea*) because this species is difficult to keep in captivity. We reared leatherbacks, making it possible for the first time to do experiments that test their response to lights, presented at night. Sixteen juvenile leatherbacks, 55 to 90 cm in straight-line carapace length and 5 to 42 days in age, were subjects. All were in excellent condition. The study took place at the Florida Atlantic University marine laboratory, in Boca Raton, Florida, U.S.A. Turtles were tested in large, circular pools and tethered to a horizontally-rotating lever arm so that their orientation as they swam was continuously recorded at 10 s intervals for 10 min trials. Data

were stored on a computer using a software program that calculated a mean angle of orientation for the trial. Half of the turtles were tested twice (at intervals ranging between 5 and 16 days) to measure their response to both lightsticks and to electralumes; the remainder were exposed either to lightsticks or to electralumes. Each turtle was exposed to four trials on a given night: blue, green, orange or control (lightstick or electralume that emitted no light), presented in a random order. The turtles were given a 3 min acclimation period with each light or control before the 10 min trial began. After each trial, the turtles were given 5 min of darkness before the next trial began. As groups, leatherbacks (with one exception) showed no significant orientation toward any color. However, individuals behaved differently, with some orienting toward the lights and others, orienting at an angle (115° - 152°) away from the light where it probably remained within their visual field. These responses indicate that the turtles detected, and responded to, the lights. We conclude that reactions of juvenile turtles to lights are behaviorally complex, and show elements of attraction and repulsion. Whether these responses are also characteristic of larger, and older, turtles remains unknown. What is evident, however, is that responses differ from those shown by loggerheads that consume the baits. Leatherbacks are more often entangled, suggesting that in the field, lights used to attract and direct predatory fishes to the baits may fail to elicit a similar response from these turtles.

THE CONSERVATION AND RESEARCH OF SEA TURTLES ALONG THE ADRIATIC AND IONIAN SEA IN ALBANIA DURING THE YEAR 2006

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During 2006 we studied 259 individual loggerhead turtles (*Caretta caretta*) and 2 green turtles (*Chelonia mydas*) captured in fishing gear. A first group of Fifty-five individual turtles were captured at the fishing area of Patok and one in Velipoje. These sea turtles were measured (CCL and CCW) and the majority of specimens were *Caretta caretta* (92.6%) and were longer (CCL) than 50 cm, whereas 2 individual *Chelonia mydas* were observed as juveniles (CCL 30 - 39 cm) and, consequently, much smaller. Of 54 individuals of *Caretta caretta*, 36 of them (67.3%) were female, 11 individuals (19.2%) were male and 7 of them (13.5%) were undefined as to sex. Fourty-four individuals of *Caretta caretta* were tagged. Most turtles were caught during May and August 2006. Results indicate that Patok is a very important area for sea turtles in Albania. All sea turtles observed were carrying various epibiont flora (algae) and epibiont fauna (Crustacea, Mollusca and Polychaeta). The animals were checked for wounds, hooks, epibionts etc. Two individuals of *Caretta caretta* were missing an appendage. A second group of sea turtles encountered from fishing gear included 24 individual (*Caretta caretta*) that were tagged during the years 2003-2005 by us at the fishing area of Patok. A third group of turtles included in our study included 189 individuals reported to us by fishermen (through our own inquiries or from fishermen by phone). These reports came from fishing areas in the Adriatic Sea and Ionian Sea: Velipoja, Shengjin, Tale, Patok, Bay of Lalzi, Durresi, Divjaka, Semani, Vlora and Saranda. Thirty-five turtles were dead. All individuals were loggerheads. We have also undertaken activities aiming to raise the level of education and awareness of fishermen and other stakeholders regarding the protection and preservation of sea turtles. The level of education and awareness of fishermen is still an important issue because the Albanian ones are not organized in co-operatives and most of them are poor. A majority of the fishermen have a low education level; some of them were engaged with illegal fishing. *Acknowledgements*: We

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USING SIDE SCAN SONAR TO MONITOR FOR SEA TURTLES IN POT FISHERIES

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High numbers of sea turtle strandings have been reported in Virginia, USA by the Sea Turtle Salvage and Stranding Network. The National Marine Fisheries Service monitors several fisheries in coastal Virginia to investigate possible sources of fishery related mortality associated with these strandings. Pot fisheries have high fishing effort, operate in areas where turtle and turtle strandings occur, and have documented interactions with turtles; but due to logistic difficulties associated with traditional observer coverage, pot gear have typically not been observed. There is a need to develop an observational approach for this gear for at least two reasons. First, within the Chesapeake Bay during 2001-2003, pot fisheries constitute both the largest landings and greatest number of trips of any of the fisheries in the Virginia Marine Resources Commission (VMRC) dataset. Second, during 2003-2004 the Sea Turtle Disentanglement Network reported 6 confirmed cases of loggerhead and leatherback entanglements in crab and whelk gear in coastal VA. During 2005-2006, the Protected Species Branch (PSB) of the Northeast Fisheries Science Center (NEFSC) developed a method to monitor using an alternative platform, side-scan sonar approach. The goal of the pilot study was to use side scan sonar to systematically detect, record, and aid any sea turtles that are entangled in gear, including those that are not observable from the surface. The ability of the American Underwater Search and Survey sonar system to correctly identify turtles in pot gear was tested on May 17th, 2006. Twenty blind trials were run by attaching zero, one, or two turtle carcasses to pot gear in 20 to 35 feet of water. A trial consisted of three sonar runs, after which the operator made a determination. The sonar operator never missed a turtle when it existed, but he did recommend investigating two targets that were not turtles. In one case where a target was identified but a turtle carcass was not on the pot line, the person pulling the pot gear noted that it was snagged on something on the bottom. It is possible the sonar operator was detecting the same object that had snagged the gear. Results from this trial study suggest that alternative platform sonar monitoring can be accurately used to detect underwater entanglements of protected species. During mid-May and June 2006, a NEFSC contractor, American Underwater Search and Survey, operated high frequency side scan sonar (900 KHz) to survey crab and whelk pots found in the lower Chesapeake Bay area and coastal waters near the mouth of the Bay. A total of 1659 pots were scanned during the study, several sonar targets were investigated, but no sea turtles were found entangled in any of the pot gear.

EXPERIMENTAL FISHING: TEMPORAL AND SPATIAL EXTENT OF LOGGERHEAD SEA TURTLE DAMAGE TO COMMERCIAL CRAB POTS IN CORE SOUND, NC

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Managers of North Carolina's blue crab (*Callinectes sapidus*) fishery face a unique resource management issue dealing with damage to gear from a protected species. In North Carolina's sounds, evidence of loggerhead sea turtle (*Caretta caretta*) damage to gear used in the blue crab fishery is mounting. This federally threatened marine turtle causes significant economic problems for blue crab fishermen by damaging crab pots, stealing bait, and overturning crab pots, effectively reducing crab catch. During the summer of 2005 (June 14-August 26), we conducted a collaborative experimental fishing study with commercial crabbers to characterize location, timing, and extent of loggerhead sea turtle damage to their crab pots. We mapped the location, movement, and catch of 100 individually-tagged crab pots throughout the study and recorded GPS linked sea turtle sightings, damage to individually-numbered crab pots, proportion of dead or eaten crabs per pot, and "fate" of individual crab pots (e.g., slightly damaged, damaged beyond repair, replaced, etc.). We observed sea turtle damage on 14% of trapping occasions, affecting 82% of the 100 pots over the fishing season. We measured 40% reductions in crab catch in damaged pots, and crab catch was significantly higher in undamaged pots ($p < 0.05$), with approximately double the mean catch of damaged pots. Crab catch peaked in mid-July, whereas pot damage peaked between late June through early July, and turtle sightings (N=10 individuals) were spatially consistent with areas of high gear damage. Bycatch consisted of predominantly finfish and other crab species, but also included two dead Diamondback terrapins (*Malaclemys terrapin*), a NC species of special concern. Our results may guide crabbers away from sea turtle and bycatch "hotspots", to times and areas of minimal overlap with sea turtles where they could concentrate their fishing effort to minimize damages.

MAPPING FISHERIES AND THEIR POTENTIAL THREAT TO SEA TURTLES IN THE EASTERN PACIFIC OCEAN

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Several sea turtle populations in the Central and South East Pacific Ocean (from Mexico to Chile) are currently experiencing critically low numbers. Species affected include; i. The hawksbill sea turtle (*Eretmochelys imbricata*) – whose numbers have been so low that it is considered rare since the 1980s, ii. The leatherback sea turtle (*Dermochelys coriacea*) – Nesting numbers at several beaches have declined drastically in the last 20 years with some populations that numbered in the thousands now approaching regional extirpation, iii. The loggerhead sea turtle (*Caretta caretta*) – Both nesting populations in the Pacific (in Japan and Australia) have experienced severe population declines in the last 25 years. Individuals from

both of these nesting populations inhabit the Eastern Pacific Ocean during the pelagic juvenile stage of their life cycle. There is also concern regarding the population size of green turtles (*Chelonia mydas*) and olive ridley turtles (*Lepidochelys olivacea*) in the Pacific, although these populations do not seem to be as severely under threat as the three listed above. Fisheries represent a significant threat to these populations and it is extremely important to identify the level of threat imposed by each specific fishing industry and to determine ways to minimize the impact of by-catch across all fishing gears. As one step towards this objective, Project GLOBAL has been gathering information about fisheries, fishing effort and by-catch in the Eastern Pacific. The project is not limited to investigating only sea turtle by-catch, but also looks at marine mammals and sea birds. We are concentrating our efforts on the effect of three major gear types (longlines, trawls and gillnets) on these taxa. Here we present a synthesis of that information as it pertains to sea turtles to address the potential threat that each fishery represents in space and time for each population, taking into account the relative threat to different life stages. We hope to be able to identify critical areas in time and space where interactions between sea turtles and fisheries are most likely to impact population levels. This information will help facilitate the successful prioritization and implementation of mitigation measures by fisheries managers.

INTERPRETING POPULATION RESPONSES OF SEA TURTLE POPULATIONS TO DISTURBANCES: THE DEMOGRAPHIC LEGACY OF PERTURBATIONS PAST

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Life history theory has been used to consider the differential effects of demographic parameters on population growth rates. Based on these characteristics, life history theory is used to make predictions about a population's response to disturbances caused by environmental or anthropogenic factors. Here we consider how well life history characterizations facilitate our understanding of population responses to disturbances, in particular sea turtles in the Atlantic and Pacific. Human-mediated disturbances that have occurred in the past 30 years provide a 'natural' experiment to test these theoretical predictions. To consider the utility of demographic profiles in tracking population responses, we construct standard population models for sea turtle populations with different demographic profiles that experienced and continue to experience a suite of anthropogenic disturbances. We then compare model-predicted responses and observed population trends across the demographic profiles. For cases where the model projections and empirical data diverge, we test alternate hypotheses to explain observed trends. Our simulations support the utility of demographic modeling and historical reconstruction as an important tool in setting realistic expectations and measurements of success for management actions, as well as a means of testing alternate hypotheses to explain population recoveries and declines.

SPATIAL PATTERNS OF BYCATCH: LOOKING ACROSS GEAR TYPES AND TAXA

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Fisheries-related mortality of endangered seabirds, marine mammals, and sea turtles from incidental take is a global concern. Existing research has generally focused on the effects of a single gear type despite the fact that bycatch of these vulnerable taxa may occur across multiple gear types within the same region. In many cases current regulations regarding maximum biological removal of endangered species are permitted on a fishery by fishery basis, without regard for the cumulative effects of the bycatch across all fisheries. As part of an ongoing effort to generate bycatch risk landscapes, we use point and surface pattern analyses to identify significant spatial patterns in bycatch across three gear types: gillnet, trawl and longline. These analyses were conducted on data from U.S. Atlantic waters, but our objective is to develop a methodology that could be used in any ocean area in which multiple gear types are deployed, particularly in coastal zones. Our analyses highlight the importance of considering bycatch effects across gear types in order to describe the full ecological footprint of fisheries bycatch on protected species.

SEA TURTLE FISHERY IN GRENADA AND ITS SHIFTING SOCIO-ECONOMIC SIGNIFICANCE

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Sea turtles have historically been an important socio-economic and cultural resource in Grenada. Today, Grenada operates the longest hunting seasons in the region as part of its legal turtle fishery, spanning 8 months of the year. The fishery targets any hard shelled turtle found in her territories but primarily affects hawksbill, loggerhead and green turtles. Other than data collected from the catch logs maintained at a few fish markets, very little is known about the foraging or nesting populations of hard shelled turtles in Grenada. To support the development of the country's first Sea Turtle Action Plan (STRAP), a study to begin to quantify the extent to which hawksbill turtles continue to forage and nest in Grenada has been established approximately 5km offshore from Grenada's mainland. Initial findings suggest that these offshore islands represent important developmental grounds for juvenile turtles as well as providing key nesting habitat for the largest concentration of nesting hawksbills in Grenada. Despite the vulnerability of these remaining stocks and the further pressure placed on this resource by two devastating hurricanes, the economic significance of sea turtles may be in the process of declining. Fewer fishermen are now targeting sea turtles exclusively and are instead typically relying on opportunistic events to catch turtles. This continued shift away from their traditional economic significance will play a key role in shaping the future for Grenada's remaining sea turtle stocks.

SITE FIDELITY AND NON-LETHAL INCIDENTAL CAPTURE OF SEA TURTLES IN VIRGINIA'S POUND NET FISHERY

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Fixed gear types, such as pound nets that remain in the same general location within a season or between seasons, pose a unique threat to sea turtles exhibiting fidelity to a particular habitat. A mark-recapture study was conducted using nets fished near the mouth of the Potomac River from 1980 to 2002. Five to seven nets were fished each year, incidentally capturing 14 to 92 live sea turtles annually. A total of 436 individual turtles were caught in these nets between 1980 and 2002. Of these, 403 turtles were originally captured and tagged from these nets, including 354 loggerheads (*Caretta caretta*; 87.8%), 48 Kemp's ridleys (*Lepidochelys kempii*; 11.9%), and one (0.3%) juvenile green turtle (*Chelonia mydas*). Of the loggerheads, 333 (94.1%) were sub-adults, 13 were adults (3.6%) and eight (2.2%) were of undetermined stage. Three Kemp's ridleys (6.25%) were adult-sized. An additional 33 turtles originally captured and tagged by other fishermen in the Chesapeake Bay were subsequently recaptured in the Potomac River nets. Among the total individual loggerheads captured and tagged for the first time in the study nets (n=333), 74 were recaptured by the same fisherman representing a 20.9% return to the original site of capture. A total of 116 recaptures of these turtles were reported including one to thirteen recaptures of the same turtles within a season and/or among seasons. These data suggest that some loggerhead sea turtles exhibit strong site fidelity to pound nets, with several individual turtles returning to the same net year after year for periods of one to eleven years. Of 48 individual Kemp's ridleys tagged, only two were recaptured in the study nets. Satellite telemetry was also used to track the movements of an adult female loggerhead captured multiple times in the Potomac River nets from 1999 to 2002. Monte Carlo random walk simulations indicate significant site fidelity to the mouth of the Potomac River.

EVALUATION OF INTERACTIONS BETWEEN SEA TURTLES AND PELAGIC LONGLINE FISHERIES IN BRAZIL: HOMOGENEOUS FISHERIES AS MANAGEMENT UNITS

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Projeto TAMAR/IBAMA has been working on the conservation of 5 sea turtles species that occur in Brazil (*Caretta caretta*, *Chelonia mydas*, *Eretmochelys imbricata*, *Lepidochelys olivacea* and *Dermochelys coriacea*) for the past 26 years. During the first 10 years, the work focused on nesting areas. Sea turtle interactions with the coastal fisheries have been the focus of Projeto TAMAR/IBAMA field activities since 1990 (Thomé *et al*, 2003), when TAMAR expanded conservation activities for sea turtles feeding areas. Conservation strategies and measures to mitigate sea turtles capture and mortality have been continuously implemented. In 2001 Projeto TAMAR/IBAMA created the Brazilian National Action Plan to Reduce Incidental Capture of Sea Turtles in Fisheries. This federal action plan was designed to fulfill the following objectives: i) Fisheries monitoring, ii) Development of specific research, iii) Mitigation measures, iv) Support

to sustainable fisheries, v) Establishing discussion forum. Through this Plan, the pelagic longline fishery has been the main investigated fishery and, in order to effectively manage it and improve the analysis about sea turtle interactions, Brazil's pelagic longline fishery was divided according to 13 parameters, into 4 distinct fisheries. 1) the American model N/NE, 2) the American model S/SE, 3) the Chinese model, and 4) the Itaipava model. In such case, the term "fishery" was defined as the unit upon which evaluation and management of interactions between sea turtles and fishing activity is based. These four different fisheries interact with sea turtles by different ways. Between 1999 and 2005 Projeto TAMAR – IBAMA, with collaboration of some partnership, sampled 11.415.492 hooks, the Chinese model longline was the principal fishery sampled, representing 64,85% of total amounted, followed by the American model N/NE longline (22,6%), American model S/SE longline (12,25%) and Itaipava model (0,3%). Despite the American model S/SE longline represents only 12,25% of total number of hooks sampled, this fishery answers by 71,5 % of the total number of turtles caught, followed by the American model N/NE (15,7%), Chinese model (9,1%) and Itaipava model (3,7%). The interaction of different species with these four fisheries are different too. The American model S/SE longline and Itaipava model catch primarily loggerhead followed by leatherback, green and olive ridley, while the American model N/NE longline catch mainly: leatherback followed by olive ridley, green and leatherback, while the Chinese model longline catch principally: olive ridley, followed by leatherback, green and loggerhead. Considering that the Brazilian coastline has more than 8.500 Km with different climatic and oceanographic conditions, and that sea turtles species interact in distinct ways, both qualitative and quantitative, with different longline fisheries, we believe that to share this fishery, according to homogeneous parameters, in more than one fisheries is an important management tool of the problem; "Sea turtles x fisheries" and, contribute for better comprehension about the interaction between sea turtles and longline fisheries, helping future conservation strategies and decisions.

TWO FISHING GEAR MODIFICATIONS TO REDUCE SEA TURTLE BYCATCH

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The Endangered Species Act implicitly mandates the reduction of sea turtle bycatch in U.S. commercial fisheries in the Northwest Atlantic Ocean. Government, academia and the fishing industry are working together to develop fishing gear modifications to reduce the bycatch of sea turtles. The National Marine Fisheries Service (NMFS) in the Northeast region has recently supported and collaborated on two such projects that have resulted in gear modifications and subsequent rule making that will reduce sea turtle bycatch in two fisheries: the Atlantic sea scallop dredge fishery and the Chesapeake Bay pound net fishery. The scallop dredge modification is a series of chains strung in squares that prevent sea turtles from entering the dredge bag. This modification was tested in 2003-2004 in a paired comparison between a standard dredge and a dredge equipped with turtle chains. A total of 3248 hauls (1624 paired tows) were conducted and subsequently analyzed for differences in the bycatch of sea turtles and targeted scallop catch. Eight turtles were captured in the scallop dredge without turtle chains and there were no catches of sea turtles in the dredge equipped with turtle chains.

Scallop catches were variable and differed between vessels. Overall a 6.7% reduction was observed in the catch of scallops. The pound net modification replaced the mesh in the top 2/3 of the pound net leader with stiff vertical lines spaced two foot apart to allow turtles to pass through. Studies were conducted in 2004-2005 comparing two modified leaders fished adjacent to two standard leaders in pound nets of Kiptopeke, VA. In 2004, the modified leader caught a leatherback turtle, while the standard leader caught seven hard shell turtles; the stiffer modified leader tested in 2005 did not capture a single turtle while 15 hard shell turtles were taken in the standard leaders. Although comparison of the fish catch data was problematic, the modified leader appeared to catch similar quantities of targeted species. Both these projects represented collaborations between the fishing industry and NMFS. The gear modifications were suggested by the fishing industry, NMFS supported the work with funding and by designing scientifically defendable sampling approaches to test the modified gear. Additionally, the studies were all conducted using commercial fishing gear operating in the fishery. This approach to gear research improved industry acceptance of the work that was conducted. Because commercial gear and fishing practices were employed, the implementation of the modification was easier and there was more confidence that the gear would work in the fishery.

EXPERIMENTS IN THE EASTERN PACIFIC TO ASSESS THE EFFECT OF A NEW HOOK DESIGN ON REDUCTION OF INCIDENTAL CATCHES OF SEA TURTLES

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A new hook design was tested in the mahi-mahi longline fisheries of Peru and Ecuador, aiming at the reduction of sea turtle hookings while maintaining the catch rate of target species. The hook tested in this study was a circle hook size 13 fitted with wire on the back of the hook to deter turtles from hooking and swallowing the hook. The appendage, made out of wire, was originally developed by a New Zealand researcher to decrease the catch of undersized fish and to minimize gut-hooking over all sizes that were to be released alive. Two successive cruises with three treatments (J hooks, circle hooks C13 with wire, and C16) were made during February and March 2006 off Peru and Ecuador. The experimental design had to be limited to fewer treatments than desirable because of sample size limitations. Eighteen sets (approximately 25000 hooks) were made during the trips. Experimental results indicate that in both legs there were considerable reductions in the hooking rate of turtles for both C13W and C16 circle hooks when comparing to the control J hooks. With respect to target species, the catch rates of C13 with wire matched the performance of the J hook in the Ecuador leg, while in the Peru leg (more coastal) J hooks caught more mahi-mahi than circle hooks. The results suggest that the addition of wires to circle hooks (or probably to any type of hook) is likely to further reduce sea turtle hooking rates, and also reduce deep hookings, with only a small additional cost and without negative impacts on target catches.

SEA TURTLE BYCATCH IN PELAGIC LONGLINE FISHERY OFF SOUTHERN BRAZIL: 2004-2006

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Between July 2004 and July 2006, 25 cruises were surveyed, 8 through onboard observers and 17 through logbooks, validated through observers working onboard the same vessels in different trips, aiming to assess the impact of sea turtle bycatch in pelagic longline fishery off southern Brazil. A total of 237 settings and 258,239 hooks were sampled between 28°S – 38°S and 36°W – 50°W. The settings occured mainly over the shelf break. The fishery target species were tunas (*Thunnus* spp.), swordfish (*Xiphias gladius*) and sharks, mainly blue-shark (*Prionace glauca*). Tuna and "J" 9/0 hooks were baited with Brazilian sardines (*Sardinella brasiliensis*), mackerel (*Scomber japonicus*) or squid (*Illex argentinus*), depending on the target species. Sea turtles were caught in all cruises and in 51.9% of the settings. In total, 346 loggerhead, *Caretta caretta*, and 8 leatherback, *Dermochelys coriacea* turtles were caught. The mean capture rates were 1.34 and 0.03 turtles/1000 hooks for loggerhead and leatherback, respectively. The capture rate varied according to season and target species. In autumn (April-June) the mean capture rate was 2.57 turtles/1000 hooks, followed by winter (July-September) 1.59 turtles/1000 hooks, summer (January-March) 0.38 turtles/1000 hooks and spring (October-December) 0.22 turtles/1000 hooks. Sea turtle bycatch was higher in settings for swordfish and sharks (mean capture rate of 2.12 turtles/1000 hooks), followed by tuna (0.98) and blue-shark (0.53). Most loggerheads caught were released alive (83.2%). In cruises with onboard observers, data about the hook insertion position and curved carapace length – CCL were also collected. In these cruises 56.8% of sea turtles caught had the hook inserted in the mouth, 29.7% internal, 10.8% external and 2.7% was not reported (n= 74 turtles). Specimens of loggerheads captured were immature, with CCL ranging from 44 to 70 cm (mean = 57.9 cm ± 4.9 cm, n=69). This size range is different from that of loggerheads stranded on the adjacent coast of Rio Grande do Sul state (mean = 74.3 cm ± 13.1 cm, n=420), suggesting that the specimens caught in longlines rarely strand on the beach. The difference between sizes is related to different stages of their life-cycle, smaller specimens have pelagic habits while larger ones are more coastal preying upon demersal species. Eight *D. coriacea* were entangled and/or hooked in their flippers and were released alive. The high fishing effort over the shelf break near Uruguay with higher capture rates, similarly reported in previous studies, reinforces the role of Rio Grande do Sul state as an important feeding area and development ground for immature loggerhead turtles. The high capture rates overlapping with fishing grounds and fishing season in southern Brazil address the need of development and implementation of mitigation measures to reduce the sea turtle bycatch.

TOWARD A GLOBAL ASSESSMENT OF BYCATCH IN MARINE FISHERIES: A CASE STUDY FOR THE UNITED STATES

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As part of a larger project aimed at assessing bycatch across large ocean basins, we present a "state of knowledge" review of sea turtle bycatch in longline, gillnet, and trawl fisheries of the United States. We describe fisheries and oceanographic regions where bycatch of different species is known to occur, and review available annual bycatch estimates in these regions. We describe how guiding legislation for NOAA-NMFS, namely the Marine Mammal Protection Act and Endangered Species Act, has shaped the development of U.S. fisheries observer programs, and how existing regulatory frameworks have (and have not) contributed to knowledge concerning sea turtle bycatch. We also discuss obstacles that limit our ability to place bycatch estimates in a population context, including lack of in-water abundance estimates, limited age-structured information, inadequate descriptions of overlap between fisheries and geographic distributions of turtle populations, and failure to coordinate management across multiple fisheries. We provide concrete examples of the lack of coordination across fisheries and consider the impacts of disparate management mandates and strategies. This review thus highlights and makes recommendations for addressing key issues in sea turtle bycatch research and management throughout U.S. fisheries.

UNDERSTANDING AND MITIGATING THE INCIDENTAL MORTALITY OF SEA TURTLES IN THE ARTISANAL LONGLINE FISHERIES OF THE EASTERN PACIFIC

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A regional program to reduce marine turtle by-catch in pelagic long-line fishing operations in the Eastern Pacific Ocean (EPO) started in 2003 in Ecuador, and has expanded to cover most of the region. The vessels of the longline fleets of the region are testing circle hooks of different sizes depending on the fishery, following an experimental design that should provide statistical evidence of the effect of the hooks with regards to sea turtle hooking rates, target catch rates, and location of hooks. A voluntary observer program is used to collect data, and to understand the fishing operations, and the interactions with the turtles. To complement this activity, instruments to release hooked turtles are provided freely to the fishers, and the techniques to handle and release turtles are explained. Frequent workshops with the fishing community, and other interested parties are another important component of the program. More than 600 observer trips have been made from ports in Peru, Ecuador, Panama, Costa Rica, El Salvador and Guatemala, covering over 1.5 million hooks. Results have been very promising throughout the region. Circle hooks size 16/0 have resulted in lower hooking rates, and in fewer deep hookings in the fisheries targeting tunas, billfishes and sharks. In the mahi-mahi (*Coryphaena hippurus*) fisheries, circle hooks sizes 13/0 and 14/0 have also reduced hooking rates but to a lesser extent. The experience acquired during the first years has allowed us to develop improved instruments, and techniques to release turtles, that are adapted to the species and sizes encountered in the region. This is probably the largest marine fisheries conservation effort ever organized in the region, with an ad-hoc network of collaborators who share two basic principles: a) no one wants to catch or kill turtles and b) no one wants to put fishermen out of business. This paper presents preliminary results of the experimental fishing trials for different fisheries in the EPO. Differences among fisheries across the region are also explained with respect to long-line rigging, duration of the fishing trip and the fishing operation. The potential of this project to accomplish sustainable fisheries is discussed. The project is supported financially,

and technically by WWF, the Western Pacific Regional Fishery Management Council (US), NOAA (US), the Overseas Fishery Cooperation Foundation (Japan), the Inter-American Tropical Tuna Commission, The Ocean Conservancy, and Defenders of Wildlife (Mexico). In every country, we count with the support and participation of the respective fisheries agencies, fishing industry and fishers organization, and national conservation organizations.

CHANGES IN LATITUDES...SPATIOTEMPORAL PATTERNS OF OBSERVED SEA TURTLE BYCATCH IN THE U.S. ATLANTIC LONGLINE FISHERY

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Sea turtle bycatch data from the National Marine Fisheries Service Pelagic Observer Program (NMFS POP) were examined for spatiotemporal patterns in captures from 1992-2005. Between 1992 and 2005, 7007 longline sets were observed, and of these sets, 771 (11%) caught turtles, mostly loggerheads and leatherbacks. Spatial and effort analyses found that effort and catch were seasonally variable. Loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) bycatch in the Northeast Distant area was higher than the expected effort and did not follow the overall regional fishery pattern. Leatherback bycatch in the Gulf of Mexico had little seasonal variation, and this constant effort may have a larger impact than previously recognized, especially for juveniles. Nearly all NMFS regions had bycatch of both loggerhead and leatherback turtles from pelagic juvenile to adult ontogenetic stages in waters ranging from 12 to 31 ^{o}C.

ESTIMATING *CARETTA CARETTA* FISHING BYCATCH FROM LINOSA RESCUE CENTER (ITALY)

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A total of 637 loggerhead sea turtles were hospitalized at the Rescue Centre from 1994 to 2005. The mean size of loggerheads caught with longlines is CCL min 47.1 cm (N=487, range=29.0-90.5 cm, SD 8.92). A decrease over years in the loggerhead mean size is shown. The causes of injuries is known for 535 specimen, and 509 (95%) of them clearly indicated interactions with commercial fishing activity. The artisanal fleet operating in the area is mainly composed by drifting longlines, and this kind of gear results the one with the higher number of interactions, with a mean of 40 loggerhead per year and 336 specimens that presented one or more hooks embedded in their flesh. *Caretta caretta* bycatch in this area is estimated at 0.88 specimen per 1,000 hooks. Hook location was investigated both manually and using X-rays in 305 loggerheads: 284 of them contained 1 hook inside, 18 turtles two hooks and 3 specimens contained 3 hooks for a total of 329 hook locations recorded. Among turtles with 1 hook, 0.4% of them showed the hook in the anterior flippers, 9.5% in the mouth, 4.2% had the hook embedded in the tongue, 85.2% had the hook inside the oesophagus, 0.4% in the stomach, 0.4% in the

intestine. Results of 12 years of activity of the Linosa Marine Turtle Rescue Centre show the high negative impact of the drifting longline fishery on the loggerhead sea turtles, *Caretta caretta* in the waters surrounding the Pelagie Islands, in the middle part of the Mediterranean Sea. *Acknowledgements*: SP gratefully acknowledges travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service, provided through the Symposium Travel Committee.

NEW LONGLINE GEAR TECHNOLOGY REDUCES SEA TURTLE INTERACTIONS IN THE HAWAII-BASED LONGLINE FISHERY

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Reducing sea turtle bycatch in pelagic longline fisheries may contribute to the recovery of sea turtle populations. Regulations designed to reduce turtle capture rates and proportion of turtles that ingest the hook (versus being hooked in the mouth or body or entangled) came into effect for the Hawaii-based longline swordfish fishery in May 2004. These regulations changed the shape and size of fishing hook and bait used by the fishery from a J-shaped hook with squid bait to a wider circle-shaped hook with fish bait. Analyses of observer program data show that, following the introduction of the regulations, there were significant reductions in sea turtle and shark capture rates and reduced proportion of turtles that ingested hooks, which may increase post release survival prospects. Capture rates of leatherback and loggerhead turtles declined significantly by 82.8% and 90.0%, respectively after the turtle regulations came into effect. Furthermore, measures did not compromise the target catch rates of swordfish. Results indicate that large-shaped circle hooks in combination with fish bait is a commercially viable turtle avoidance method that may be suitable for use in other pelagic longline fisheries worldwide, potentially resulting in substantial reductions in sea turtle bycatch in global pelagic longline fisheries.

INTERACTIONS WITH SMALL SCALE FISHERIES IN GREECE: AN IMPORTANT FACTOR FOR THE REDUCTION OF TURTLE MORTALITY AT SEA

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Greece has a fishing fleet of 18,588 vessels, of which 17,088 consist of small-scale fisheries, operating close to the shore using static nets and bottom long lines (Source: Common Fisheries Register). In the context of the European Marine Turtle Project co-funded by DG Fisheries (1999-2002), it has been possible to estimate the catch rate for bottom trawlers (400 turtles/year, with no direct mortality) and surface longlines (1,200-5,500 turtles/year with negligible direct mortality). This information is quite accurate as it is based on on-board observations and the data are comparable to the total fishing effort. On the other hand, small-scale fisheries represent a challenge when it comes down to assessing the extent of their interaction with sea turtles, as there are no available data on the fishing effort, and further, there are an unknown number of vessels using professional gear under non-professional licenses. However, there are strong indications that small-scale fisheries are responsible for high percentages of turtle deaths/injuries. These are (a) communications with fishermen, in the course of LIFE-Nature projects undertaken by ARCHELON in the Bays of Lakonikos, Kyparissia and Amvrakikos (b) Causes of death for many of the stranded turtles suggest that they were the result of their capture in small-scale fisheries and (c) the fact that the majority of sea turtles admitted to ARCHELON's Rescue Centre (67.2%) suffer from fisheries induced injuries, while 41.6% have head injuries, known to be caused by coastal fishermen (n=469, 1994-2005). The above led to ARCHELON implementing another LIFE-Nature Project, focused on coastal fisheries, aiming to reduce mortality of turtles at sea. The activities focused in areas accountable for 79% of the stranding reports: Crete, Western Greece, the Bays of Messiniakos and Argolikos in Peloponnesus, Kavala Bay and Rodos Island. Information was collected by developing contacts with Fishermen Associations as well as individual fishermen in these areas, filling in representative questionnaires. A total of 285 fishermen were contacted, belonging to 54 different Associations, while 42 representative questionnaires were filled. Some qualitative results of this study reveal that turtles are captured in small-scale fishing gear at least once a year; most captures occur close to river deltas, lagoons and vegetated areas; damages to fishing gear are usually in the form of holes in nets that can be mended; when captured, sea turtles are sometimes released by the fishermen, while others will deliberately attack them, usually by hitting them on the head. The reasons for this are anger at damages caused by marine animals, as well as the fishermen's belief that they will keep turtles off their fishing ground, in opposition to measures that sometimes have a negative impact on their finances or even superstition. The above suggest that in Greece, a significant number of turtles are captured every year in small-scale fisheries. It is therefore necessary that collaborative programmes with small-scale fisheries should be established and expanded, in order to ensure a reduction of turtle mortality at sea. The authors wish to thank Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service for their kind support, which has made it possible to attend the Symposium.

UNDERSTANDING AND MITIGATING THE ENTANGLEMENT OF SEA TURTLES IN THE ARTISANAL LONGLINE FISHERIES OF THE EASTERN PACIFIC

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In late 2003, a program with the aim to reduce incidental bycatch of sea turtles in pelagic longline fisheries was initiated in Ecuador. This program later expanded to other countries bordering the eastern Pacific Ocean, from Peru to Mexico. One of the main objectives of the program is to test the efficacy of circular hooks, by performing a comparative study of turtle hooking rates, turtle entanglement rates and fish catch rates between different sizes of circular hooks and "J" hooks. The program places observers aboard fishing vessels to collect data on the amount of bycatch and catch, turtle entanglements, and gear characteristics, including mainline and buoy materials and configuration. Here we report our findings about sea turtle entanglements based on data collected during the first years of the program. During this period data were collected on over 660 fishing trips, and close to 1.5 million hooks. The data represent surface longline fisheries targeting tunas, mahi-mahis, billfishes and sharks. Understanding the characteristics of turtle entanglement is an important aspect of reducing the impact of longine fisheries on sea turtle populations because entanglements can lead to mortality. We present the results of an analysis of data on over 400 entanglements involving five species of turtles. Preliminary results showed very large differences in entanglements rates (in turtles per mile of line, or per number of hooks) between Peru and Ecuador (high rates), and Central America (lower rates). We present details on entanglement rates, and size composition of entanglements by turtle species. We compare entanglement rates with hooking rates for the five species, and we summarize the different locations of entanglement of turtles in the longline gear. We also discuss characteristics of the longline gear that appear to attract sea turtles or that facilitate entanglement (e.g., materials used, length of mainline, characteristics of floats, etc.). We close with a discussion of proposed and existing experiments on gear modifications intended to mitigate entanglement.

TESTING CIRCLE HOOKS IN THE MEDITERRANEAN SEA – PRELIMINARY RESULTS ON *CARETTA CARETTA* BYCATCH

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We ran 2 experiments aimed at evaluating the effectiveness of circle hooks to reduce the negative impact of the drifting longline fishery on loggerhead sea turtles *Caretta caretta*. Fishing trips were carried out in 2005 and 2006 in the Strait of Sicily, an area of the Mediterranean Sea where the loggerhead bycatch rate in longline gear is known to be high (0.88 turtles per 1,000 hooks). Circle hooks were tested by alternating 1 circle and 1 traditional jig hook along the mainline in both experiments. The 1st experiment was set to verify the importance of different shape of hooks in reducing sea turtle bycatch. We tested 16/0 circle hooks versus jig hooks with similar gape for a total of 20 fishing trips. Eleven loggerheads were hooked on jig hooks, while 5 loggerheads were hooked on circle hooks. The 2nd experiment was set to investigate the importance of both hook shape and size. We tested 16/0 circle hooks versus 4/0 jig hooks traditionally used by small fishing vessels. This artisanal gear usually employ jig hooks with a small gape (e.g. 4/0 or 5/0). A total of 15 fishing trips were run . Results show that 69 loggerheads were hooked on smaller jig hooks, while only 2 loggerheads were hooked on larger circle hooks. Our preliminary findings show that: (1) when hook gape is similar, circular shape is effective in reducing loggerhead bycatch; (2) jig hooks with a small gape have a higher bycatch rate than circle hooks with a large gape. *Acknowledgments*: SP gratefully acknowledges travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service, provided through the Symposium Travel Committee.

BYCATCH OF SEA TURTLES IN TUMACO´S FISHERIES (SOUTH PACIFIC FROM COLOMBIA)

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Around the world bycatch is a major source of mortality for many species in different kinds of fisheries like pelagic and bottom longlines (traditional and commercial), gill nets, trawls, gill/entanglement nets or entrapment gear and traps. Such threats occur at various life stages at different intensities. Being aware of the situation of sea turtles in Tumaco, we started in 2004 and during 6 months a project in which we worked with fishermen groups who reported sea turtle bycatch and liberations in the water during their trips. This project had the objective of learning about the state of sea turtles populations in this area and the pressure over this resource, mainly by interviews and surveys with traditional fishermen from this area. We have also been performing meetings and workshops aimed at traditional fishermen from Tumaco. These talks had the objective to inform about bycatch of sea turtles and to raise awareness about the state of the sea turtles populations. The results showed that a moderate human and bycatch pressure exists, which increases from November through May (the season of mahi

mahi - *Coryphaena hippurus*), especially over adult individuals of *Chelonia agassizii* or black turtle, however, sex of these individuals caught were not identified. Although *Eretmochelys imbricata* or hawksbills are captured as well, it is only in fewer proportions and mostly individuals in the juvenile stage. Environmental education activities reached especially fishermen and children, as well as salesmen in the central market, in which we performed interviews. We identified that the turtles are used for familiar consumption and local commerce in the central market for the community. The most important problem in this area is the local consumption and ignorance of the actual situation of sea turtle populations around the world in addition to pollution as most of the time turtles mistake plastic bags for food. We accomplished the liberations of some turtles caught and found in the local market thanks to Contamination Control Centre of the Pacific (CCCP) and the Captain of the Port. Awareness campaigns were carried out in collaboration with different governmental institutions: Environmental Police, INCODER, and local communities and organizations (RECOMPAS, FUNDAPESCA) as well. We found it necessary to continue the campaigns and environmental education in this region, and to keep working with traditional fishermen and the local community. This project was made possible by awards from “Endangered Species – Jorge Ignacio Hernandez Camacho”.

EXPERIMENTS WITH CIRCLE HOOKS FOR MITIGATION BYCATCH OF SEA TURTLES IN LONGLINE FISHERIES FROM THE COLOMBIAN PACIFIC

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Longline fisheries are considered the most important cause of mortality in the populations of sea turtles around the world, especially in leatherback populations from the East Pacific Ocean. Therefore, WWF and CIAT began a sea turtle bycatch mitigation program in 2004, which aims at reducing incidental capture and mortality of marine turtles without affecting catches. At the same time it aims to research the efficiency of circular hooks in longline fisheries as well as the effect on reducing incidental capture of turtles. The project in Colombia has four stages: 1. Diagnosis; surveys fishermen in coastal communities from Valle del Cauca and south of Nariño, in the border to Ecuador. 2. Institutional meetings have also been held with government officers, representatives from large and small-scale fisheries as well as fishermen’s associations. These meetings and workshops were made possible with the support of the following organizations: The Colombian Institute for Rural Development (INCODER), Valle del Cauca Regional Environmental Authority – Pacific Section (CVC), the small-scale (artisanal) fishermen’s associations (ANPAC, CORPACIFICO), the Industrial Fishing association (ACODIARPE), fishing companies Bahia Cupica and the South Pacific Community Councils Network (RECOMPAS). 3. Training observers to take information during fishing 4. Experiments; Probably, bottom longline fisheries are considerably less than some pelagic longline fisheries but in Colombia this kind of fishery is less common than other countries, and the major practice is bottom fisheries for catching species such as grouper (*Epinephelus* spp.) and *Brotula clarkae*. Therefore, the experiments for bottom fisheries are experimental lines with 500 hooks: 250 traditional “J” hooks (Number 7) and 250 circle hooks (Number 12 – analogous to tall traditional hooks). These are placed alternately on the principal line because it is necessary to have the same probability of capture. The experimental line is added to the traditional line and is operated at the same time. Those experiments have been in progress in two localities for same

time now, Charambira and Gorgona National Park. Experiments in the Gorgona National Park were done in collaboration with the National Park Authority which has been monitoring bottom fisheries for 7 years approximately. On some trips in these locations, an observer took information about the capture of commercial fish and bycatch of sea turtles. The pelagic longline fisheries are seasonal from November until May for catching the dolphinfish, *Coryphaena hippurus*. Generally it is practiced by a small group of industrial fisherman and is less common in traditional fisheries because the local fisherman do not have the equipment needed. However the magnitude of this interaction between sea turtles and bottom longline fisheries is unknown. During approximately 120 trips, four events were reported in which olive ridley sea turtles (*Lepidochelys olivacea*) were caught with traditional "J" hooks. These hooks were found in the flippers of the individuals or wrapped around their necks and flippers, but only one was found in the experimental line and the other events were found in the traditional line to which the experimental line was added. The individuals caught were three females (one dead) and one male. The results will guide the focus of future trials and serve to promote the use of circle hooks in other communities of the Colombian Pacific and will encourage joint efforts with corresponding authorities such as INCODER.

SURVIVAL OF OCEANIC LOGGERHEAD TURTLES IN THE NORTH ATLANTIC

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We deployed pop-off archival transmitting tags on 15 loggerhead turtles that had been hooked in the U.S. pelagic longline fishery and on 10 loggerheads that had been dip-netted off the surface in the North Atlantic Ocean to assess survival. We used a known fate model with the transmission data to estimate annual survival rates and determine if there were differences in survival between the two groups. The best model of the data suggested there was no difference in survival between the lightly hooked and control turtles.

LAUNCHING A SEA TURTLE DISENTANGLEMENT PROGRAM IN RHODE ISLAND

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Rhode Island is a regular summer home to three species of sea turtles: leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), and Kemp's ridley (*Lepidochelys kempii*), with occasional occurrences of green turtle (*Chelonia mydas*) and rare sightings of the hawksbill turtle (*Eretmochelys imbricata*). From 1987–2004, Rhode Island recorded a minimum of 23 fisheries entanglements of sea turtles—primarily leatherbacks. Lack of dedicated (funded) responders and response vessels has limited the number of entanglements that could be responded to in a timely manner, and as a result, entangled turtles have been lost (fate unknown) or died from the entanglement. In summer 2005, Rhode Island Sea Grant received a contract from NOAA Fisheries to establish, maintain, and operate a new program—the Rhode Island Sea Turtle Disentanglement Network (RISTDN)—for responding to reports of entangled marine turtles in Rhode Island, and for dissemination of knowledge gained from the response

effort. This included training a group of experienced people and enlisting a cadre of boats to respond to turtle entanglement calls, fielding calls for all Rhode Island marine turtle entanglements through a dedicated cell phone hotline, and responding to the entanglement and subsequently releasing the turtle. In 2005, the hotline received six calls and mounted on-scene responses to three of them — two were reports of live leatherbacks that were successfully disentangled and released with no visible signs of injury. The third response was to confirm a likely dead leatherback turtle, but RISTDN responders were unable to locate the turtle. Excellent communication among all groups and agencies involved in the program and an effective "public relations" campaign were keys to the success of the program in its first year. Put in context with the two other disentanglement programs in New England (Maine and Massachusetts), the leatherback was the primary turtle found entangled (21 of 22 confirmed reports) and all but one of those turtles were entangled in pot gear. This past summer was quiet in Rhode Island, with no disentanglement calls to the hotline, despite good publicity about the hotline's availability. It appeared to be a quiet summer overall with only a single sea turtle stranding (loggerhead) reported in Rhode Island and only five entanglements (all leatherbacks and all entangled in pot gear) reported in the greater New England area.

FORMALIZING DISENTANGLEMENT EFFORT: THE MASSACHUSETTS SEA TURTLE DISENTANGLEMENT NETWORK, 2005-2006

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Since its formation in 2005 the Massachusetts Sea Turtle Disentanglement Network (MASTDN) has developed training and safe response protocols to address and document sea turtle bycatch off Massachusetts. To date, over 80 responders, from non-profit organizations as well as local, state, and federal agencies, have been trained as members of the MASTDN. During the 2005 and 2006 seasons, 24 cases of entangled sea turtles were confirmed, including 6 carcasses. Initial reports came from recreational boaters (15), commercial fishermen (4), government agencies (3), and research/conservation groups (2). Entanglement cases generally involved leatherbacks with multiple wraps of the fore flippers and/or the neck. All of the confirmed and documented cases were entangled in braided rope from fixed pot fisheries, mooring lines, or unknown sources. Most of the disentanglement operations made use of resources from multiple agencies, including staff, communications and/or vessels. Of 19 on-water responses conducted by MASTDN members, the success rate of disentanglement was 100% in the 7 cases where a vessel stood-by the entangled animal until the responders arrived. If the vessel was unable to stand-by, or reported the entanglement after leaving the scene, responders were often unable to re-locate the animal and the success rate fell to 33%. While the majority of cases involved animals apparently anchored by their entanglements, notable exceptions were documented and reinforce the importance of standing-by entangled animals. Such an exception involved an entangled leatherback that was disentangled from single pot gear more than fourteen miles from the original report location the previous day. Positive identification was achieved through photos taken during the initial report and during the disentanglement operation. Continued outreach and training by the MASTDN will focus on personnel safety and the importance of standing by entangled animals.

BYCATCH IN THE ARTISANAL PERUVIAN FISHERIES: GILLNETS VERSUS LONGLINES

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Fisheries bycatch remains one of the major threats to sea turtles and other vulnerable and endangered marine fauna. While much attention has been focused in recent years on longline bycatch, less is known about incidental take in the rapidly expanding gillnet fisheries in Peru. We present information collected since 2005 by onboard observers on bycatch of sea turtles and other marine fauna such as dolphins, seabirds and sharks in the artisanal (small scale) fisheries in central and southern Peru. Data are from both gillnets and longline vessels. Preliminary results show that Peru's gillnet fleet has a similar frequency of interactions with sea turtles as the longline fleet (CPUE of 0.3304 vs. 0.3326 turtles/set for gillnets and longlines, respectively). At the species level, however, there are differences in interaction rates. Artisanal longline vessels primarily interacted with loggerhead turtles, whereas gillnets had greater take of leatherbacks and greens. In addition to fishing gear impact on turtles, there is also the issue of retained bycatch which tends to be much higher in localities where coastal gillnets operates. From turtles caught in longlines, 98.4% were released with minor injuries or without injuries. Of those turtles captured with gillnets, 70.1% were released without injury or with minor injuries and 23% were retained for human consumption. We discuss relative impacts of gillnet and longline fishing practices, current and planned mitigation measures and implications for sea turtle conservation and management in Peru. We highlight the need to address gillnet impacts on marine fauna - especially in the case of the critically endangered leatherback turtle.

SYNERGY OF TURTLE EXCLUDER AND BY-CATCH REDUCTION TECHNOLOGIES IN SHRIMP TRAWL NETS IN THE GULF OF GUINEA

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The majority of commercial vessels in West Africa sub region are shrimp trawlers of about 23.0 – 25.0m length overall (LOA). In Nigeria and Cameroon over 252 vessels (representing 86% of the licensed industrial vessels) catch marine shrimps which are exported to earn foreign currency worth about US $65 million annually. Demersal shrimp trawling generates large quantity of by-catch (landed and discarded/trash fish) at a ratio of 1:8 to 1:19 of shrimps to by-catch. In addition the endangered turtles are captured as incidental catch to shrimps because they (shrimps, fish and turtles) stay in close proximity to each other within the environment especially in relatively shallow waters below 50 m depth. The reduction of incidental catch of sea turtles and juvenile fish in shrimp trawling are therefore regarded as priority issues in the total efforts to conserve the resources and develop more responsible and sustainable fisheries. In 1996 Turtle Excluder Device (TED) became a precondition and regulatory requirement for export of shrimps to US markets. In September 2006 a 3-man team of U.S. experts conducted a re-certification exercise and inspection of TEDs' design, operation and monitoring and control in

Nigeria. There was a very high degree of compliance by the operators in the industry as well as other stakeholders. Experimental fishing trials have been carried out with three types of By-catch Reduction Devices (BRD) on board commercial vessels in the coastal waters off Lagos Nigeria and Douala Cameroon in the Gulf of Guinea. The trials were carried out under a Global Environmental Facility (GEF)/United Nations Environmental Programmes (UNEP)/Food and Agriculture Organization of the United Nations (FAO) sponsored shrimp fisheries project. Trawl nets fitted with either square mesh codend, square mesh window or 90 degree turned/gentle codend have been observed to be cost effective and environmentally friendly options to mitigate the problem of juvenile and immature fish by-catch in shrimp trawling as compared to diamond mesh codend. The current developmental efforts involve pragmatic and holistic approaches including flume tank tests and sea trials in order to optimize the complementary roles of installing TED and BRD in the same trawl net. Recommendations are proffered for improvement in geometrical configuration and TED performance in order to minimize shrimp loss, optimize operational efficiency and thereby facilitate better compliance by the industrial fishermen.

TURTLE BYCATCH IN LONGLINE FISHERIES: OFFSET VS NON OFFSET CIRCULAR HOOKS

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With the adoption of circle hooks in many longline fisheries, fishery managers, conservation advocates, and fishermen hope to decrease the incidental catch of sea turtles. Current circle hook designs included both offset and non offset hook types. Experiments were conducted in the Costa Rican longline fisheries to determine whether there were any differences in catch rates of targeted fish, incidental catch of sea turtles, or hooking locations of sea turtles between non-offset 14/0 circle hooks and 10° offset 14/0 circle hooks. The commercial longline vessels were contracted to conduct experiments in the Pacific waters of Costa Rica from 2004-2006. A total of 44 sets were conducted with a total of 35,466 hooks deployed. Offset and non-offset 14/0 circle hooks were alternated along each set and squid bait was used throughout the experiments. Initial analysis of catch data indicate that 733 sea turtles were incidentally captured in the 44 sets (mean CPUE: 20.3). Non-offset circle hooks and 10° offset circle hooks had similar catch rates of sea turtles and similar catch rates of targeted fish species.

DEVELOPING STRATEGIES TO REDUCE INCIDENTAL CAPTURE OF SEA TURTLES

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Over the past two decades, many sea turtle populations have significantly declined. One contributing factor to this decline has been identified as turtle bycatch associated with pelagic longline fisheries. Recent estimates indicate that thousands of sea turtles interact with pelagic longline fisheries each year. The focus of our experiments was to develop methodologies for testing potential strategies aimed at reducing sea turtle interactions with fishing gear. Using tangle nets set in the Estero Coyote near the town of Punta Abreojos, Baja California, Mexico, we examined the catch rates of green turtles (*Chelonia mydas*). Two exploratory experiments were conducted. During the day, we examined the effects of shark shaped silhouettes on turtle catch rates. During the night, we tested the effects of light sticks used in pelagic longline fisheries on turtle catch rates. Previous experiments with captive raised sea turtles indicate turtles have an innate avoidance behavior to shark shapes. Using similarly sized shark silhouettes, our preliminary results showed a decrease in turtle capture rates when shark shapes were present. This initial result suggests that shark silhouettes may work as a deterrent to sea turtles in certain fisheries. Recent laboratory experiments suggest that lightsticks used in the longline fisheries are one of the cues that attract turtles to the longlines. Our initial field experiments in Baja California, MX, however, suggest that turtles are caught less when lightsticks were present. This may be due to the lightsticks illuminating the nets and allowing turtles avoid becoming entangled. If so, this methodology could be used to test lightsticks designed to be less visible to sea turtles.

LEGISLATION THAT PROTECTS SEA TURTLES IN GUATEMALA

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This presentation includes a brief review of Guatemalan sea turtle legislation over the years, a legal analysis under the framework of international agreements and current Guatemalan law and regulations related to sea turtles. Conservation of sea turtles and the actions developed for that purpose represent the longest existing program to protect endangered species in Guatemala. In 1971 the government of Guatemala promoted two major actions to protect sea turtles: sea turtle egg incubation and liberation of new born sea turtles to the sea. For the last 34 years both activities have been developed by the government, non governmental organizations and individual persons. In 2002 specific regulations were enacted by the National Advisory Committee of Protected Areas in Guatemala (CONAP in Spanish), under regulations CONAP No. ALC 056/2002. These regulations were later ratified in 2004. New regulations and the results of their initial implementation are described in the following bullets: •Collection of sea turtle eggs according to established conservation quota that at the present time represents a 20% of a single nest. This regulation is applied by 10% of the turtle farms, the other 90% are working with 12 eggs per nest. •Incubation of sea turtle eggs and liberation of new born sea turtles to the sea. From 2002 to 2005 a total of 166,117 eggs were incubated. •Control activities to curtail poaching and illegal trade of sea turtles and its eggs. A total of 69 monitoring and control activities were conducted between 2002 and 2005 and 3,582 eggs were confiscated. •Turtle Excluder Devices (TEDs) are mandatory on shrimp boats to reduce the number of accidental deaths of sea turtles. From 2002 to 2005 a total of 21 inspections were conducted in 106 boats, and only four reported proper use of the regulations. •Collection and analysis of data from all sea turtle conservation farms during each nesting season. Reports are available for the years 1999 to 2005.

USING GPS & GIS TO ENFORCE SEA TURTLE PROTECTION ORDINANCE

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At the Town of Hilton Head Island, the function of the GIS Analyst is to support all departments in their efforts to conduct town business. The primary focus of the GIS is to provide technical support, mapping, and analysis on all manner of spatial and temporal GIS data and aerial imagery. One aspect of this support involves the use of Global Positioning Systems (GPS). The Code Enforcement officer for the Town of Hilton Head Island communicated the need for additional technical support in order to properly enforce the Sea Turtle Protection Ordinance. The Sea Turtle Protection Ordinance was adopted to help reduce the disorientation of sea turtles during nesting and hatching season. Due to previous lack of enforcement, the number of hatchlings disorientation has been on the rise. The link between artificial light and hatchling strandings has been well documented in the research literature. With over 740 addresses along the beach, the enforcement of the light violations has historically been a major obstacle for proper enforcement and record keeping. The lack of adequate technology and those capable of using it has posed a significant challenge for proper enforcement and record keeping. With the

aid of a mapping grade GPS, a laser range finder and a compass, it becomes possible to travel the twelve miles of beach at night and capture the addresses of homes in violation. Upon returning to the office, the analyst is then able to generate user friendly maps that evening. The maps are created using ESRI software known as ArcGIS. The maps are then relayed to the enforcement officer which allow for warnings to be served the following day. The implementation of the technology and the development of this process allows for efficient code enforcement. With the development of the model, the methodology has potential applications for other sea turtle conservation projects. Given available technology, this process can be shared and the methodology duplicated throughout other coastal communities. The principal driving force behind a proper process is to maintain consistent GPS accuracy and documented methods that can and will be used to support legal cases. With an established sea turtle protection ordinance, consistent enforcement, and record keeping; conservation efforts can be strengthened. The results of the 2006 nesting and hatching season have yet to be completed, but preliminary data suggests that this technology has significantly decreased nesting and hatchling disorientation. The Town of Hilton Head issued 588 warnings with supporting documentation for lights this season. The number of warnings is 270 more than the last four years combined. The 2006 year showed 185 document nests on Hilton Head Island. The number is up from last year's 166 nests and up more than 25 percent from the 10-year average of 146.

TREATS ON TURTLE TREATIES

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For over a decade considerable interest and effort have been focused on the development of international agreements for the conservation of marine turtles and their habitats. A bilateral accord, a trilateral agreement, two regional memoranda of understanding, and a legally binding treaty - all specifically for marine turtle conservation - have been the subject of news flashes, progress reports, updates, scholarly evaluations, enthusiastic proclamations, and gloomy critiques. Recently the fervor for these instruments seems to have subsided, and basic questions need answers: What was developed? With what objective? What did it involve? How was it administered? What achievements have been made? How has turtle conservation been improved by these advances? In what ways were these international accords instrumental in achieving conservation goals? In what ways have they failed? The results to date are highly variable. One accord, accompanied by fanfare and enthusiastic proclamations, has yet to be consummated, affording minimal benefits to strengthening multi-lateral attitudes toward turtle conservation. An MoU, although initially providing tangible achievements – despite considerable odds, has been left to languish by a major inter-governmental organization, and been ignored by powerful States with clear interests and responsibilities in the region. On the other hand, a bilateral accord – the first of its kind, and winner of an international prize – has continued to nurture strong cooperation at the technical level, transcending severe problems at the highest political levels. A hemispheric treaty has disappointed conservationists throughout the region because of its lethargy in resolving basic administrative issues; yet, there have been tangible contributions and cultivation of inter-governmental interests in collaboration. The instrument covering the largest, most diverse area, with nearly two dozen Signatory States, has shown the most rapid advancement, easily overtaking other agreements that were developed before it, and producing various tangible advances promoting the conservation of turtles and their habitats. Yet, it too has much to resolve if it is to achieve its intended goals. Clearly, it is too early to determine whether any of these instruments has failed or succeeded in the conservation of the

slow-maturing, long-lived, highly migratory reptiles for which they were developed. The interminable frustrations of administrative, bureaucratic, and political obstacles, to say nothing of the substantial expenditures in human and financial resources, make it easy to criticize these initiatives, especially from the insulated comfort of an ivory tower. But they must be viewed within the light of the realities of international relations; some essential treaties have taken decades just to be negotiated and adopted: short of military intervention, there is no simple way to robustly promote the widespread adoption of collaborative measures for the conservation of shared resources. Until an alternative less-worse than international instruments is devised for sponsoring multi-lateral cooperation in the ways that divergent human societies and governance levels interact with resources that they all share and impact, there is reason for hope that there will be a treat to these turtle treaties. There is also every reason for turtle conservationists to become better informed, and involved with international instruments.

CUMULATIVE ANALYSIS OF AUTHORIZED SEA TURTLE TAKES IN U.S. COMMERCIAL FISHERIES

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Each year, U.S. commercial fishing operations catch and kill thousands of sea turtles. The United States government, as required by the Endangered Species Act, issues permits which authorize the “take” of sea turtles incidental to commercial fishing operations. These permits allow for fishing activity while ensuring that interactions with sea turtles do not jeopardize the health or recovery of turtle populations. The government is required to consider the cumulative impact of all activities before issuing such authorizations. However, the U.S. government has never added up the total number of sea turtles it allows commercial fisheries to catch, thus failing to ensure that the total activity by all fisheries is not pushing turtles to the brink of extinction. By analyzing all Incidental Take Statements for all U.S. commercial fisheries, it was possible to obtain the number of sea turtles the U.S. government authorizes U.S. commercial fishing operations to take. The analysis showed that the government authorizes more than 340,000 sea turtles to be injured and nearly 10,000 sea turtles to be killed each year. Worse yet, when most commercial fisheries catch their authorized number of sea turtles, the government allows fishing activity to continue even if more turtles are caught. The U.S. government needs to implement a system to ensure that permitted fishing activities are not driving threatened or endangered species to extinction. To solve this problem, the government must determine how many sea turtles of each species and in each region of the United States can be harmed and killed without jeopardizing the continued existence of their populations or their recovery, issue authorizations to interact with turtles based on these numbers, and then actually enforce the limits that they create.

ASSESSMENT OF THE IMPLEMENTATION OF THE PROTOCOL TO THE CARTAGENA CONVENTION CONCERNING SPECIALLY PROTECTED AREAS AND WILDLIFE (SPAW), WITH A SPECIAL FOCUS ON SEA TURTLES LISTED ON ANNEX II

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I (RM) conducted the first review of enabling legislation among Parties to the Protocol concerning Specially Protected Areas and Wildlife (SPAW) to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention). I evaluated progress made during the five years (2000-2005) since the Protocol entered into force, and document the degree to which SPAW Parties have legislation to implement Articles 10, 1l, 13 and 14, with regard to six species of sea turtles listed on Annex II (such listing requires the protection of species and critical habitat). As regionally depleted, relatively well-studied wildlife shared among all Party jurisdictions, sea turtles provide a useful opportunity to gauge the degree to which the Protocol's 12 Parties have responded to the obligation "to adopt co-operative measures to ensure the protection and recovery of endangered and threatened species" (Art. 11). The objectives of Articles 10 and 11 are to reach consensus regarding endangered species designation and protection. Article 13 addresses the need for decisions about "industrial and other projects and activities" to be made after taking into consideration the "possible direct and indirect impacts, including cumulative impacts" of the proposed project or activity. Article 14 requires all Parties to take traditional and indigenous practices into account and to provide for appropriate exemptions. Based on information obtained from published sources, especially the UNEP-Caribbean Environment Programme library in Jamaica, as well as information drawn from the outcome report of a UNEP-hosted workshop (December 1993) on the development and criteria of appropriate legislation, I developed a normative list of legal characteristics and relevant sectors addressed by each of the targeted Articles. I then sent a questionnaire to all SPAW Regional Programme Focal Points that are Party to the Protocol, requesting copies of relevant legislation. I reviewed original legislative text as well as published analyses relating to legislation and management, and interviewed in-country experts. In the end I recognized approximately 130 relevant fisheries, human rights, environmental, and trade/commerce laws and sector-specific policies of each Party that enable the Protocol's mandate to achieve recovery for Caribbean sea turtles. By comparing existing legislative mandates with a checklist of criteria developed specifically for this purpose, I characterized strengths, weaknesses, and gaps in the national regulatory framework of each Party. Among my conclusions are that a majority of Parties have at least partially met the mandates of Articles 10 and 11, while a minority have met the mandates of Articles 13 and 14. Despite gaps identified in each Party's legislative framework, it is clear that progress has been made since 2000 and that examples of appropriate legislation are now available as potential models for other States to follow, suggesting that further and more timely progress could proceed. The review recommends actions that could be taken by the SPAW Programme to increase national capacity for the development of enabling legislation and participation in the Protocol, and provides a model for further legislative review and assessment pertaining to Annex II listed species.

DEVELOPING STRATEGIES FOR GLOBAL AND REGIONAL SEA TURTLE STATUS ASSESSMENTS: PERSPECTIVES FROM THE MTSG MEMBERSHIP

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One of the responsibilities of the Marine Turtle Specialist Group (MTSG) is to conduct global status assessments of sea turtle species, to be included in the IUCN-World Conservation Union's Red List of Threatened Species. However, scientists have argued that in general, the IUCN Red List criteria are inadequate for determining the status of sea turtles; largely because the global approach does not adequately reflect the status of regional or local subpopulations. As part of its Sea Turtle Assessment Strategy, the MTSG will launch a regional sea turtle assessment initiative for all species in all regions in an effort to accurately describe abundance changes at these smaller spatial scales. To ensure that the strategies employed in this effort are reflective of the attitudes and ideas of its membership, the MTSG leadership circulated a Red List Questionnaire to membership during the second half of 2006. A total of 12 questions were included, inquiring about aspects such as how members felt about MTSG's obligation to undertake Global Red List Assessments, what components they believed were important for a regional assessment strategy, and what format a regional assessment final report should adhere to. The survey had over 50 respondents from more than 20 different countries. This paper summarizes the results of this MTSG Red List Questionnaire and highlights some of the key aspects that MTSG members believe are necessary for developing the most effective regional assessments for sea turtles.

LEATHERBACK CONSERVATION AREA: THE EFFECTIVENESS OF A TIME/AREA CLOSURE IN PROTECTING LEATHERBACK SEA TURTLES

Karen Steele
Sea Turtle Restoration Project

The presentation will discuss the effectiveness of the Leatherback Conservation Area, in place since 2001 along the US Pacific Coast, at protecting leatherback sea turtles that forage in this area, which primarily originate from rookery beaches in Indonesia. The time/area closure is in place each year from August 15 – November 15 and extends from Monterey Bay, California to Pacific City, Oregon, which bans drift gillnet fishing gear from this area during this time. This protective measure was implemented as a reasonable and prudent alternative by the National Marine Fisheries Service - following the completion of a Biological Opinion for the drift gillnet fishery that concludes such operations are deleterious to local leatherback populations. This presentation will first examine the data used to determine the need for this closure. This will include data gathered from fisheries bycatch, tagging and tracking and aerial surveying. Gaps in data and knowledge regarding the population of leatherbacks present along the US West Coast at the time of the closure will be discussed. The time/area closure will then be examined from a number of perspectives. Bycatch data on the leatherback sea turtle from the California-Oregon drift gillnet fishery will be compared prior to and following the implementation of the Leatherback

Conservation Area to evaluate the potential effectiveness of this conservation measure in mitigating fishery impacts. New data collected since the time/area closure on the population distribution of the leatherback sea turtle along the US West Coast will then be briefly presented. This will be discussed in relation to the current boundaries of the Leatherback Conservation Area. Finally, potential economic impacts to the drift gillnet fishery due to this closure will be briefly analyzed using ex-vessel value of landings, number of permit holders and historical economic patterns of the California-Drift gillnet fishery. Based on the above data a final analysis will be presented on the effectiveness of the Leatherback Conservation Area as a balance between conservation efforts and the fishing industry.

SKELETOCHRONOLOGICAL ANALYSIS OF AGE AND GROWTH FOR LEATHERBACK SEA TURTLES IN THE WESTERN NORTH ATLANTIC

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Although growth and age data are essential for leatherback management, estimates of these demographic parameters remain speculative due to the cryptic life history of this endangered species. Rapid captive growth rates combined with bone growth patterns atypical of reptiles have led researchers to propose that leatherbacks might mature in as little as 3 to 6 years. Skeletochronological analysis of marks observed along the lateral edges of histological sections taken from the scleral ossicles of leatherbacks originating from the eastern Pacific Ocean suggested that average age at maturity might occur at 13 to 14 years of age. However, researchers conducting this study were unable to verify that the marks analyzed represented annual cycles instead of resulting from environmental or physiological stressors. Because the marks in Kemp's ridley humeri are known to be annual in nature, in this study we first conducted a comparative skeletochronological analysis of Kemp's ridley scleral ossicles and humeri to validate the annual deposition of marks in ossicles. We then analyzed growth marks in leatherback scleral ossicles obtained from 20 large juveniles and adults ranging from 122.0 to 172.2 cm CCL (mean 147.1 cm), two small juveniles measuring 17 and 27 cm CCL, and 4 hatchlings that were found dead along the Atlantic and Gulf coasts of the US. We found that the lengths of the first marks deposited at the core of the ossicle were equivalent to hatchling ossicle lengths, demonstrating that this core mark is not an annual mark. Due to lateral compaction and resorption at the ossicle core, the number of marks visible at the tips of ossicle sections was consistently and significantly greater than the number of marks visible along the lateral edges, demonstrating that growth marks counts should be performed at the tips so that age is not underestimated. Ossicles from a small number of leatherbacks exhibited no resorption of early growth marks, allowing direct counts of the number of marks present to obtain age estimates. However, for the remainder it was necessary to use a correction factor protocol that incorporated the trajectory of early growth increments to estimate the number of resorbed marks, which was then added to the number of observed marks to obtain an age estimate for each animal. A generalized smoothing spline model was used to assess growth rates and to obtain an estimate of age at maturity for leatherbacks in the western North Atlantic. The results of these analyses suggest that leatherbacks in this part of the world may not reach reproductive maturity until 29 (95% CI 26 - 32) years of age. This age estimate is much greater than those proposed in previous studies and has significant implications for population management and recovery.

UTILISING VOLUNTEERS TO COLLECT INWATER OBSERVATION DATA - AN ASSESSMENT FROM THE CAYMAN ISLANDS TCOT PROJECT

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The recruitment of recreational divers for basic population assessment allows rapid accumulation of uncomplicated observation data over a wide temporal and spatial area. We present the results of a 26 month programme "Caribbean Turtle Watch" initiated as part of Turtles in the Caribbean Overseas Territories (TCOT). A total of 521 dives were recorded from 8 dive operators over both Grand and Little Cayman. 116 known dive sites were covered. Data are analyzed to present size class distribution and an indications of abundance of all sighted species, spatial patterns of marine turtle observation with respect to Marine Protected Areas in the Cayman Islands, as well as overall spatial, seasonal and diel patterns of observation which may give insight into habitat use, feeding or activity patterns and ontogenetic habitat shifts. Furthermore, the impact of diver pressure on turtle presence and/or abundance, and the impact of turtle sightings on the level of enjoyment experienced by each diver are analyzed. This provides insight into the potential economic value of healthy and abundant reefs and marine turtle populations to the Cayman Islands economy which is heavily reliant on dive tourism.

LONG-TERM VARIATION IN ANNUAL RECRUITMENT FROM SOURCE ROOKERIES TO A GREEN TURTLE FORAGING GROUND

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Mitochondrial DNA haplotype frequencies in a population of immature green turtles at Union Creek Marine Reserve, Great Inagua, Bahamas, have been determined each year from 1992 through 2003. There is significant variation in the composition of the population among years. Mixed stock analyses employing a Bayesian hierarchical model were used to generate estimates of rookery contributions for each year. The proportions of rookery contributions varied among years both for the entire population and for recruits only. We discuss the limitations of one-year samples for characterizing rookery contributions to a foraging ground population. Previously, we published a description of the genetic composition of the Union Creek population based on a one-year sample collected in 1992. The current results change our understanding of the composition of this population and how we evaluate effects of distance to rookery and rookery size on foraging ground composition. Annual variation in recruits may reflect differences in annual survival to recruitment of hatchlings from each rookery or may represent differences in ocean currents directing small green turtles from oceanic to neritic habitats. We will discuss how these possible mechanisms can be distinguished and the implications of variable recruitment on the biology and conservation of green turtles. Effective management of migratory sea turtles requires knowledge of temporal as well as spatial patterns. Studies of initial recruitment patterns could reveal important insights on the distribution and movements of oceanic-stage green turtles.

INSIGHTS INTO THE IN-WATER ECOLOGY OF JUVENILE HAWKSBILL AND GREEN TURTLES IN CAYMAN ISLANDS FORAGING HABITAT

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We present results of an in-water research program for juvenile hawksbill (*Eretmochelys imbricata*) and green turtles (*Chelonia mydas*) in the Cayman Islands. Diverse data on population dynamics (via capture-mark-recapture) and diving behaviour (via time depth recorders and ultrasonic acoustics) are integrated with benthic habitat maps produced by visual interpretation of high resolution aerial photography and satellite imagery. Through ongoing in-water monitoring (now entering its 7th year) we aim to provide detailed data relevant to the conservation and management of juvenile hawksbill and green turtles in Caribbean foraging habitat.

TRENDS IN SEASONAL DISTRIBUTION AND RELATIVE ABUNDANCE OF SEA TURTLES IN NORTH CAROLINA, USA FROM MARINE RECREATIONAL FISHERY STATISTICS SURVEY (MRFSS), 1990-2004

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The Marine Recreational Fishery Statistics Survey (MRFSS) of the National Marine Fisheries Service, NOAA, provided a unique opportunity to observe changes in the spatial and temporal distribution and relative abundance of sea turtles within North Carolina. The MRFSS was initiated in 1979 to estimate the impact of recreational fishing on marine resources along the Atlantic and Gulf of Mexico coasts of the USA. Utilizing interviews of anglers who have just completed a fishing trip, the MRFSS acquires catch and demographic data. The anglers are asked the type of fishing conducted (charter/headboat, private/rental boat or from shore [pier, beaches, banks]), the number of hours fished, and in which body of water most of their fishing activity was conducted. Since 1990, individuals fishing in North Carolina marine waters were asked if they had observed a sea turtle on their fishing trip. Anglers were not asked to tally nor identify the turtles sighted, but simply to indicate the presence or absence of sea turtles during a trip. From 1990 to 2004, over 265,000 anglers were queried for a total of 1,233,438 hours of fishing effort. Of these anglers, about 4% reported seeing a live turtle while fishing. Although the trend is not significant, results indicated an increase in sightings of sea turtles by anglers from 1990-2004. Turtles were sighted consistently in Bogue Sound, Cape Fear River, Core Sound, New River, Newport River, Pamlico Sound and the Atlantic Ocean. Turtles were sighted sporadically in Albemarle Sound, Lockwood Folly River, Topsail Sound, North River, and Roanoke Sound. Turtles were sighted year-round in the Atlantic Ocean but were absent from other bodies of water in the winter. The MRFSS is limited in that it does not provide number, species, or size composition of turtles sighted. Furthermore, effort varies depending upon time of year anglers are queried and location of fishing activity. Nevertheless, MRFSS data can still be used to corroborate or supplement data obtained from other surveys.

THE EFFECT OF BOTTOM TYPE AND PREY AVAILABILITY ON LOGGERHEAD CATCH RATES BASED ON IN-WATER SURVEYS OFF THE SOUTHEASTERN COAST OF THE U.S.

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In 2000-2003 the South Carolina Department of Natural Resources conducted a regional in-water turtle survey to determine abundance of sea turtles off the southeast coast of the U.S. During this 4 year period 3,020 separate sampling events were conducted, collecting a total of 826 loggerheads, 7 green and 57 Kemp's ridley sea turtles. In addition to collecting information on the sea turtles themselves, information was collected on the bycatch associated with each sampling event. Count information was collected on all species, and lengths and weights were recorded for priority fish and invertebrate species. Over 423,300 individuals were recorded representing nearly 150 different species each of fish and invertebrates. A 2001 study conducted by the Southeast Area Monitoring and Assessment Program-South Atlantic (SEAMAP-SA) found that bycatch can be a legitimate surrogate for habitat type. This paper will analyze the bycatch data collected during this study to test two hypotheses: to determine if loggerhead catch rates vary by habitat or bottom type and to determine the relationship between catch rates and the presence of known loggerhead prey items. Analyses for both components of this paper are pending.

GROWTH RATES AND AGE-AT-SIZE OF JUVENILE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN THE MEDITERRANEAN SEA, ESTIMATED THROUGH LENGTH FREQUENCY DATA

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Growth rate is a fundamental parameter to understand population dynamics, and estimating it in different areas/populations is necessary, because it can be influenced by both environmental and genetic factors. For instance, in the Mediterranean, loggerhead turtles (*Caretta caretta*) mature at a smaller size than any other population: the smallest nesting female recorded was 60 cm CCLn-t. Whether this is due to a lower growth rate or to a younger age at maturity is uncertain. We investigated this aspect through a length frequency analysis of 2944 turtles collected during a 26 year period and ranging 6-60 cm CCLn-t (we excluded turtles above the minimum size of nesting females because growth after maturity is very slow and this may affect the analysis). We calculated growth rates by tracking the progression of individual cohorts, by means of a modal progression analysis performed in the range 30-60 cm, where the sample size was adequate for this approach. Mean annual growth rates were estimated by linking the

distinct modes and ranged from 0.22 cm/yr to 4.07 cm/yr, with a mean of 2.08 cm/yr. For the size class 6-30 cm we directly estimated the number of modes/cohorts, thanks to the great size difference among cohorts and the low number of cohorts typical of this small size class. Results suggest that an average turtle takes about 19 years to grow to 60 cm CCL: about four years to 30 cm and other 15 years from 30 to 60 cm. Since the mean size of nesting females is around 80 cm CCL in the most important Mediterranean nesting sites, on the average maturity would be attained at a much older age. When compared with data from the Atlantic, these results suggest that the smaller size at maturity of Mediterranean turtles is mainly due to a slower growth.

ANALYSIS OF SEA TURTLE STRANDINGS IN SOUTHERN PALM BEACH COUNTY (1980-2006) USING GIS AND SPATIAL ANALYST

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The Gumbo Limbo Nature Center has been a participant in the Sea Turtle Stranding and Salvage Network (coordinated in Florida by the Florida Fish and Wildlife Conservation Commission) since the late 1970s. In the early years data were collected on debilitated and deceased sea turtles within the five-mile city limits of Boca Raton. Overtime, efforts expanded to include southern Palm Beach County (from the Palm Beach County Line 26°19'15"N -80°04'29"W, north to the Boynton Inlet, 26°32'43"N -80°02'35"W). In this presentation, we will present an analysis of data collected from 1980-2006 with emphasis on data collected within Boca Raton city limits. Analysis of species distribution, size-class, seasonality, and disease occurrence will be conducted using Microsoft Excel 2000, ArcGIS 9.0 with the extension Spatial Analyst. Strandings overall occurred most often during the height of the nesting season (May, June and July). During the non-nesting months, the sub adult turtles were found stranded more often than other size classes. Leatherback strandings (n=14), however, occurred only in the fall and winter months. We find it interesting that strandings of this species have not occurred throughout the leatherback nesting season (March to June in Boca Raton). The green turtle (*Chelonia mydas*) stranded at the highest frequency (n=197), followed closely by the loggerhead turtle (*Caretta caretta*, n=186). As expected, the stranding densities of both the green and loggerhead turtles were higher within the city limits of Boca Raton. This can be explained simply on the increased likelihood of a stranded turtle being reported within the city limits, where significant effort has occurred to educate the public on the proper reporting procedures. To the north of the city, there are a greater percentage of private lands where we expect the larger turtles to be reported by the public more often then the smaller turtle strandings. Analysis of stranding data using GIS and Spatial Analyst has greatly simplified data interpretation. Trends that are understood (e.g. greater strandings reported in areas of greater effort) are easily expressed visually in density maps. Presenting data in this way can assist managers and conservationists to focus resources using visual, data supported documentation.

CONSERVATION AND BIOLOGY OF DIAMONDBACK TERRAPIN (*MALACLEMYS TERRAPIN*) POPULATIONS IN SALT MARSHES OF ALABAMA

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The demography and ecology of *Malaclemys terrapin pileata* were studied in the salt marshes of southwestern Alabama during 2004–2006. A variety of methodologies were utilized in an attempt to obtain information on population density and nesting activity. This included head surveys and modified crab traps in salt marshes, depredated nest surveys and drift fences with pitfall traps on nesting beaches, and radio tracking of reproductive females. In 2004, twenty-four heads were spotted in eleven total surveys of Cedar Point Marsh, Airport Marsh, Mon Louis Creek, and Little Dauphin Island. Seventy-four depredated nests were found on the nesting beaches surrounding these marshes. In 2005, twenty-five heads were seen in seven surveys of the four marshes. However, only fifteen depredated nests were observed that year (primarily due to overwash of nesting areas due to a series of storms). In 2006, forty heads were observed in thirteen surveys, although these head surveys were completed only in Cedar Point and Jemison's Marsh. The nest surveys were concentrated on the beaches surrounding Cedar Point Marsh, where 109 depredated nests were found. Seven adult females were captured in the pitfall traps, and two females were captured while nesting. Seventeen terrapins were caught in the modified crab traps: two in Jemison's Marsh and fifteen in Cedar Point Marsh. All turtles were PIT tagged and their shells notched. A suite of morphological measurements as well as blood samples were collected. The blood samples will be used in both genetic and hormone studies of this population. The results suggest that limited populations of terrapins exist in the salt marshes of Alabama with the largest detected nesting aggregation occurring near Cedar Point. The stability and threats to the conservation of these populations are currently being examined in order to assess optimal management strategies.

RESULTS OF FORAGING GROUND SURVEYS AT MONA AND MONITO ISLANDS, PUERTO RICO

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Mona and Monito Islands encompass several benthic habitat types that are utilized by a wide size range of hawksbill turtles. Surveys conducted since 1992 have yielded 2000 capture records including 950 recapture events. We present temporal trends in relative turtle abundance in three key habitats, the animal's distribution within these habitats, the size range of turtles found, somatic growth rates obtained from recaptured individuals, and a relative measure of food availability within two cliff-wall habitat types.

SEX-RATIO OF JUVENILE PELAGIC LOGGERHEADS *CARETTA CARETTA* OFF MADEIRA ISLAND (PORTUGAL), NE ATLANTIC: A 3-METHOD APPROACH

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Like many other reptiles, loggerhead turtles exhibit temperature-dependent sex determination (TSD), i.e., the sex of the offspring is influenced by the incubation temperature of the eggs. Temperature-dependent sex determination has the potential of producing biased sex ratios. Therefore, the sex ratios produced from TSD are of ecological and conservational interest, as knowledge on the population's sex-ratios is essential for wild populations' management and conservation. However, sea turtles exhibit no sexual dimorphism up to sub-adult or adult age classes. Therefore, sex determination needs to be addressed using other techniques, such as laparoscopy, histology of the gonad or steroid hormones assessment. In the current study we present preliminary data on Madeira Archipelago sea turtle population sex-ratio using the three methods mentioned above. During the summers of 2004, 2005 and 2006 the sea turtle population was sampled in the waters off Madeira Island (Portugal) and brought in to the laboratory. Laparoscopies were performed in order to determine each animal's sex, as well as to get a biopsy sample of the gonad for histological sex assignment. Blood samples were also collected for comparison with steroid hormone levels, and biometry data collected. Histological processing of the 70 biopsy samples collected up to now is currently under way, as well as the radioimunassay for testosterone and estradiol assessment. Results obtained up to now identified both males and females, but females appear to predominate. The accuracy of the three methods will be compared and the sex ratio obtained for this juvenile pelagic population will be presented and correlated with age classes and several of the biometrical parameters taken. The sex-ratio will also be compared with the sex ratios known for the hatchling source population for this population, as well as with the corresponding adult population in the eastern United States nesting beaches. This study aims to contribute to a better knowledge of this population's structure, and a helpful tool for management and conservation policies. Acknowledgements: Cláudia Delgado gratefully acknowledges travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service provided through the Symposium Travel Committee, as well as the Portuguese Foundation for Science and Technology (grant SFRH/BD/8413/2002).

DEVELOPING A STATEWIDE PROGRAM OF IN-WATER MONITORING OF SEA TURTLES IN FLORIDA

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The Florida Fish and Wildlife Conservation Commission (FWC) coordinates data collection from a network of index sea turtle nesting beaches that allows for the evaluation of nesting trends of loggerheads (*Caretta caretta*), green turtles, (*Chelonia mydas*) and leatherbacks (*Dermochelys coriacea*). However, data from in-water aggregations of sea turtles, which include life stages other than adult females, as well as hawksbills (*Eretmochelys imbricata*) and Kemp's ridleys (*Lepidochelys kempii*), are not currently included in statewide population assessments. In order to obtain a more complete evaluation of the status and trends of the state's sea turtle populations, we explored the feasibility of developing a statewide, in-water index monitoring network. We began by inventorying all marine turtle in-water research that is ongoing or has already taken place in Florida. We developed an initial list of 21 active and 15 inactive projects and then used surveys, interviews, and literature reviews to obtain additional information on each project. The vast majority of projects (15 active, 9 inactive) were conducted on the east coast of the state, mainly in inshore lagoons or over nearshore hardbottom reefs. Research on the west coast and Panhandle region was found to be sporadic. Statewide, green turtles and loggerheads, especially of the juvenile and subadult life stages, made up the majority of captures and sightings. Kemp's ridleys were commonly captured in west coast studies, but data on hawksbill and leatherback aggregations were sparse. On the basis of habitat distributions and known occurrences of marine turtles, we identified 11 specific geographic gap areas that warrant study. We also recommended 12 existing in-water projects for inclusion in a proposed index monitoring network. Participation in this program would require collection of catch-per-unit-effort (CPUE) data, as well as a standard set of measurements, including morphometrics and health assessment. The network is envisioned as a collaborative effort among in-water researchers and a coordinating entity, possibly FWC. To develop a broader picture of sea turtle distributions in the state beyond those at in-water project sites, we compiled a list of additional projects and databases that provide information on sea turtles in Florida waters. These include aerial surveys, relocation trawling, stranding networks, fisheries bycatch reporting, dredge operations, and aerial surveys for other species. We also compiled a list of satellite telemetry projects that involve tracking sea turtles either from Florida or into Florida from outside the state. The end result of this endeavor is a comprehensive database, GIS maps, and a narrative document describing the in-water marine turtle research that has occurred in Florida.

INDICES OF ABUNDANCE FOR SEA TURTLE POPULATIONS IN NORTH CAROLINA, U.S.A.

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Sea turtles captured in pound nets in the Pamlico-Albermarle Estuarine Complex, NC, USA, were sampled 1995 - 1997 and 2001 - 2003 to monitor trends in abundance during their fall emigration from the temperate sounds. Juvenile loggerhead (*Caretta caretta*), green (*Chelonia mydas*), and Kemp's ridley (*Lepidochelys kempii*) turtles were captured, in decreasing order of abundance. Over the 9 yr period, the catch rates of loggerhead turtles increased significantly at a rate of 13.2% yr^{-1}, perhaps indicating that as a whole, the species in the Western North Atlantic is recovering at a very slow rate. We did not detect a trend for either green or Kemp's ridley turtles, likely due to low statistical power. We noted a significant shift in the size distribution of loggerheads; the mode increased over time. There was no discernable pattern in annual size distributions of green turtles even though there was a significant difference in annual size distributions. Our analyses demonstrate the need for long-term studies of sea turtles on foraging grounds at multiple sites throughout their ranges.

THE DISAPPEARING EASTERN PACIFIC HAWKSBILL TURTLE: A DIRECTED STUDY TO EVALUATE THE POPULATION

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Although evidence suggests that hawksbill (*Eretmochelys imbricata*) turtles were once abundant in the Eastern Pacific (EP), currently the population appears to be - possibly - one of the most endangered in the world. Nonetheless, the population has received virtually no attention from the sea turtle conservation community and directed, systematic studies to evaluate current status and abundance are non-existent. In 2007 a directed effort to generate information and awareness regarding this neglected population will be undertaken in the Gulf of California, Mexico, which provides a confined foraging habitat for juvenile individuals and where many of the more recent reports regarding this population have taken place. The project will include the following: 1) evaluation of historical abundance through a compilation of historical literature and interviews with fisher elders; 2) evaluation of current distribution and abundance through a regional hawksbill sighting network, interviews with fishers, in-water sampling, and satellite telemetry of 2 or more turtles; 3) stock assessment through genetic sampling; and 4) education/outreach to raise awareness of and reverse the largely unnoticed decline of this critically endangered population. The study will provide much needed information on this data deficient population of sea turtles, thus assisting in its classification, conservation and management.

SEASONAL DISTRIBUTION AND ESTIMATED DENSITY OF SEA TURTLES IN CORE AND PAMLICO SOUNDS AND NEARSHORE WATERS OF NORTH CAROLINA, USA

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To be in compliance with the Endangered Species Act, the United States Department of the Navy is required to assess the potential impacts of conducting at-sea training operations to sea turtles and their environment. There are few area-specific sea turtle density data for the Navy's operations areas (OPAREAs), including the Marine Corps Air Station (MCAS) Cherry Point OPAREAs, which encompasses portions of Core and Pamlico Sound, North Carolina. We documented the seasonal distribution and estimated density of sea turtles within Core and Pamlico Sound, and adjacent coastal waters extending one mile offshore. Sea surface temperature data (SST) extracted from 1.4 km/pixel resolution Advanced Very High Resolution Radiometer satellite remote imagery were used to estimate water temperatures for each survey. Due to the difficulty of distinguishing species at high altitudes, we did not identify turtles to species except in the case of leatherback turtle (*Dermochelys coriacea*) sightings. A total of 92 turtles were sighted during 41 aerial surveys, conducted from July 2004 to April 2006. In the spring (7.9°C to 21.7°C), the majority of turtles sighted were along the coast, mainly from the northern Core Banks northward to Cape Hatteras. Two turtles were sighted just within the eastern Pamlico Sound, and one was within the vicinity of the OPAREA. By the summer (25.2°C to 30.8°C), turtles were fairly evenly dispersed along the entire survey range of the coast and Pamlico Sound, with only a few sightings in Core Sound. The only leatherback turtle sighting occurred in the summer, just south of Cape Hatteras. In the autumn (9.6°C to 29.6°C), the majority of turtles sighted were along the coast and in eastern Pamlico Sound; however, fewer turtles were observed along the coast than in the summer. The greatest number of turtles sighted within Core Sound occurred in autumn, with four individuals being seen. No turtles were seen during the winter surveys (7.6°C to 11.2°C). For the entire survey area, the estimated density of turtles was greatest along the coast in the summer (40.6 turtles/100 km², SE = 55.2) and in Core and Pamlico Sounds in the autumn (0.87 turtles/100 km², SE = 1.56). The range of mean temperatures at which turtles were sighted was 9.7°C to 30.8°C. The majority of turtles we sighted were within water ≥ 11°C. As poikilotherms, sea turtles distributions are generally limited by water temperature. Based on the findings of this study, sea turtles are more likely to be encountered within Cherry Point OPAREAs during the summer, and when SST is ≥ 11°C.

COMPARISON OF HISTOLOGICAL PROCESSING METHODS FOR SKELETOCHRONOLOGICAL ANALYSIS

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Over the past several decades, skeletochronological analyses of growth marks in sea turtle bones have provided age and growth data that are critical for accurate parameterization of population models and predicting the effects of management decisions. However, when conducting these analyses, researchers have used several different histological techniques for bone preparation. Given that there may be differences in the extent to which each technique accentuates growth marks within bone sections, it is important to evaluate them to determine

their relative effectiveness. In this study, sections of humeri obtained from 20 Kemp's ridley sea turtles (30.3 to 48.7 cm SCL) that stranded dead along the U.S. Atlantic coast were prepared using two of the most common techniques: 1) untreated and viewed in a 4:6 ethanol-glycerin solution and 2) decalcified, thin-sectioned, and stained with hematoxylin. The number of lines of arrested growth (LAGs) that denote the outer limits of individual growth marks were counted independently by three observers in unstained and stained sections taken from individual animals and were then compared. Unstained sections were viewed solely under a Nikon dissecting microscope, while stained sections were viewed both on the Nikon and on an Olympus BX41 trinocular compound microscope to look for possible differences. Significantly more LAGs were observed in the stained sections than in the unstained sections.

SEA TURTLE CONGREGATIONS IN DISCRETE TEMPERATE SHORELINE AREAS IN COLD NORTHERN CHILEAN COASTAL WATERS

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The presence of sea turtles along the northern Chilean coast has been described elsewhere since Molina (1782), always noticing the sighting of one or few scattered individuals. We have conducted environmental monitoring studies along the coast from 21^{o} to 26^{o} South Latitude degrees since 1995 observing that *Chelonia mydas* began to congregate at increasing numbers into at least three discrete areas: (a) a thermoelectric warm discharge plume in Mejillones del Sur bay, (b) a semi enclosed small inner-city fishermen port in Antofagasta city coastline, and (c) Constitución cove, another small countryside fishermen port (Ca. 16 miles Northwest Antofagasta). To understand the phenomena and get close to a risk assessment of the fact, we conducted population size/sex, body size/weight characterization, mark recapture, and radiotracking/TDR device utilization to explain liaison and/or utilization of such warmer areas by sea turtles. At the beginning we hypothesized that sea turtles may get trapped in such warmer spots due to their ectothermic conditions, later on we moved to the belief that sea turtles are using it as a mechanism of thermoregulation while exploiting colder foraging areas in the surroundings. Our results show that algal specific proportions are significantly different among the three sites. Main food items, *Ulva* and *Gracilaria* showed significant energy density differences between (a) and (c) and are absent in (b) where sea turtles feed mainly on fish and mollusk flesh from fish market leftovers. Recaptured individuals 3 – 7 months later showed good body condition. TDRs and radio tracking equipped sea turtles at (a) indicates that a warm water plume may be a body heat source to exploit colder foraging sites and increase their metabolic efficiency while in the area. We also describe standard diving patterns and daily/behavior schedules of two individuals. Population structure suggest that Mejillones Peninsula has become the foraging grounds for juvenile immature (42%), subadults (24%) coming from oceanic currents, as well as adults (34%; >670 mm SCLn-t, according to Green (1994), from their inter-reproductive migratory cycle. During the study we faced several environmental problems, from oil spills, sea turtles injured by boat collisions and positive buoyancy syndrome, to sea lion attacks on sea turtles. A risk assessment and conservation measurements have been elaborated to ensure survival of sea turtle species temporarily present in the area. *Acknowledgements*: Symposium participation was possible thanks to generous donations by several organizations (Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and Fish and Wildlife Service), the

Sea Turtle Symposium and the Universidad de Antofagasta through its Ocean Resources Faculty and Central Research Unit.

PRESENCE OF THE LOGGERHEAD SEA TURTLE IN CAHUITA NATIONAL PARK, 26 YEARS AFTER ITS CREATION

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The project took place in the marine area of Cahuita National Park (CNP), located on the southeastern Caribbean coast of Costa Rica (82° 49 E, 09° 45 N). This park has the largest and most important coral reef area of the country (600 ha) and is an important feeding and developmental area for three species of sea turtles: *Caretta caretta*, *Eretmochelys imbricata* and *Chelonia mydas*. This protected area was created in 1970, and in its declaration the loggerhead is included in the existing sea turtle species; however, no scientifically validated nesting or sightings have been recorded since. In 2004 the remains of an adult specimen were found in the sector of Puerto Vargas. During September and October of 2005 and 2006, observations were made by setting up entanglement nets in various parts of the reef and by monitoring using transects and reef surveys. Two juvenile individuals were identified in Liki Shoal (Puerto Vargas) in 2005, and one other individual was observed both seasons in Punta Cahuita, where it possibly resides. In 2006, one adult male was captured and tagged at the same site, while another identified loggerhead, possibly a female was observed nearby the capture area. The physical condition of the animals was evaluated and the habitat where they were found was described. One of the captured turtles had tags that were placed during the 2005 season in Pearls Cays in Nicaragua. This and other observations not only prove the presence of *C. caretta* in CNP, but also suggest ecological links between the coral reef systems of Nicaragua and the south Caribbean of Costa Rica.

GREEN SEA TURTLES (*CHELONIA MYDAS*) OF THE EVERGLADES NATIONAL PARK: HABITAT ASSOCIATIONS AND GENETIC ANALYSES

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Everglades National Park (ENP), USA, is an ecosystem of internationally recognized importance home to many endangered and threatened species, including green sea turtles. The Park has been designated an International Biosphere Reserve, a World Heritage Site, and a Wetland of International Importance in light of its ecological significance. However, relatively little is known about the ecology of sea turtles in the coastal Everglades. We therefore recently initiated a comprehensive program focusing on mark-recapture, satellite tracking, foraging ecology, health, and genetic research in the Big Sable Creek complex (BSC) of the ENP on the southwest Florida coast. Thus far, we have recorded subadult green sea turtles (*Chelonia*

mydas) ranging from 10 to 60 cm carapace length in an unusual habitat—mangrove tidal creeks. We collected GPS coordinates of 36 different green sea turtles sightings. Many of these have been in isolated and shallow headwater regions of tidal creeks, approximately two kilometers from the Gulf coast. We mapped habitat features in the BSC tidal-creek complex, including submerged algal-covered logs that are remnants of old red mangroves (*Rhizophora* mangle) and clear, salt-water seeps. In a GIS analysis, we then overlaid the locations of the sea turtle sightings on these habitat feature maps to assess fine-scale associations of turtles and their habitats. As well, we took straight and curved carapace measurements, affixed inconel flipper tags, inserted PIT tags, and sampled for genetic analysis. Genetic samples collected from these turtles are being sequenced at the mtDNA control region and genotyped at microsatellite loci. We plan to elucidate levels of genetic differentiation between the ENP and other Atlantic populations, as well as among temporal periods at the study site, and the natal origins and dispersal patterns of these turtles. We present preliminary results of these analyses in this poster.

ECOLOGY OF THE LOGGERHEAD TURTLES LIVING IN COASTAL WATERS OF JAPAN

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North Pacific loggerhead turtles were considered spending years in the offshore waters along the Pacific coast of California, USA and Baja California, Mexico before return to Japanese waters for reproduction. Studies concerning loggerheads were related to nesting females, their eggs and hatchlings. On the other hand, there was very little information about oceanic turtles. Furthermore, even size distribution of those around the coastal waters of Japan was not cleared. There are two ways to investigate turtles around Japan; examination of stranded turtles and examination of captured turtles. In this study, we investigated 693 loggerhead turtles incidentally captured in three-pound nets around Cape Muroto, Shikoku, to clarify the ecology of the loggerhead turtles living in coastal waters of Japan. Their standard straight carapace lengths (SCL) were measured by a caliper from July 2002 to June 2006. SCL histogram shows uni-modal distribution with a modal range between 740-760mm (751mm±68.3 (SD), range: 563-1050mm). This value was larger than that of the North-Eastern Pacific, which is known to be a major nursery ground for loggerhead turtles breeding in Japan, and smaller than that of nesting females in Japan. This indicates that captured turtles in Japan include immature turtles and that these turtles (SCL>563mm) could return to Japan before reaching maturity. Additionally, turtles were captured all year round. At this point, turtles with SCL over 832mm (i.e. average of Minabe, one of the major nesting beaches in Japan) were considered mature ones. The majority of them were captured from April to September, especially from May to July. This period coincides with the nesting season in Japan.

THE FIRST RECORDS OF SEA TURTLE STRANDINGS IN SYRIA: INDICATIONS OF SYRIA'S YEAR ROUND IMPORTANCE FOR ADULT AND JUVENILE SEA TURTLE POPULATIONS

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Results from the 2004 nesting season confirmed that a beach near Latakia in Syria was an important nesting site for green turtles in the Mediterranean and a study from the winter of 2005 on the interaction between fisheries and sea turtles in Syria indicated that fishermen regularly encounter turtles of both species (loggerhead and green) that nest in the Mediterranean. In continuation of these efforts, the northern coastline of Syria has been regularly surveyed to record stranded turtles. Several additional at-sea observations were made from boat patrols in the shallow near-shore region. Date, location, species, curved carapace length and width, and cause of death (if determined) were logged for stranded turtles together with photographic records of each encounter. Turtles were spray-painted to avoid duplicate records of the same stranded individual. Species and estimated size class (juvenile [CCL=25-40cm], medium [CCL=40-65 cm] or adult) were recorded for at-sea observations. Results presented here are from surveys between January 2005 and July 2006 and provide strong indications as to Syria's importance for sea turtle populations in the Mediterranean. In total, 156 turtle strandings were recorded, comprising 123 [78.8%] green turtles and 33 [21.1%] loggerheads. Of the green turtles; 23 (18.7%) were adult females, 44 (35.8%) were medium size and 56 (45.5%) were juveniles. Of the loggerhead turtles; 15 (45.5%) were adult females, 14 (42.4%) medium size and 4 (12.1%) were juveniles. In 2005, eleven turtles were recorded between January and March, 33 turtles between April and June, 33 turtles between July and September and 17 turtles between October and December. Certain key facts can be taken from these findings: 1, all size classes of both species of sea turtle that nests in the Mediterranean occur in Syrian coastal waters. 2, sea turtles of both species occur year-round in Syrian waters. 3, the large number and density of stranded turtles indicate important foraging turtle populations; in addition to the large nesting aggregation. 4, this large number of strandings also indicates the high level of threats facing turtles in Syria's coastal waters, with fishing being a major contributor to turtle deaths. 5, a most alarming finding was the continuation of deliberate killing of adult females during their nesting emergences on the beach at Latakia; something first reported from the 2004 nesting season. These results prove that, in addition to its significant nesting beaches, Syrian coastal waters should be considered regionally important areas for foraging sea turtles and require the application of full and proper conservation measures to protect the populations present. Acknowledgements: The survey boat was purchased through an award to MJ from Ford – Middle East. The work was supported by a grant from the Marine Conservation Society, Turtle Conservation Fund. We thank Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, US Fish and Wildlife Service and the Sea Turtle Symposium for travel grants to attend the Symposium. AFR additionally thanks the Total Foundation for sponsorship to attend the Symposium.

ESTIMATING OF MALE POPULATION OF BLACK SEA TURTLE IN MICHOACAN

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During 2004, we carried out a study to estimate the male population of black sea turtles in Michoacan. We made 30 capture-recapture events with males during mating and courtship in front of Colola waters with outboard boat. Using a capture-recapture Shnabel method we estimated 565 males of black sea turtle (+-255-1200). With this information we estimate too, the sex ratio in reproductive population and the operative sex ratio, we estimate also the aggregation index of males in front of Colola beach using the morisita method. This information suggests that the male population have a gregarious behaviour in the west side of the beach where it is more common to observe courtship and mating activity of black turtle in the first 100 m in front of Colola beach.

IN-WATER SURVEYS FOR SEA TURTLES IN TWO NATIONAL PARKS OF THE DOMINICAN REPUBLIC

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Since 1996, in-water sea turtle research in the Dominican Republic has been conducted exclusively in the area of Jaragua National Park in the southwestern part of the country. Beginning in 2005, we started conducting in-water surveys by boat and snorkelling transects in Montecristi Underwater National Park and del Este National Park, in northwestern and southeastern Dominican Republic, respectively. Turtle captures were performed using the rodeo technique for shallow areas and hand capture by divers in coral reef areas. Immature hawksbill and green sea turtles were found in seagrass beds and coral reef habitats. Captured turtles ranged in size from 24.6-55.6 cm curved carapace length (n = 13). Although sighting frequency (particularly for Montecristi) was much lower than in our main study site at Jaragua, the juvenile aggregation at Saona Island (del Este National Park) showed many interesting features. Particularly noteworthy, was the presence of hawksbills in a very shallow (less than 1m) seagrass bed area in southeast Saona Island. Distribution of sighted turtles, sighting frequencies, habitat observations, threats, and conservation opportunities are reported and discussed.

ABUNDANCE, DISTRIBUTION, AND CONDITION OF GREEN SEA TURTLES (*CHELONIA MYDAS*) AROUND ST. CROIX AND ST. THOMAS, UNITED STATES VIRGIN ISLANDS

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Three species of sea turtles are commonly found around the United States Virgin Islands. Leatherback sea turtles (*Dermochelys coriacea*) migrate to nest on St. Croix while green sea turtles (*Chelonia mydas*) and hawksbill sea turtles (*Eretmochelys imbricata*) are observed year round. Nesting behaviors of all three species have been studied in several locations around St. Croix. However, little has been done to assess the foraging population of sea turtles around the territory. The purpose of this study was to assess the foraging population of green sea turtles around the islands of St. Croix and St. Thomas. The study was also designed to characterize the health and habitat of green sea turtles through a survey of their abundance, distribution, and physical condition. Additionally, because fibropapilloma has been recently detected on turtles in the Caribbean, the presence of the virus on sampled turtles was also documented. Ten sites were sampled around the island of St. Croix and three on the island of St. Thomas. The following observations were made: 1) the presence of external flipper tags, 2) curved and straight carapace length and width, 3) straight plastron length and width, 4) damage to the carapace, 5) other injuries, entanglements, and/or scars, 6) carapace fouling, and 8) the presence of epithelial fibropapilloma lesions. A digital photograph log was created for each turtle and used to later quantify condition. No green turtles were caught around the island of St. Croix during the summer or winter of 2005. Thirteen green turtles were caught around St. Thomas during the summer and 28 during the winter. More turtles were caught at Brewers Bay during both sampling periods. The juvenile/adult ratio was 8:5 during the summer and 20:8 during the winter. In the summer, all nine turtles caught at Brewers Bay had some degree of carapace damage and one had an abnormal scute pattern. One of the three turtles caught at Buck Island in June had carapace damage and the one turtle caught at Water bay did not have any damage to its carapace. In the winter, twelve of the 14 turtles caught at Brewers bay had carapace damage and three turtles had abnormal scute patterns. One turtle had only three flippers and one had a hook lodged in its mouth. One of the four turtles caught at Buck Island and three of the ten turtle caught Water bay had carapace damage. One turtle caught at Water bay in December had algal growth on 31.9% of its carapace. No turtle caught throughout the study had any visible fibropapilloma lesions. Net avoidance was the most important factor in the poor capture rate around St. Croix. Green turtles around St. Thomas reacted passively to net capture, which is most likely because net fishing is more popular on St. Croix. While this study has begun to answer some questions about foraging green turtles, it has asked some others. In the future, more in-water work will be needed to further understand how sea turtles utilize foraging areas.

POPULATION ASSESSMENT OF SEA TURTLES IN THE LAKE WORTH LAGOON

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The Lake Worth Lagoon (LWL) is a 20-mile long body of water located just west of the Atlantic Ocean along the coast of Palm Beach County, Florida. The lagoon was historically a freshwater lake, but it has been severely altered by human activities since the late 1800's. Today, the LWL is a moderately polluted estuary and is the site of extensive environmental enhancement. Five species of sea turtle have been reported in the LWL, largely from stranding reports and anecdotal observations. This study seeks to characterize the size, diversity, and health of the LWL *Chelonia mydas* (green; CM) and *Caretta caretta* (loggerhead; CC) populations using a combination of netting activities and visual transects. Seven three-day, quarterly sampling events have been conducted since March 2005. These events have yielded 34 captures (33 CM and 1 CC) during 45 net sets, for an overall Catch Per Unit Effort (CPUE) of 2.51, and over 150 sea turtles sightings on 179 km of visual transects. Straight carapace length (SCL) averaged 42.6, and ranged 29.8 – 54.9 cm. Moderate or severe cases of fibropapillomatosis (FP) have been documented in 63% of the captured CM. Sightings, captures, FP rates, and FP severity were higher during the winter sampling months, while SCL was highest during the summer. The seasonality of captures and sightings, CPUE, FP rate, and SCL range are all similar to sampling sites in the Indian River Lagoon (IRL), a well-documented sea turtle developmental habitat located 50 km north of the LWL. Though more data is needed, based on these preliminary comparisons, the LWL likely also functions as an important developmental habitat for juvenile green sea turtles.

AN ASSESSMENT OF SEA TURTLE ASSEMBLAGES IN TEXAS ESTUARIES

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The Sea Turtle and Fisheries Ecology Research Lab (STFERL) at Texas A&M University - Galveston has documented sea turtle occurrence in shallow, offshore waters of Texas since 1991, but little is known about constituent assemblages in adjacent estuaries. Recovery of endangered species like the Kemp's ridley (*Lepidochelys kempii*) depends, in part, on a comprehensive examination of sea turtle use of Texas coastal habitats that relies on in-water data to: document spatial/temporal occurrence; identify essential habitat; assess potential fisheries and non-fisheries threats to survival; and revise outdated recovery plans. STFERL is conducting entanglement netting surveys to assess sea turtle species composition, abundance and distribution in five Texas estuaries - 1) Upper coast: Sabine Lake and Galveston Bay; 2) Mid-coast: Lavaca/Matagorda Bay; and 3) Lower coast: Aransas Bay Complex and Lower Laguna Madre - during 2006-07. This assessment relies primarily on determining relative abundance of sea turtles as measured by catch-per-unit-effort (CPUE = # of turtles/km-hour of netting). The current surveys along with historical sampling by STFERL in the Lower Laguna Madre (1991-94; 2002-03) and Lavaca/Matagorda Bay (1996; 2001-02) provide additional CPUE data with which to assess population trends across time. Entanglement netting during May-August 2006 yielded 36 sea turtle captures, all from mid and lower coast estuaries. Green

(*Chelonia mydas*: 27), Kemp's ridley (8), and loggerhead turtles (*Caretta caretta*: 1) comprised these captures. Green turtles dominated seagrass habitats of lower coast estuaries while mid coast counterparts primarily yielded Kemp's ridleys. CPUE from the lower Laguna Madre and Lavaca/Matagorda Bay in 2006 was approximately three times higher than the overall mean CPUE for previous years in these locations. Recapture of tagged turtles during the 2007 field season will enable assessment of growth and residence trends for estuarine-dependent life stages. Plans for 2007 also include sampling a wider array of habitats and more randomization of netting locations in selected estuaries to generate better population estimates and maximize information retrieval opportunities.

PRELIMINARY RESEARCH AND CONSERVATION OF SEA TURTLES ALONG VALIZAS-CABO POLONIO FORAGING AREA IN URUGUAY

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Valizas-Cabo Polonio is one of the most southerly study sites for juvenile green turtle (*Chelonia mydas*) feeding areas along the South-western Atlantic Ocean. The area is located in the Rocha department (34º 20´ S; 54º 47´ W) covering over 53 km² of a marine-coastal ecosystem, which includes 17 km² of mainland and 36 km² of marine surface. This area which is part of the "Eastern Wetlands and Coastal Fringe" Biosphere Reserve, and also a RAMSAR site since 1982, has recently been proposed as the second coastal-marine protected area of the country. Its geomorphologic and biological characteristics such as rocky shores with abundant seaweed beds and forage material make the Valizas-Cabo Polonio coastal-marine area a relevant feeding and developmental habitat for juvenile green turtles. During the summer months of 2005 and 2006, juvenile green turtles were captured along the study area, using an entanglement net. Each individual was measured and tagged in both front flippers. Monthly censuses were conducted along 105 km of the coastline from, from Punta del Diablo (45 km to the North) to La Paloma (60 km to the South). Necropsies of dead stranded sea turtles were carried out searching for cause of death. All the research activities were accomplished with education and conservation activities with Valizas and Cabo Polonio communities. A total of 22 juvenile green turtles were captured. Curved carapace length (CCL) of the turtles ranged from 31.9 – 50.9 cm (mean = 38.5 cm, SD =5.1).Three recapture events were confirmed, one of them was an individual tagged in Valizas, captured eight months later in Espiritu Santo – Brazil (2250 km away), being an evidence of migratory behavior. The other two were recaptured in the study area, one was tagged in Cerro Verde (52 km North) eight days before, and the second individual was tagged and recaptured in a period of fourteen days in the same area Valizas-Cabo Polonio. A total of 50 stranded sea turtles were found during the beach surveys, being 19 green turtles ranging from 29.5 – 56.6 cm (mean = 40.0 cm, SD = 7.7), 25 loggerhead turtles ranging from 51.2 – 83.1 cm (mean = 64.2 cm, SD = 9.2) and 6 leatherbacks ranging from 129.0 – 155.0 cm (mean = 143.6, SD =10.0). Anthropogenic debris was found in the stomach contents of two green turtles. The lethal and sub-lethal effects of this debris still remain unknown. Evidence of drowning due to incidental capture in fishing gear was recorded in 5 loggerheads and 3 green turtles. No cause of death was determined in the rest of the individuals due to high putrefaction state. However, it is estimated that fisheries may be killing a higher number than the evidenced in the survey. Education and conservation activities with the local communities (workshops with fishermen, activities at local schools, beach cleaning with tourists and locals, etc) conducted in previous years enable us to develop all the described activities with the great support of the locals from Valizas and Cabo Polonio.

A COMPARISON OF SARASOTA COUNTY, FLORIDA, SEA TURTLE STRANDINGS IN 2005 AND 2006, TWO CONSECUTIVE RED TIDE YEARS

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Mote Marine Laboratory's Stranding Investigations Program is responsible for responding to calls regarding stranded (sick, injured, or dead) sea turtles in Sarasota County, Florida. Over the last 14 years, we have responded to over 800 sea turtle strandings along the central southwest coast of Florida, with an average of 39 sea turtle strandings per year through 2004. The years of 2005 and 2006 presented more than a three-fold rise in sea turtle strandings in Sarasota County, as two distinct Red Tide blooms affected our waters, one in 2005 and one in 2006. *Karenia brevis*, a dinoflagellate, is a naturally occurring organism in the Gulf waters off the southwest coast of Florida and is responsible for local "Red Tide" blooms. While background levels of this organism generally remain under 10,000 cells/liter, concentrations above 100,000 cells/liter result in fish kills and are considered a substantial bloom. *Karenia brevis* produces the neurotoxin, brevetoxin, and this toxin has been shown to cause morbidity and mortality in marine animals and sea turtles. In both 2005 and 2006, *Karenia brevis* levels in Sarasota County coastal waters reached in excess of 5,000,000 cells/liter of water, causing fish kills and murky coastal waters. Coinciding with these blooms was a substantial increase in sea turtle strandings along the central southwest Florida region. In 2005, the Stranding Investigations Program far surpassed the average of 39 sea turtle strandings per year, responding to a total of 174 stranded sea turtles, and as of December 5, 2006, we have responded to a total of 146 sea turtle strandings for the year of 2006. In this poster, we will compare and contrast the sea turtle strandings responded to in the years of 2005 and 2006, two consecutive Red Tide years, with respect to species, size, and location of the stranded sea turtles.

SHIFTS IN SIZE DISTRIBUTIONS REVEAL LONG-TERM POPULATION SHIFTS IN US LOGGERHEADS

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Over the last six years the number of nesting female loggerhead sea turtles (*Caretta caretta*) has been decreasing in Florida. This is in contrast to the previous decade, when the nesting population appeared to have a positive trend of 4% per year. Has a new threat emerged or is this the result of something that happened to the turtles in years past? We have taken a new broad scale approach to address these questions by analyzing shifts in the size distribution data for the Atlantic population of loggerheads. We compiled several datasets from both fishery dependent and fishery independent sources that span up to 30 years. These include strandings data for the US Atlantic and Gulf coast, incidental captures in the St. Lucie, Florida power plant intake canal and several fisheries datasets. By utilizing data from various sources, ranging from direct fisheries take to those completely independent of fisheries, and considering issues such as shifts in sampling effort and selectivity, we can identify consistent patterns in loggerhead size distributions that can be attributed to human-induced mortality. Our approach allows us to identify shifts or patterns in size distribution that may provide insight into the population trends we are observing on the beaches today. Initially we have observed that there are holes in the

normal distribution of sizes during certain time periods over the past 30 years. For example, data from the St. Lucie power plant and strandings both show a marked shift to a bi-modal distribution in the late 1980s. Our next step will be to compare the observed size patterns with major fisheries changes and management decisions. By fitting the size data to a timeline of fishing pressure and changes in management we can better understand potential causes of the recent decline in loggerhead nesting.

AN ANALYSIS OF SIZE FREQUENCIES OF LOGGERHEAD TURTLES AND COMPARISON BETWEEN HISTORICAL STRANDINGS AND RECENT IN-WATER COLLECTIONS FROM THE SOUTH CAROLINA COAST

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Data on location, size and species of sea turtle strandings have been consistently monitored for the South Carolina coast since 1980. A total of 3,821 loggerheads stranded between 1980 and September 2006. An analysis of the size frequencies of stranded turtles indicates that the percentage of adults (>90 cm) from 1980 to 1989 was about 15%, but increased to about 30% after 1990 when use of Turtle Excluder Devices (TEDs) in the shrimp trawling fleet became mandatory. This suggests that larger turtles continued to be more vulnerable to becoming trapped in shrimp trawls after TEDs were required because exit openings were relatively small. The percentages of stranded adult loggerheads have now decreased consistently in recent years to 10% in 2005 and 2006. This is concurrent with the requirement of leatherback-sized TEDs that more successfully release adult loggerheads. Correspondingly, the overall mean carapace length of beach-stranded turtles declined from 78.9 cm in 2001 to 72.1 cm in 2006. Between 2000-2003, an in-water monitoring survey was conducted to collect sea turtles with thirty-minute trawl tows during late spring and summer. Eight hundred and twenty-six loggerheads were collected in 2,621 sampling events. Sampling was conducted in the Atlantic Ocean between depths of 4.6 and 12.2 m from Georgetown, SC to St. Augustine, FL. In sampling off South Carolina, 285 loggerheads were captured in the in-water study in 1,244 sampling events. Various morphometric and weight measurements were taken in addition to blood samples that were used for sex determination using radioimmunoassay techniques. Historical, limited in-water data on sea turtles are also available from an observer study on shrimp trawlers in 1976 and 1977 and the SEAMAP nearshore monitoring project (1989-2005). Length frequency data from the 2000-2003 in-water study yielded a single mode (70-79 cm). However, length frequency data for stranded turtles (2000-2003) were bimodal, with a major mode at the same size class as noted for the in-water survey (70-79 cm), and a second smaller mode at 100-109 cm. The other historical in-water data also indicate a unimodal distribution of size frequencies although the mode was smaller (60-69 cm). The bimodal distribution in stranded turtles further supports the conclusion that larger turtles were more at risk than juveniles both before and after TEDs were required in 1990. The results of this analysis suggest that use of size frequencies obtained from strandings data are probably not adequate for assessing the true size distribution of the local population if a fishery or other activity may be causing disproportionately higher mortality rates in certain size classes.

GREEN TURTLE HERDS PARTITIONED BY SIZE/AGE INTO ADJACENT GRAZING HABITATS OF THE MARQUESAS KEYS, FLORIDA USA

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This presentation describes respective aggregations of small (27—56 cm SCL) and large (69—109 cm SCL) green turtles grazing separately in adjacent seagrass habitats. We studied this size-class partitioning in waters near the Marquesas Keys, a ring of islands between the Atlantic Ocean and the Gulf of Mexico, north of the Straits of Florida. Several lines of evidence contributed to our hypothesis that waters near the Marquesas were regionally important for multiple green-turtle developmental stages: 1) a historic green turtle fishery had been formerly based out of nearby Key West, 2) fishermen near the Marquesas commonly observed small sea turtles likely to be juvenile green turtles, 3) large juvenile green turtles satellite tracked from northerly developmental habitats had end points near the Marquesas, and 4) adult green turtles have been satellite tracked by other researchers from nesting beaches to waters near the Marquesas. We studied sea turtles near the Marquesas by making hand captures and observations from small vessels conducting haphazard, unmarked, nonlinear, transect (HUNT) searches. These HUNTs took place with two observers in a 2.5-m tower on a 7.4-m, shallow-draft vessel. Our search paths and times were continually recorded by an onboard GPS, which also stored position locations for sightings and captures. Between 2002 and 2006 we sighted 301 green turtles along 376 km of HUNTs. Of these turtles, 60 were captured. There was a significant difference in turtle size (without overlap) between two principal habitat types near the Marquesas. Small juveniles (27.0—55.2 cm SCL, mean=43.1 cm, SD=7.5 cm, n=31) were captured in shallow (predominantly 0.5-1.5 m) waters with dense Thalassia seagrass surrounded by islands and grass flats. Large immatures (subadults) and adults (69.3—108.5 cm SCL, mean=89.5 cm, SD=10.1 cm, n=29) were captured from deeper (3-4 m) waters with patchy Thalassia and other seagrasses open to tidal currents and seas from the Atlantic and Gulf of Mexico. Sightings and captures per unit effort (transect distance) indicate that these habitats are grazed by one of the densest aggregations of green turtles in Florida. The open, deeper-water habitat is unique in the southeastern US for having foraging green turtles of subadult and adult sizes. This open habitat shows signs of extensive green turtle grazing, including abundant floating dung and clearly defined, close-cropped grazing plots. The grazing aggregation in both habitats appears to be distributed in a clustered pattern rather than random. We hypothesize that the small green turtles in the shallow habitat benefit from elevated growth rates due to higher water temperature and that the secluded habitat limits access by large sharks known to prey on turtles in the area.

POPULATION STRUCTURE, MOVEMENTS AND GROWTH RATES OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN PALM BEACH COUNTY WATERS, FLORIDA, USA

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This study represents the first effort to survey Palm Beach County coral reefs (Florida, USA) for hawksbill turtles (*Eretmochelys imbricata*). Individual turtles have been hand-captured at depth using SCUBA, retained on a vessel for the collection of morphometric data, tag placement, photographs, tissue sampling for DNA analysis, and blood sampling for gender determination. A reference library of local hawksbill photographs has been developed to document newly tagged individuals, and the effectiveness of photographic identification is being assessed. Feeding behavior has been documented using underwater digital videography, and food samples identified. Divers aboard local dive charters report sightings when tagged turtles are encountered. To date, 90 hawksbills have been captured and an additional 7 re-captured in 83 dive days (typically 2- tanks). This aggregation consists of primarily juveniles and sub-adults, ranging from 39.5 - 82.3 cm (mean 58.2 cm) straight carapace length. Turtles have been captured within several miles of shore at depths ranging from 1.5 m – 24.4 m (mean 18.8 m). A total of 80 re-sightings have been confirmed for 35 tagged turtles, with a maximum of 9 sightings of one individual over a 833 day period. Of seven re-captures, straight carapace length increased by an average of 2.2 cm/yr. Serum testosterone analyses have revealed a 2.5:1 female:male sex ratio. Location data indicate strong site-fidelity and close association with both natural and artificial coral reef structures. Untagged turtles continue to be reported regularly within the survey area. Satellite telemetry will be tested within the next few months. Preliminary mtDNA sequence data have identified six Caribbean haplotypes represented in this population.

Population Biology and Monitoring – the beach

MIXED MODELS, STATISTICAL POWER AND SEA TURTLE NESTING BEACH SURVEYS. HOW LONG AND WHEN?

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Nesting beach studies continue to be the lynch pin of sea turtle population assessment and trend analysis. They are important socially and politically as well, being visible and accessible points of entry for community and stakeholder involvement. Classical techniques that assume independence of observation are not appropriate for such scenarios and can lead to biased estimates. Mixed models (incorporating fixed and random effects) are useful for modeling observations more akin to real world situations where data are noisy, unbalanced and composed of multiple error terms. We examine the potential of mixed models to provide precision and statistical power comparisons of survey protocols with differing temporal coverage. Knowing the temporal variability in beach attendance is crucial for calculating power and making design decisions. We used mixed models to calculate the size of these components of variability (e.g. day to day, year to year and a year-day interaction) and evaluate how changes to the sampling design affect the ability to detect trends in population numbers. We used data from 17 years of saturation tagging of hawksbills (*Eretmochelys imbricata*) at Pasture Bay, Long Island Antigua to test the statistical power of monitoring designs involving shorter survey periods than the current design of 155 nights each year. There has been virtually no use of mixed models in sea turtle research. Given their appropriateness for the kinds of data generated in recovery and conservation planning for sea turtles, mixed models provide a novel approach to answering sea turtle conservation and management questions.

AN INCREASE IN LOGGERHEAD SEA TURTLE NESTING ACTIVITY IN VIRGINIA: IS THIS A NATURAL TREND OR AN INDUCED PHENOMENON?

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Virginia is the northern limit of the loggerhead sea turtle (*Caretta caretta*) nesting range on the U.S. Atlantic coast. As many as eight to ten nests have been documented in a single breeding season and the majority of reported nests occurred on the state's southern mainland beaches. From 1969 – 1979, Cape Romain National Wildlife Refuge, Charleston County, South Carolina engaged in an experimental egg translocation program during which 226 nests (23,309 eggs) were moved from Cape Island and relocated to three mid-Atlantic national wildlife refuges: Pea Island NWR (PINWR), Dare County, North Carolina (55 nests, 5,675 eggs, range of years=1972–1978); Back Bay NWR (BBNWR), City of Virginia Beach, Virginia (78 nests, 7,315 eggs, range of years=1972–1979); and the southern half of Assateague Island which is owned

and managed by Chincoteague NWR (hereafter referred to as CNWR), Accomack County, Virginia (93 nests, 10,319 eggs, range of years=1969–1979). The goal of this project was to extend the U.S. Atlantic loggerhead's breeding range to what was then considered its historical northern limit by translocating eggs to federally protected beaches that were physically and ecologically similar to southern sites with well-established nesting populations. This objective was based on rare observances of nesting activity as far north as New Jersey prior to the initiation of the study. Hatch success rates (i.e., percentage of hatchlings that emerged from translocated eggs and subsequently entered the ocean throughout the study period) at the translocation sites varied (PINWR=62%, n=3,509 hatchlings; BBNWR=76%, n=5,577 hatchlings; CNWR=55%, n=5,703 hatchlings) and was correlated with the stage of incubation when translocations occurred and to a lesser extent the geographic distance between Cape Island and the translocation site. Although natural nests were documented at all three translocation sites prior to the study, they occurred with far greater frequency at PINWR and BBNWR. Based on preliminary review of the study's reports, nesting attempts at CNWR were extremely rare (annual mean=0.73 nests, SD=0.79) during the project period. In 2006, CNWR had a total of 7 nests, the highest number reported at CNWR to date. Moreover, the annual mean between 2002 and 2006 increased to 2.6 nests (SD=2.97). Loggerheads exhibit high natal site fidelity and are estimated to reach sexual maturity between 30 and 35 years of age, which coincides with the number of years between the aforementioned increase in nesting activity and the initiation of the translocation project in 1969. In this poster we address the question of whether the observed increase may be the result of past translocation efforts, a natural expansion of the nesting range because of greater protection afforded the species since its federal listing in 1978, or a product of other factors such as increased monitoring or climate change.

NESTING SUCCESS RATES OF LOGGERHEAD (*CARETTA CARETTA*) AND GREEN TURTLES (*CHELONIA MYDAS*) AT THE ARCHIE CARR NATIONAL WILDLIFE REFUGE, BREVARD COUNTY, FLORIDA – SECOND YEAR FOR ENGINEERED DUNES

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The Archie Carr National Wildlife Refuge (ACNWR) is a globally significant nesting beach for loggerheads and green turtles. In 2006, a total of 9,018 loggerhead nests and 1,382 green turtle nests were laid within the 21 km of the ACNWR that the University of Central Florida Marine Turtle Research Group (UCFMTRG) monitors. Since establishment of the refuge in 1990, armoring (sea walls, groins, and rock revetments) has been prohibited, resulting in a "natural" beach for nesting marine turtles. In 2005, engineered dunes were constructed to replace the dunes destroyed by the 2004 hurricanes. The 2005 marine turtle nesting season resulted in an increase in nest production compared to 2004; however, the nesting success rates (number of nests over the total number of crawls) were significantly lower than nesting success rates of 2004. In 2006, the engineered dunes were re-shaped to create a gradual slope and to reconstruct damaged dunes from the storms of 2005. Marine turtle nesting activity was monitored again during the 2006 nesting season within the ACNWR by UCFMTRG. Nesting success rates for the engineered dunes and natural beach were determined for loggerheads and green turtles, and compared to the 2005 and 2004 nesting success rates. Compared to the 2005 nesting success rates, the 2006 rates were higher and were similar to the "natural" 2004

nesting success rates. It appears that the more gradual slope that characterized the template of the 2006 engineered dunes is more conducive to marine turtle nesting.

SEA TURTLE HATCHLING PRODUCTION FROM FLORIDA'S BEACHES 2001-2005: ANNUAL PRODUCTION AND SOURCES OF MORTALITY

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The Florida Fish and Wildlife Conservation Commission conducts two marine turtle nest monitoring programs: the Statewide Nesting Beach Survey (SNBS) and the Index Nesting Beach Survey (INBS) programs. The SNBS program allows for the documentation of the total distribution, seasonality and abundance of sea turtle nesting in Florida. The INBS program is complementary to the SNBS program, and was established to measure trends in population abundance. The collection of nesting data for both programs is accomplished through a network of permit holders who monitor 190 beaches, covering approximately 1300 km each year. From data collected through these two programs, we measured loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*) hatchling production from Florida beaches between 2001 and 2005 using seventeen sampled beaches from around the state. Following a common protocol, researchers at each site conducted nesting surveys and inventoried a spatially and temporally representative sample of the nests for hatchling production. Sample nests were inventoried to measure hatching success (hatched eggs/total eggs) and emergence success (hatchlings that emerged from the nest/total eggs). Both nesting beach and year had significant effects on the variability in loggerhead hatchling production on Florida beaches. Through analysis of the nest productivity data, we were able to estimate how many hatchlings were produced on Florida beaches during that period, and to identify egg/hatchling mortality factors on Florida beaches. Nest predation and erosion from storms were identified as two principal sources of nest mortality in Florida that varied by beach and year. Because Florida has the largest number of loggerheads nesting in the Western Hemisphere and significant numbers of nesting green turtles, hatchling production is important for both management and recovery planning.

DEMOGRAPHY OF FEMALE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) ON BLACKBEARD NWR

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Female loggerhead sea turtles (*Caretta caretta*) were studied on Blackbeard National Wildlife Refuge beginning in 2001 through the end of the 2006 nesting season. The nesting season generally occurs from May until August. Efforts are made to protect their nests from depredation and inundation in order to increase hatching success. Females reach sexual maturity between ages 25 and 35. The incubation period for loggerheads in Georgia is ~60 days. This is somewhat variable due to temperature. Sex determination for hatchlings is also temperature

dependent. Approximately 134 nests were deposited in 2001; 177 in 2002; 213 in 2003; ~30 in 2004; 196 in 2005; and 227 in 2006. Fifty four identified nesting females were observed in 2001; seventy five in 2002; eighty five in 2003; zero in 2004; seventy six in 2005; and eighty in 2006. Of these females, they were observed to nest from one to six times on Blackbeard Island during a season. However, a female may nest on different beaches within a single season. Nesting trends, including remigration rates, internesting intervals and fecundity rates were measured. The mean remigration rate is 3.02 years for 41 females observed; 61% nested at three year intervals. Each female that nested was measured, identified by inconel and PIT tags, and divided into appropriate size classes. The distribution shows that this population is composed mostly of medium to large adults. Recruitment rates will be discussed and well as general demographic patterns for the Georgia nesting population.

COMPARING CHANGES IN HATCHING SUCCESS OF GREEN AND LOGGERHEAD SEA TURTLES IN BOCA RATON, FL

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Since 1990, the Boca Raton Sea Turtle Program has collected nesting and hatching data for every nest on all five miles of Boca's beaches. This data includes nest location, incubation time, disturbances, and post-hatching counts of all hatched and unhatched eggs in each nest. Field observations suggest that the percentage of unhatched eggs per nest has increased since 1990, and preliminary data analysis of all undisturbed nests for all years support this observation. Hatching success is affected by the temperature, moisture, and gas exchange in the nest, and may also be affected by the nutrition, health and contaminant load of nesting females. My research will examine hatching success as percentage of unhatched eggs per nest for both green and loggerhead sea turtles. I will look at trends for each species individually and will also compare trends between the two species. My hypothesis is that hatching success is decreasing over time, and that this decrease is the result of population-wide effects, rather than the local nesting environment. Boca's beaches are divided into ten zones (A-J) that encompass a wide variety of nesting habitats. Given these differences, one would expect to find significant differences in hatching success for both species for each zone. If nesting success is decreasing for all zones in a similar manner, one can conclude that this decrease is the result of population-wide effects rather than local nesting conditions. If hatching success varies significantly for each zone and shows both increased and decreased success, one can conclude that hatching success is the result of nesting beach conditions. A significant difference in hatching success between loggerhead and green sea turtles may suggest that diet or nesting habits are influencing hatching success. This observational study will not single any one nesting mechanism, local or population-wide, that is impacting hatching success, but will report area trends that may guide future research.

THE IMPORTANCE OF LOCAL COMMUNITIES ON TURTLE NESTING SUCCESS: THE CASE OF THE KUNAS FROM SOUTHEAST PANAMA

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The protection of the nesting beaches is one of the most important factors that contributes to sea turtle conservation. During the nesting season of 2006, several beaches between Panama´s border and Uraba Gulf in Colombia were survey by boat. We discovered the importance of Armila as a nesting beach in the Caribbean for leatherback sea turtles (*Dermochelys coriacea*). This beach is situated at 8º39´48.9´´N and 77º 26´54.7´´W, about 15km north of the Colombia-Panama's border, and it belongs to Kuna indigenous territory. This region appears to be optimal for nesting. There is no female or egg exploitation by the native community and there is no depredation by domestic animals. Kuna seems to be very conscious and respectful with nature and conservation of their environment and consider that any damage to a single turtle (including eggs) can negatively affect their ability to find and use natural resources in a sustainable way. All people in the community participate in the protection of turtles and their authorization to conduct our survey was discussed and accepted by all members of the community in the daily evening meeting where they decide their common future. With their help, we recorded a high density of turtle tracks on Armila beach with estimated values between 4,000 and 4,400 in only 5 km of beach between April and late June of 2006. Moreover, we have estimated a very high natural nest survival of 66%. This value is significantly higher than those found on close nesting beaches. For example, in 2006 at Playona (Uraba Gulf), which is together with Acandi the most important leatherback nesting area in Colombia, there was no survival at all (0%). However, this beach had a density of 195 nests and 70 females per kilometer in a study area of 3 km. At Playona, the most important cause of nest lost was from domestic predators and poaching. In contrast, on Acandí situated only 1 km from Playona, we found a nest survival of 69%, nest density of 508 and 181 females per kilometer, in 2.2 km length beach. There were occasional or sporadic nesting at other beaches on the Uraba Gulf with very low density values. In Armila, most nests remain undisturbed and average hatching success was 72% in natural nests. The main impacts on nests on Armila and Acandí were beach erosion and nest flooding. We show a rare case and a perfect model of the conservation and management of nesting beaches, which is possible in ancestral communities, like the indigenous Kuna, that maintain their ancestral social organization. So, Armila in the southeast of Panama, together to Acandí and Playona in the northwest of Colombia, would be one of the most important leatherback conservation and nesting areas in the entire Caribbean area.

MARINE TURTLE ACTIVITIES IN MOZAMBIQUE

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The Mozambican coast hosts five of the world's seven species of marine turtle. The northernmost section is the hotspot for green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*) and olive ridley turtles (*Lepidochelys olivacea*). Five species occur in central section: loggerhead, green, leatherback, hawksbill and olive ridley turtles. The most common species that nest in the area is the loggerhead. Finally, the southern

section is an important breeding site for two species, the loggerhead and leatherback turtles. Natural causes threaten the marine turtle populations in Mozambique, including predation of hatchlings, beach erosion, and the increasing impact of human activities. Among the threats are loss and degradation of nesting areas and inter-nesting and foraging habitats, overexploitation of eggs, meat, carapaces ("tortoiseshell") and other products, incidental capture by and subsequent drowning in trawls and gillnets, as well as other fishing gear and pollution. The close proximity of coastal dwellers causes turtles to be vulnerable on shore and in coastal waters Apart from the survey carried out by Hughes in the 1971 and the current work in Maputo, Gaza, Inhambane, Nampula and Cabo Delgado, very little is known regarding the situation of marine turtles in Mozambique. However, some efforts are currently underway to protect turtle nesting areas in the country, mostly in the southern parts of Mozambique. The tagging programme is now coordinating six tagging and nest monitoring projects in southern section (Maputo Special Reserve, Biodiversity Conservations, and Sustainable Development Project in Macaneta), central section (Bazaruto National Park and Vilanculos Coastal Wildlife Sanctuary - São Sebastião) and finally in the northern section (Primeiras and Segundas Islands and in the Quirimbas National Park) of the country.

UP & UP: PROGRESS IN THE RECOVERY OF THE HAWKSBILL POPULATION NESTING ON MONA ISLAND, PUERTO RICO

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Mona Island, Puerto Rico, harbors the largest hawksbill turtle breeding colony under U.S. jurisdiction. During the past ten years, nesting activity on the island's beaches has risen over 400% to levels exceeding 1,000 nests. Potential factors contributing to this large increase include: regional measures taken to reduced trade in hawksbill products, a reduction in Cuba's managed turtle harvest, and reduced abundance of top-predators. Locally implemented measures such as pig fencing erected on Mona Island designed to reduce turtle nest loss, plus increased vigilance to reduce turtle poaching can be credited with having the greatest impact on promoting growth of the hawksbill population. The results of over fifteen years of monitoring the Mona Island beaches for hawksbill nesting activity are presented and compared with the population trends reported for several other important breeding areas for hawksbill turtles in the Caribbean Sea. Further steps required to ensure the recovery of this species are discussed.

STOCHASTIC MODEL FOR THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) TORTUGUERO NESTING POPULATION, COSTA RICA

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The leatherback turtle (*Dermochelys coriacea*) is categorized as critically endangered on the IUCN red list. Its population has drastically and rapidly diminished in the Pacific as well as in Malaysia. According to researchers, this fact is likely to be attributed to human activities, mainly through egg collection and incidental bycatch. This situation seems to remain stable in the Atlantic Ocean, despite recent studies mentioning a possible but low decrease in populations

nesting along the Caribbean coast between Nicaragua and Panama. A discrete stochastic model, age-class and sex structured, was used to simulate population dynamics linked to the females nesting at Tortuguero, Costa Rica, where the leatherback presence is both economically and culturally important. This model takes only this rookery into account and includes demographic and environmental stochasticity. Demographic parameters were estimated from the Tortuguero database but were also sourced from other works. The model is interactive and, with the Stella simulation software, revealed where the Tortuguero rookery was exposed to various bycatch scenarios. Due to the current levels of human egg collection and dog predation, viability of the Tortuguero population could be at risk even when exposed to low bycatch. Knowing the importance of fishery activities in the Atlantic, as well as leatherback migratory and feeding habits, at least low bycatch is likely to be feared. Global warming effects were also simulated, featuring adverse impacts. However, it is hoped that leatherbacks will be able to adapt to a changing environment. Leatherback populations must be carefully monitored in order to appreciate evolution in terms of abundance. Investigation must continue to provide better insight regarding leatherback migratory routes and be accompanied with suitable mitigation measures at a global scale. Acknowledgements: We thank the Caribbean Conservation Corporation for logistical and data collection support. We acknowledge travel support from the French Rhône-Alpes region. Sebastian Troëng and Emma Harrison have been immensely helpful in reviewing our work. We are grateful to Milani Chaloupka and Dominique Lebreton for their valuable comments and advice. The efforts of Andrea de Haro, the research assistants and participants of the 2006 and past Leatherback Programs are gratefully acknowledged. The Ministry of Environment and Energy and the park rangers in Tortuguero National Park provided the necessary research permits and also gave us access to the facilities at the Jalova ranger station.

CURRENT STATUS OF CONSERVATION OF BLACK SEA TURTLE (*CHELONIA* AGASSIZI: AKA *CHELONIA MYDAS* AGASSIZI) IN MICHOACAN, MEXICO: AN HISTORICAL PERSPECTIVE

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During the last five years, the black sea turtle population in Michoacan shows a discrete increase in nesting females, primarily on Colola Beach. An analysis of the historical nesting activity on several nesting beaches along the Michoacan shoreline in 1978 shows the nesting activity of the black turtle on 17 beaches. Through this year, Colola and Maruata beaches represent only 48% of nesting females estimated on the Michoacan coast. We report nesting activity on nine beaches through 2003 including Colola and Maruata Beaches, which represents 92% of the total nesting black sea turtles estimated at Michoacan this year. These results have serious implications for the effective recovery of the black turtle population in Michoacan, because the higher concentration of nesting females in Colola and Maruata (92% of entire population in Michoacan) have implications on the sex ratios (82% of hatchling produced in Colola are females), and increase the risk of threats. We observed an increase in nesting females in the last five years on Colola Beach, but we lost nesting females on other beaches due to lack of conservation activities.

CARIBBEAN LEATHERBACKS: RESULTS OF NESTING SEASONS FROM 1984-2006, CULEBRA ISLAND-PUERTO RICO

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The beaches of Culebra Island (18°18'N, 65°18'W) in Puerto Rico are considered critical nesting habitats for leatherback turtles. For the past twenty-two years, leatherback nesting areas have been monitored at Culebra Island suggesting their importance and local contribution to the Caribbean population. The objective of this study is to report nesting activity recorded during the last three nesting seasons and compare data to that of previous years. Since 2004, an Index Nesting Beach Survey has been implemented on the main nesting beaches of the island. A total of 110 nests were recorded during the index peiod in 2004 with a season total of 173. Results from the 2005 season were similar, with 116 nests recorded in the index nesting period and a total of 257 nests for the season. A total of 100 nests were counted during the index survey in 2006, and 133 nests were recorded for the complete season. Peak nesting density occurred early in the index survey period each year. The total number of nests reported from 1984 to 2006 indicates a decrease in number of nests. However, since 2004 (date the decrease was reported), a simultaneous increase in nearby areas such as Fajardo (mainland Puerto Rico) and St. Croix (US Virgin Islands) was detected. Past reports suggest inter-nesting of leatherbacks on those beaches and others in the nearby areas. Therefore, we suggest this may be one of the factors for such low numbers of nests in recent years at Culebra Island. Finally, tourist and urban development continues to be a major threat to the leatherback nesting population of Culebra Island and mainland Puerto Rico, which constitutes an important rookery for the Caribbean Region.

PALAU MARINE TURTLE CONSERVATION AND MONITORING PROGRAM

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Between 2004 and 2006, 1,054 turtle nests were surveyed in the Republic of Palau: 904 green turtle (*Chelonia mydas*) nests and 150 hawksbill (*Eretmochelys imbricata*) nests. During this time, 108 nesting *C. mydas* were tagged in Hatohobei State on Helen Island and 36 were tagged in Sonsorol State on Merir Island. Nesting *C. mydas* on Helen had a mean minimum curved carapace length (CCL_{min}) of 101.4 cm (SD=5.2), a mean curved carapace length from nuchal notch to tip ($CCL_{n\text{-}t}$) of 101.2 cm (SD = 8.8), a mean maximum curved carapace length (CCL_{max}) of 103.7 cm (SD=5.5), and a mean curved carapace width (CC_{width}) of 91.6 cm (SD=9.2). Nesting *C. mydas* on Merir had a CCL_{min} of 104.1 cm (SD=6.0), $CCL_{n\text{-}t}$ of 104.9 cm (SD=6.2), CCL_{max} of 106.3 cm (SD=5.9), and CC_{width} of 94.3 cm (SD=4.9). Most nesting activity for *C. mydas* occurred from April to August at Helen and Merir. Individual tagged *C. mydas*

returned 1 to 9 times to nest at Helen between April and August 2005 and 1 to 8 times between September 2005 and June 2006. Average nesting intervals for the 68 green turtles tagged from September 2005 to June 2006 on Helen Island was 12 days. Average number of eggs per clutch between September 2005 and June 2006 was 106 with an average of 84 hatched and 23 unhatched eggs. Tissue samples were taken from 6 foraging *E. imbricata*, 47 foraging *C. mydas*, and 22 nesting *C. mydas* during the summer of 2005. A total of 17 captive *E. imbricata* were tagged in Koror State in 2005. From 2005-2006, 30% of all observed *E. imbricata* nests were poached. Threats to turtle populations in Palau include human poaching of nests, entanglement in abandoned fishing nets, egg predation by wild pigs as well as monitor lizards, and nesting habitat degradation from coastal development and storms. One satellite transmitter was attached to Diliomekang, a nesting *E. imbricata* in the Rock Islands of Koror State on July 27th, 2006. A second transmitter was deployed on Hocharihi, a *C. mydas*, on Sep 27th from Helen Island. The movements of both are currently monitored. The project received technical and funding support from Bureau of Marine Resources, Palau Conservation Society, Palau Fish and Wildlife Protection, Palau Automated Land and Resource Information Systems, US Fish and Wildlife Service, Community Conservation Network, and the Pacific Islands Regional Office of NOAA Fisheries. Data was collected by the national Marine Turtle Conservation and Monitoring Program office working in partnership with state conservation officers and the communities of Hatohobei, Sonsorol, Angaur, Peleliu, Koror, Melekeok Ngiwal, Ngaraard, Ngarchelong, and Kayangel.

ESTIMATING THE POPULATION GROWTH RATE FROM BEACH COUNT DATA OF NESTING FEMALE TURTLES

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To assess status of a population, longitudinal estimates of abundance or index of abundance are necessary. For many protected species, these estimates often are obtained via mark-recapture analyses, distance sampling, or simple counts. Although simple counts of individuals in a population may not be a good index of the total population, these data sometimes are the only available information. Consequently, analytical methods are necessary to estimate the rate of change in population size from these data. I use a state-space modeling method to estimate the population growth rate from simple longitudinal count data. I assume that the population follows a geometric population growth ($N_t = \lambda N_{t-1}$) and that counts are random samples from the population. Based on these assumptions, the population growth rate is estimated via a Bayesian state-space modeling. The observed counts are modeled with either uniform or binomial distributions. For uniform distribution, $O_t \sim UNIF(0, N_t)$, where O_t is the count at time t and N_t is the population size. For the binomial distribution, $O_t \sim BIN(N_t, p_t)$, where p_t is the detection probability at time t. Analyses on simulated data indicated that the proposed method provided unbiased and precise posterior distributions for the population growth rate. Longer time-series data provided more precise marginal posterior distributions on the growth rate. Posterior simulations indicated that the binomial model fitted well to data. Although the proposed modeling approach was based on the assumption that the minimal data were available, the same approach can be extended if more data become available. For example, the detection probability may be modeled with one or more covariates if information on sampling effort is available. Detection probability may be modeled with serial correlations, which are likely to be found in many datasets. Further, if multiple datasets are available for a population (or a

management unit), these data can be modeled with one underlying population growth rate. Such approach, i.e., random effects of multiple datasets, can provide a robust estimate of the population growth rate, in which uncertainty of the growth rate from multiple datasets can be explicitly included. This Bayesian state-space modeling approach provides an alternative to existing regression-type analyses for estimating population growth rates. There are several attractive features of the approach. The model is simple and easy to understand. The state-space modeling approach is flexible and has been well-established for fisheries science. Results of the analysis are easy to interpret. For example, the probability that the population growth rate is greater than one can be computed from a posterior distribution. With risk functions, decision analysis can be incorporated directly into the analysis, which makes the analysis attractive to managers. The assumed population model can be extended to other forms, such as logistic, Ricker, and others. Finally, auxiliary information about parameters, e.g., population growth rate and detection probabilities, can be incorporated directly into the analysis via prior distributions.

LONG-TERM ASSESSMENT OF NEST PRODUCTION AT THE ARCHIE CARR NWR AND JUVENILE ABUNDANCE IN THE INDIAN RIVER LAGOON SUGGESTS THE BEGINNING OF THE RECOVERY OF THE FLORIDA GREEN TURTLE

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Nest production of green turtles in the Archie Carr NWR recorded from 1982 through 2006 has shown a 67 fold increase. This includes a record high 3,177 nests in 2005 and 1,384 nests recorded in 2006, an expected “low” year. The Carr Refuge beach extends 21 km on the east-central coast of Florida. In the nearby Indian River Lagoon, the CPUE for juvenile green turtles captured in large mesh tangle nets has increased by an order of magnitude during the same time period. We hypothesize that the long-term, uninterrupted nature of these increases in two disparate life-history stages indicates the beginning of the recovery of the Florida green turtle.

NESTING FREQUENCY OF MARINE TURTLES VISITING ON KOSGODA BEACH, SOUTHERN SRI LANKA

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Five of the world’s seven species of marine turtles come ashore to nest in Sri Lanka: the green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), loggerhead (*Caretta caretta*), hawksbill (*Eretmochelys imbricata*) and leatherback turtles (*Dermochelys coriacea*). A four kilometer stretch of beach at Kosgoda provides nesting habitat for all five species of marine turtles. A section of beach about 1050 m long on the project site was marked by wooden posts at 50 meter intervals starting from 0 to 21. Nesting activities were recorded from the time a turtle

emerged from the sea until the turtle returned to the sea, and nests were protected until the eggs hatched. A total of 367 individual nesting turtles visited Kosgoda Beach during the study period from August 2003 to July 2006: 83% were green turtles and 17% were olive ridley turtles. In addition, one leatherback turtle nested during the study period. A total of 1089 nests were deposited by the three species, of which 90% were from green turtles and 10% from olive ridleys. No loggerheads or hawksbills nested on Kosgoda Beach during study period. Green turtles were the most common species nesting on Kosgoda beach. Individual green turtles deposited an average of two nests per season, and olive ridleys averaged one nest per season. The average number of eggs per nest was 111 eggs for green turtle nests and 114 eggs for olive ridley nests. These values were very similar to the figures obtained for Rekawa Beach. Observation on nesting frequency throughout the year shows that the peak season occurs during March, April and May. However, only one kilometer of beach was monitored on Kosgoda Beach during this study. Thus, there is a possibility that some nests were missed on Kosgoda Beach and that turtles could have deposited outside the monitoring area within the same nesting season. Both Kosgoda and Rekawa sites show similar nesting frequencies of the two most commonly visiting species. Acknowledgments: We would like to acknowledge to the Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service, National Science Foundation Sri Lanka, Ford Foundation and Sea Turtle Symposium for their funding support to attend to the symposium.

TO FLUFF OR NOT TO FLUFF, THAT IS THE BEACH NOURISHMENT QUESTION!

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It is common practice following beach nourishment projects to till the newly formed platform in order to decrease its compactness and to make it more amiable to the general public and sea turtle nesting. However, tilling can negatively impact nesting ecology, depending primarily on the timing of its completeness and on sand water content. Anna Maria Island, a small barrier island on the southwest coast of Florida, was renourished and tilled during the 2002/03 and 2005/06 sea turtle nesting seasons. The difference between the outcomes of these two beach nourishment projects was very extreme. The early season had a disastrous nesting and hatching success while the most recent was very successful. Significant data were collected from these two seasons regarding the impact of beach tilling and on the importance of certain sand physical properties. We report on lessons learned and offer advice to sea turtle biologists facing future similar beach tilling projects. The low nesting and hatching success recorded after the 2002/03 beach nourishment was attributed to two main reasons: 1) a short settling time between beach tilling and the start of nesting season; 2) a very wet summer. The newly tilled sand was extremely soft and did not allow the rainfall to drain very well. This led to the formation of swales and quicksand-like areas throughout the beach. All nests located in these regions flooded and drowned. During the most recent nesting season, we expected a similar outcome. However, because of lessons learned in the past, we monitored specific beach sand parameters that we suspected had contributed to the disastrous outcome of the early season. These physical properties were sand compactness, sand moisture content and water table level. Data were collected weekly, and the monitoring plan encompassed the entire nesting beach. The nesting and hatching success resulting from the 2005/06 beach renourishment project was extremely high. We attribute this primarily to a dry summer and to our increased knowledge of

the interactions between the sand physical properties of our beach. This knowledge enabled us to predict the incubation success of specific beach sections and be more selective when relocating nests. Because of our success during this past nesting season, we must emphasize the importance for sea turtle biologists to know how different sand properties interact in their beach. This knowledge is paramount for advising State managers and beach nourishment contractors on the efficacy of beach tilling.

A DECADE OF CONSERVATION AND RESEARCH AT A SOLITARY OLIVE RIDLEY NESTING BEACH: PUNTA BANCO, COSTA RICA

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The limited long-term data available regarding olive ridley (*Lepidochelys olivacea*) nesting characteristics is obtained through research conducted at arribada beaches, while long-term data originating from solitary (non-arribada) nesting beaches is nearly non-existent. The 2005 olive ridley nesting season on the Pacific coast of Costa Rica constitutes PRETOMA's (Programa Restauración de Tortugas Marinas) 10th consecutive year of conservation and research at the beach of Punta Banco, located on the southern Pacific Coast of Costa Rica, making it the longest monitored solitary olive ridley nesting beach in the world. We present results from the Punta Banco project which represent the first ever decade-long data set regarding nesting characteristics of olive ridley turtles at a solitary nesting beach. Considering HS differences between solitary and arribada nesting beaches, as well as the fact that worldwide there exists a much greater number of solitary than arribada nesting beaches, it is important to include data from solitary nesting beaches to better estimate nesting trends and global populations of this species.

DIPTERAN LARVAE INFESTATION OF LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) NESTS ON GANDOCA BEACH, COSTA RICA

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Dipteran larvae infest sea turtle nests, but it is not yet known whether they act as scavengers or as predators. Because of the decline in many leatherback sea turtle (*Dermochelys coriacea*) populations, any possible threat to their reproductive success merits research. The ecological characteristics of dipteran larvae collected from leatherback nests on Gandoca Beach, Costa Rica (9°35' N, 82°34' W) were examined during the 2005 and 2006 nesting seasons. The relationship between nest productivity measures and larval infestation rates was investigated at both the rookery and individual nest levels. Our objectives were to assess if flies pose a threat to the overall reproductive success of leatherbacks, identify the fly species infesting nests, estimate infestation timing, determine nest entry mechanisms and ascertain which nest factors affect infestation rates. Post-emergence nest excavations revealed that dipteran infestation exceeded 75% of nests in both nesting seasons, but levels were much lower when evaluated as the proportion of the clutch infested. This suggests that fly larvae preferentially scavenge

necrotic tissue within the nests, but the fact that several live hatchlings were attacked by larvae indicates that flies also act opportunistically as predators. Larvae were collected from infested nests, reared to adulthood and identified. Several species infested clutches with *Eumacronychia sternalis* from the Sarcophagidae being dominant. Gross estimates, utilizing the known development timeframe for *E. sternalis* showed that infestation was taking place shortly after hatchling emergence. Odors emanating from decomposing eggs are probably carried to the surface by emerging hatchlings and attract flies to the nest. Subsequently, gravid female flies deposit larvae on the sand surface and the larvae burrow through the sand column to reach the nest chamber. Experimental burrowing trials with larvae collected from leatherback nests showed that fly larvae were able to burrow to average leatherback nest depths. Negative binomial regression models were used to assess which nest factors influenced fly infestation rates. The variables that best predicted the incidence of larvae within nests were: sampling year, bacteria or fungus invasion, and the interaction between nest depth and the number of dead hatchlings. Infestation levels in egg hatcheries were not higher, possibly because of protective net baskets covering the clutches. Our results suggest that flies do not seriously threaten leatherback turtles. However, they cause incidental hatchling mortality and we suggest that measures be taken to protect nests against dipteran larvae infestation. Acknowledgements: We gratefully acknowledge travel support from Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, US Fish and Wildlife Service provided through the Symposium Travel Committee, as well as research funding from World Wildlife Fund, Environment Canada and Ontario Ministry of Natural Resources.

MULTISTATE MODEL APPLIED TO LOGGERHEAD SEA TURTLE MARK-RECAPTURE DATA

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Bald Head Island, North Carolina, is one of the highest density nesting beaches of loggerhead sea turtles (*Caretta caretta*) in the turtle's northern range on the East Coast of the USA. The beach survey conducted on the island only allows for the capture of adult female sea turtles during the breeding state even though females may spend multiple years in the unobservable non-breeding state. The majority of females captured over the last 16 years have never been recaptured at the original capture site. These transients in the data coupled with the unobservable states violate assumptions in most current unistate mark-recapture models. A multistate mark-recapture model developed for leatherback sea turtles will be applied to the data from Bald Head Island. Multistate modeling provides a new technique to estimate sea turtle demographic data in which all model assumptions can be met. The multistate model outputs female survival rates, capture probability, and transition probabilities between breeding and non-breeding states. A correction factor for trap-dependence and transients will be included given that both tested significant in the global model goodness-of-fit tests. A time effect on survival and transition probabilities will also be assessed in the full suite of models run. Model selection will be based on QAIC values and biological meaning of the model parameters. The results from this study and advantages of multistate modeling to sea turtle demographic data and population models will be discussed.

COMPARISON OF LOGGERHEAD REPRODUCTIVE SUCCESS IN SEAWALL NESTS AND NON-SEAWALL NESTS IN SOUTHERN INDIAN RIVER COUNTY, FLORIDA, 2006

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The Southeast Coast of Florida accounts for more than 80% of the loggerhead nesting in the state. Within this area, a large proportion of Indian River County's coastline has been classified as critically eroded (70%). In an effort to save their properties, beachfront owners have placed seawalls on approximately 7.6% of the County's 36 kilometers of coastline. There is growing evidence that seawalls inhibit nesting and result in more abandoned nesting attempts. In this study, we looked at whether loggerhead nests deposited in front of seawalls had lower reproductive success than those on the natural sections of beach. We marked a random sample of nests on the natural beach and all nests in front of seawalls in the southern half of the County. Marked nests were followed through incubation and excavated either 3 days after emergence or 70 days post-deposition. Mean hatching success for nests in front of seawalls (mean=0.854, SD=0.17, n=49) was not significantly different than nests on the natural beach (mean=0.881, SD=0.15, n=52; t-test, p=0.40). The mean emergence success was also not significantly different between seawall and non-seawall nests (t-test, p=0.91). One explanation for these results was the low tropical storm season this summer. Seawall nests averaged 3.9 meters from the base of the wall, but most (55%) were within 3 meters. Higher storm tides would have washed over these nests and repeated wash-overs probably would have reduced their hatching success. But, for the most part, this did not occur. Also, many of the most recent seawalls were a reaction to the hurricanes of 2004. Since that time the beach has recovered in many areas and during this summer we experienced significant sand accretion. We believe long-term monitoring of nesting in front of seawalls is necessary, especially since many of these areas have a net loss of sand over time and the beach will likely become narrower than it is today.

MORE REPORTS OF LIVING TAG GREEN TURTLES IN XCACEL, QUINTANA ROO, MÉXICO

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The living tag technique was started at X'cacel Beach, Quintana Roo, Mexico in 1990. In 2006, five nesting green turtles with living tags were reported. One animal measured 105.6 cm curved carapace length (CCL). The living tag was located on the second right costal scute corresponding with the 1990 season and was released less than two weeks after hatching. The other four turtles were tagged in 1991. The turtle with the tag J3630 was the first registry of a green turtle with living tag that returned to nest in 2004, and represented the second registry of a head-started turtle that returned to nest in the region. Data for all the turtles included clutch size, nesting frequency and nest site fidelity. Only the one turtle from 1990 was not confirmed as a head-started turtle. The living tag program is discussed in this paper.

DENSITY-DEPENDENT EFFECTS ON HATCHING SUCCESS IN OLIVE RIDLEY TURTLES

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Recently the olive ridley arribada at Playa Nancite has declined drastically. We hypothesized that the decline on Playa Nancite could be due to low hatching success as a result of the high density of nests on the beach, such that recruitment to the population was insufficient to balance losses. To test this hypothesis, we examined density-dependent effects on hatching success and their underlying mechanisms by experimentally manipulating nest densities on the nesting beach. We set up four nest density treatments in 5 experimental blocks. We studied the effects of density on hatching success, CO_2 and O_2 concentrations and temperature both within a nest and in sand adjacent to a nest frequently during incubation. We found that experimental nest densities affected hatching success with highest density having lowest hatching success. Further, higher nest density led to lower O_2 levels and higher CO_2 levels in the nest with greater changes in the latter part of the incubation. Highest temperatures were recorded in high density areas. Temperatures were lower in the sand surrounding the nest than in the nest. Longterm failure in production of hatchlings due to historic high densities could contribute to the decline of arribadas on Playa Nancite.

DRAMATIC IMPACT OF ARMY ANTS ON *DERMOCHELYS CORIACEA* NESTS AT PONGARA NATIONAL PARK (GABON, CENTRAL AFRICA)

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Insect underground predation was found to be one of the main hazards to leatherback nests in Pongara, with 67 % of the marked nests affected in some extent. Such predation rates appear to be highly dramatic considering that this area is one of the hotspots in the world for the nesting of *Dermochelys coriacea*. Our research was carried out at Pongara National Park in Gabon, Central Africa during the 2005/2006 nesting season. The study area spreads over six kilometers of beach where natural nests were marked with wooden sticks to allow daily survey and nest exhumation after hatching occured. During exhumation of the nest, yolkless eggs, egg shells and unhatched eggs were counted. Unhatched eggs were first classified as predated and non-predated and then opened to examine their contents. We found a high variety of unidentified contents in predated eggs which ranged from plain sand to possibly rotten pigmented embryos. Predated eggs showed several types of holes on the shell that were attributed to ants as they were found dead in huge amounts inside predated eggs and sometimes alive in the nest incubation chamber. Ants collected and preserved in eppendorf tubes with 96º alcohol were identified as *Dorylus spininodis* Emery, 1901 belonging to the Dorylinae subfamily commonly known as "Army ants". It is a pan-african species so the hipotesis of an introduced species is eliminated. Their activities are mainly underground; that is why, no signs of predation activity were recorded above sand during daily surveys of the nests. Doryline ants are known to exploit large sources of food, such as termite nests, during long periods of time, which leads us to think

that they could have specialised on feeding on turtle nests. Moreover, their feeding regime is composed on foods rich in lipids, the only known way to study these subterranean ants being using palm oil baits (Berghoff, 2002). Predation by *Dorylus* spp. has already been signaled in South Africa for *Caretta caretta* nests (Maxwell, 1998). Results could be biased by the fact that there was a tedency to mark nests near vegetation. Further research should be done on this topic so as to elucidate if ants have a spatial or temporal preference and to confirm their predation mechanism. This work was made posible thanks to a research grant from the Basque Government and the logistics provided by Gabon Environnement, a local NGO. It is also part of the PROTOMAC network.

THREE YEARS OF MONITORING TURTLE NESTING IN SYRIA (2004-2006): WHAT PROGRESS HAS BEEN MADE TOWARDS PROTECTION?

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Before 2004, Syrian beaches were of no known importance concerning sea turtle nesting in the Mediterranean. There were only indications from the early 1990s that low-level nesting by loggerhead turtles (*Caretta caretta*) existed (Kasparek, 1995). The surprise came in the summer of 2004, that Syria ranked third in the Mediterranean (after Turkey and Cyprus) for green turtle (*Chelonia mydas*) nesting through discovery of one major and several minor nesting beaches, in addition to verifying the predicted low-level loggerhead nesting (Rees *et al*, in press). Follow-up work in the summer of 2005 recorded green turtle nesting levels at approximately one third of the previous year (Jony, unpublished data) during what was apparently a 'bad' year for green turtles in the Mediterranean. In 2006, nesting levels recovered and exceeded all expectations. There were 218 nests (seven from loggerheads and 211 from greens) recorded along the main 12.5 km nesting beach, located south of Latakia. The high-level nesting recorded in 2006 sadly does not reflect improved conditions at the nesting beaches, but is part of natural fluctuations in levels of nesting from one year to the next. The nesting beaches are still being misused and degraded. Beach users discard large amounts of plastic litter which ends up on the beach, brought in by the sea currents or blown from the dumps built into the beach dunes. This plastic hinders nest construction and safe passage of the hatchlings down the beach to the sea. Tractors and other 4WD vehicles still regularly use the beach, their tires compressing the sand, crushing nests or creating impassable ruts that act as death traps for the hatchlings. The glow in the sky, behind the nesting beach created by artificial lighting, still lures hundreds of hatchling turtles to their deaths in the dunes. Nesting turtles are still deliberately and maliciously being injured and killed while they harmlessly crawl over the beach. Large populations of ghost crabs, supported by the quantity of litter on the beach, attack many of the hatchling turtles, killing them on the beach or maiming the escapees thus reducing their survival chances at sea. On top of this, packs of feral dogs and wild canids depredate many of the nests, destroying whole clutches after several days of repeated plundering. The nesting levels recorded in Syria for 2006 are encouraging, but the huge loss of nests and hatchlings to anthropogenic factors must be significantly reduced if we are to ensure the population is to survive another generation. *Acknowledgements:* The monitoring project was carried out with support from the Marine Conservation Society, Turtle Conservation Fund and awards to MJ from Ford – Middle East. Kasparek M. 1995. The Nesting of Marine Turtles on the Coast of Syria. Zoology in the Middle East 11, 51-62. Rees AF. A Saad and M Jony. In press. Marine turtle nesting survey, Syria

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ESTIMATING TOTAL POPULATION SIZE FOR ADULT FEMALE SEA TURTLES: ACCOUNTING FOR NON-NESTERS

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Assessment of population size and changes therein is important to sea turtle management and population or life history research. Investigators might be interested in testing hypotheses about the effect of current population size or density (number of animals per unit resource) on future population processes. Decision makers might want to determine a level of allowable take of individual turtles of specified life stage. Nevertheless, monitoring most stages of sea turtle life histories is difficult, because obtaining access to individuals is difficult. Although in-water assessments are becoming more common, nesting females and their hatchlings remain the most accessible life stages. In some cases adult females of a given nesting population are sufficiently philopatric that the population itself can be well defined. If a well designed tagging study is conducted on this population, survival, breeding probability, and the size of the nesting population in a given year can be estimated. However, with published statistical methodology the size of the entire breeding population (including those females skipping nesting in that year) cannot be estimated without assuming that each adult female in this population has the same probability of nesting in a given year (even those that had just nested in the previous year). We present a method for estimating the total size of a breeding population (including nesters those skipping nesting) from a tagging study limited to the nesting population, allowing for the probability of nesting in a given year to depend on an individual’s nesting status in the previous year (i.e., a Markov process). From this we further develop estimators for rate of growth from year to year in both nesting population and total breeding population, and the proportion of the breeding population that is breeding in a given year. We also discuss assumptions and apply these methods to a breeding population of hawksbill sea turtles (*Eretmochelys imbricata*) from the Caribbean. We anticipate that this method could also be useful for in-water studies of well defined populations.

A SPATIOTEMPORAL ANALYSIS OF LOGGERHEAD SEA TURTLE NESTS (*CARETTA CARETTA*) WITHIN CUMBERLAND ISLAND NATIONAL SEASHORE, INCLUDING LITTLE CUMBERLAND AND CUMBERLAND ISLANDS, CAMDEN COUNTY, GEORGIA.

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The linear distribution of loggerhead (*Caretta caretta*) nests along the ocean beach has been mapped on Little Cumberland Island since 1964 and on Cumberland Island since 1975. Together, these island beaches represent the nesting activity of the loggerhead within the

boundaries of Cumberland Island National Seashore (CUIS), Camden County, Georgia. CUIS was created in 1972 and placed at that time under the management of the National Park Service, U.S. Department of Interior. Two multiple-year periods (1985-1991 and 2001-2006) have been selected for historical comparison of nesting distribution, representing a subset of approximately 3,000 records. Distributions are analyzed by eighth mile beach sectors derived from historical data. Patterns along the beach suggest that a variety of environmental factors are affecting nest site selection. The location of Christmas Creek separating Cumberland Island from Little Cumberland Island is an obvious example of a nesting discontinuity. Other causes for distributional anomalies are less obvious and may include dune height (dark horizon), fresh water runoff, areas of severe erosion, and a unique geomorphic characteristic of the CUIS beach apparently related to near shore currents. Of particular interest is an apparent shift in the location of nesting density between the two time periods (1985-1991 and 2002-2005) that may correlate with an erosion-depositional pattern affecting the quality of nesting habitat along the beach front. Possible anthropogenic causes for nesting discontinuities are discussed, including the chronic presence of mainland lights originating from several sources visible to the CUIS nesting beach.

NESTING BEHAVIOUR AND SOME BIOLOGICAL ASPECTS OF THE HAWKSBILL SEA TURTLE (*ERETMOCHELYS IMBRICATA*) AT HORMOZ ISLAND, IRAN

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An area in the northern Persian Gulf has been used for nesting by a large number of hawksbill turtles. This investigation was undertaken during the nesting season from March 2006 to June 2006 on Hormoz Island, an important nesting region for hawksbill turtles in Iran. Specific biometrical measurements were taken, such as turtle weight and straight carapace length and width. The number and location of nests, as well as egg number, diameter and weight were also recorded. In addition, beach slope and sand grain size were measured. The results were analyzed using SPSS and Minitab software. During this season, 41 turtles were chosen for biometry with only 49% of them have a success lading. Average turtle weight was 44.9 kg (range=34-54 kg). Mean straight carapace length was 62.5 cm (range=58.5-72 cm). Curve straight length included almost 76% of length carapace. Length and width were significantly correlated at the 95% level.

NESTING BEACH PREFERENCES OF LOGGERHEAD (*CARETTA CARETTA*) AND LEATHERBACK (*DERMOCHELYS CORIACEA*) SEA TURTLES AT MAPUTO SPECIAL RESERVE (MOZAMBIQUE), AND THEIR CONSERVATION AND MANAGEMENT IMPLICATIONS

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The Maputo Special Reserve (MSR) is composed of 34 km of sand beaches and coastal vegetated dunes and is one of the most important nesting areas for loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) turtles in Mozambique. The present study, conducted on the 25 km of the MSR coastline, involved identifying the most important nesting periods and beach zones for both sea turtles species. The study area was divided into five zones, each approximately 5 km long. All sea turtle activities within those zones were recorded daily, whether it resulted in nesting or not, during three consecutive nesting seasons (1999/00 to 2001/02). Loggerhead turtles proved to be the most widespread species within the MSR with an average annual nesting population estimated at 60 ± 11 (SD) compared with leatherback, whose population was estimated at 15 ± 5 (SD). The average proportion of nests between loggerhead and leatherback was 2.17:1, with significant variation across the three seasons. A relatively low ratio of nests to false crawls was observed (1.33:1 for loggerhead and 1.41:1 for leatherback) and appeared to be related to the excellent condition that the area offers for both species and the relative low level of human disturbance and competition between species. Both species presented more or less the same temporal and spatial nesting patterns. The nesting season normally starts in October and extends up to February with a peak for both species in the 2nd half of December. Nests of both species were not randomly distributed along the five zones, favouring the extreme northern and southern portions (zones 1 & 5). Preliminary evidence suggests that the two species have almost the same beach preference, although loggerheads appear to prefer more the southern zone and leatherbacks the northern.

INFLUENCE OF NEST DEPTH ON INCUBATION AND EMERGENCE OF LOGGERHEAD TURTLES

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The depth at which turtle eggs incubate is influenced by environmental parameters that affect embryonic development. Incubation temperature and humidity can strongly influence incubation time, hatching success, hatchling size or sex ratio. Therefore, the depth at which nests are re-buried is a key factor for the success of nest relocation programs. One hundred and eight loggerhead (*Caretta caretta*) nests were incubated in standard conditions and at different depths in a hatchery in a Boavista beach (Cabo Verde) so as to evaluate the influence of nest depth on incubation. Doomed nests (nests with low chances of survival) were relocated to a hatchery and buried at different depths (35, 40, 45, 50 and 55 cm). Eighteen nests were placed at each of the selected depths and monitored until hatching. Incubation temperature was recorded continuously within nests at every depth. We also placed 18 nests (in the hatchery) at the same

depth at which they were laid by the female *in situ*. Information about incubation time and temperature, hatchling size and the effects of nest depth on these parameters are provided. Incubation duration was strongly affected by nest depth, with mean values that differed up to 5 days between 35 and 50 cm depth nests. In general, deeper nests incubated longer. This could have a direct effect on sex ratio. Percentage of females hatched from each nest was estimated using Mrosovsky *et al*. (1994) and Marcovaldi (1994) models. Incubation at 35 cm can produce 89.4–97.7% females, whereas incubation at 50 cm could produce around 62.4–64.9% females. Survival in deeper nests (60%) was generally higher than in shallower nests (45%) but differences between mean success values at different depths were not significant. Additionally, nest depth appeared to have an influence on emergence behavior. Deeper nests enhanced a synchronous emergence resulting in a higher number of hatchlings emerging simultaneously. A positive correlation between the number of hatchlings in the largest emergence and nest incubation depth was found (r=0,220; F=4,434; p=0.038; n=89). Thus, more numerous emergences could enhance hatching survival by satiating predators or limiting time available to capture multiple prey.

OLIVE RIDLEY SEA TURTLE INTERNESTING INTERVALS AT PIRAMBU, BRAZIL

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Olive ridleys (*Lepidochelys olivacea*) are considered to be the most abundant of all sea turtle species worldwide. In some Pacific and Indic nesting beaches, they perform mass nesting events (*arribadas*); however, in the Western Atlantic coast the species is less abundant. Constant studies on *arribada* beaches have been conducted, but much is still uncertain about olive ridleys' reproductive behavior, especially in solitary nesting grounds. Until recently, the Galibi Nature Reserve in Suriname hosted the largest reproductive population of olive ridleys within the Western Atlantic coast, but a 90% decline was estimated for the past three decades. In French Guiana, no more than 1,000 nests were estimated for the 1999 nesting season. The state of Sergipe is the main nesting ground for olive ridleys in Brazil and, at present, probably in the entire Western Atlantic coast, according to recent nesting data observed over the past seven years. In Sergipe, olive ridleys reproduce mainly at Santa Isabel Natural Reserve, part of which is included in Pirambu's research station (within 10°43'S and 36º50'S), where this study was performed. Pirambu's station belongs to the Brazilian Marine Turtle Conservation Program and has been monitored for the past 20 years. Standard night patrols and tagging take place from September through March. The objective of the present study was to identify the internesting interval of the population. Only data from the 2004/05 and 2005/06 nesting seasons were used, during which more intensified patrol efforts began. During the 2004/05 nesting season, 166 individuals were encountered, 22 of which were later recaptured. In 2005/06, 319 individuals were encountered, and 80 were recaptured. A total of 81 internesting intervals were obtained. Only one individual was seen nesting three times. Internesting intervals ranged between 15 and 50 days with the majority between 18 and 22 days. Comments on comparisons with other olive ridley populations are also presented.

THE TIMING OF LOGGERHEAD FEMALE EMERGENCES FROM THE SEA IN JAPAN

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In this study we examined the temporal pattern of loggerhead sea turtles emerging from the sea in Japan. The Minabe-Senri Beach, which is one of the major rookeries for northern Pacific loggerhead population, has been patrolled about an hour intervals each night from mid June until early August since 1990. Upon encountering a turtle or a new track on the beach, project personnel report to the base over the radio to record the time and the behavior. Data gathered during the 2002-2006 nesting seasons were used in the present study. Tidal cycles for each night of the seasons were divided into eight periods of approximately equal duration. Each emergence (n=703) was allocated into one of the eight tidal stages, representing the period in which it occurred. The resulting frequency in each cell was divided by accumulated time of the periods corresponding to each tidal stage in order to obtain emergence probability in each tidal stages. In the research field, land activity has uni-modal temporal distribution, with a peak at the window of 21-22h; about one quarter of all new emergences were encountered in this one-hour window. Chi-square analysis showed no significant deviation from the expectation of equal emergence probability in each tidal stage, representing fewer effects of tidal cycle on turtle emergence on this beach. This result can be explained by relatively small mean daily tidal range in this beach (1.0 m), as Frazer pointed out (1983).

RESULTS OF TRANSPLANTED NESTS OF GREEN TURTLES IN TWO IMPORTANT NESTING BEACHES IN CUBA

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Natural incubation is extremely difficult for many nests on some beaches where they can be destroyed by another turtle or by the sea. Little beach habitat exists in some areas of Cuba, making it difficult to incubate large numbers of nests. Therefore, areas like Caleta de los Piojos Beach and Barcelo Beach are very important green turtle (*Chelonia mydas*) nesting beaches in Cuba. During the 2000 nesting season (June-September) at Calete de los Piojos Beach and the 2005 nesting season (July-September) at Barcelo Beach, two methods were used for the translocation of nests that were susceptible to destruction. Nests were moved either: 1) immediately after deposition; or 2) greater than 24 hours after deposition. A total of 81 nests were transplanted immediately or shortly after deposition to a protected area in Caleta de los Piojos Beach. A total of 121 nests were transplanted to a protect area in Barcelo beach 24 or more hours after deposition. Both methods were compared using a non-parametric t-test, because the data obtained from Barcelo beach did not have a normal distribution. The hatching success for nests translocated soon or immediately after deposition was estimated at 71.76% (range=16.54-96.36%, SE=1.80). For nests translocated after 24 hours (121 nests) the hatching success was estimated at 61.02% (range=0-100%, SE=3.15). Statistical analyses indicated a significant difference (t-test, p=0.003) in hatching success between the two transplant methods.

Our results indicate that nest translocations should be performed soon after nest deposition in order to ensure the best hatch rates possible.

IMPORTED RED FIRE ANT (*SOLENOPSIS INVICTA*) IMPACT ON LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) NESTS ON SEA ISLAND, GEORGIA

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Based on high depredation rates of *Caretta caretta* (loggerhead) nests by *Solenopsis invicta* (imported red fire ants) in the 2005 nesting season at Sea Island, Georgia, three studies were designed to determine: (1) if *S. invicta* are capable of entering *C. caretta* eggs, (2) if *S. invicta* will tunnel to depths representing an actual nest chamber, and (3) if *S. invicta* depredation on *C. caretta* nests can be prevented using Advion (Indoxacarb). The first two studies were conducted in the laboratory at the University of Georgia, Tifton. In the first study, viable *C. caretta* eggs (n=3) collected from Sea Island, GA were placed three inches deep in three separate containers and *S. invicta* were provided access to the containers for one week. In the second study, viable *C. caretta* eggs (n=9) were placed in three separate containers, each with eggs at depths of 3 inches, 10 inches, and 18 inches. The third study was conducted at Sea Island, GA. *C. caretta* nests that had *S. invicta* present within 10 feet (N=27) were split into two treatments: nests treated with Advion (n=13) and untreated nests (n=14.) In the first study, two of the three eggs were completely depredated by *S. invicta*. In the second study, all eggs were depredated by *S. invicta*. In the third study, *S. invicta* were found within 10 feet of all untreated nests and were present in two egg chambers, with no sign of egg depredation. At one treated nest *S. invicta* were found within ten feet, and absent in the egg chamber. Hatching and emergence data showed no significant difference between the two treatments. The lack of depredation during incubation suggests that vulnerability occurs for *C. caretta* depredation by *S. invicta* during hatching and emerging when an *S. invicta* colony is present within 100 feet of the nest. Management of *S. invicta* in *C. caretta* nesting areas should be considered. Further field studies will be conducted next season with a greater sample size to quantify the impacts of *S. invicta* on *C. caretta* nests.

POPULATION GENETIC ANALYSIS OF LOGGERHEAD TURTLES IN THE CAPE VERDE ISLANDS

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Cape Verde harbors one of the world's largest nesting aggregations of loggerhead sea turtles (*Caretta caretta*),with thousands of females laying eggs on its beaches every nesting season. Cape Verde is an archipelago in Macaronesia, situated 600 km west of Senegal and comprised of 10 volcanic islands and five islets. The vast majority of nesting activity in Cape Verde occurs on the Boavista, Sal, Santa Luzia and Maio islands. Sequences of 391 b.p. of the mitochondrial DNA control region were analyzed in 158 adult females to elucidate population genetic structure and phylogeography. Samples were collected at four nesting sites; Boavista (n=62), Sal (n=49), Sta. Luzia (n=35) and Maio (n=12) between 2004-2005. The number of haplotypes, haplotype diversity (h), nucleotide diversity (Pi), haplotype frequencies and fixation indices (Fst) were obtained. We examined if latitudinal variation in genetic composition occurs throughout Cape Verde, since the most distant islands are more than 200 km apart. These results will indicate us if rookeries from different islands may be considered as one or different management unit.

CLUTCH TEMPERATURE PREDICTION: MODELING SUN, SAND AND SEA TURTLE SEX

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Beach sand temperature is a very important component of sea turtle nesting biology because it can impact many aspects of its reproduction ecology such as incubation duration, nest moisture content, incubation gas concentrations and sex determination. Sand temperature is often monitored by sea turtle biologists and used to estimate incubation length and sex of the hatchlings emerging from their beaches. This is commonly done by burying data loggers on the beach or in nests. However, this technology can be costly and not available in certain areas of the world. This study developed a model to predict sand temperature at different depths based on air temperature. Field data were collected using a 2-meter pole fitted with 9 temperature data loggers. This apparatus was buried on the beach so that it would record temperatures from 0.3 meter above sand surface to 1.0 meter below. All data loggers recorded temperature simultaneously at 15 minute intervals. Temperature was recorded for air, above and below the air-sand interface, and at different sand depths ranging from 0.05 meter to 1.0 meter. Temperature was also recorded from loggerhead clutches and sand 1 meter away to assess the effect of metabolic heat on overall incubation temperature. Data were collected at different Florida beaches that varied according to sand type, compactness, color and moisture. Our model was derived by first establishing the relationship between air temperature, sand color, albedo, sand compactness and moisture. Secondly, an equation that incorporated these variables was derived to predict sand heat transfer. Our data show that there is a 12 hour lag

between air and sand temperature at mid loggerhead clutch depth. Air temperature is highest at noon, while the clutch temperature peaks at midnight. Field data also show that the amplitude of the temperature sine wave abates with increasing depth. With minimal mathematical manipulations, this equation allows turtle biologists to modify it according to their specific beach characteristics such as sand moisture and color. By knowing the basic sand properties on a beach, sea turtle biologists can use this generalized equation to estimate clutch temperature. This can be a very useful tool for nesting beaches throughout the world and for assessment of beaches that have undergone anthropogenic sand changes such as those associated with beach nourishment projects.

ANNUAL TREND AND SEASONAL FLUCTUATION (1996-2005) OF *CARETTA CARETTA* EGGS ON FETHIYE BEACH, TURKEY

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In this study, the seasonal and annual variation in the number of loggerhead turtle eggs (in 813 nests) deposited on Fethiye beach was compared from 1996 to 2005 with 15 day intervals. The mean number of eggs was higher in the first interval in comparison to the rest of the intervals for each year. Annual comparisons proved no annual trend but showed seasonal fluctuations with spikes at multiple lags of 5. Acknowledgement: The senior author would like to thank the grants of following organizations which provided our participation to symposium:Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, US Fish and Wildlife Service and Sea Turtle Symposium.

MARINE TURTLE NEST COUNTS AND BEACH CHOICES ON BIOKO ISLAND (GULF OF GUINEA, AFRICA) ACROSS SIX NESTING SEASONS (2000/2001 THROUGH 2005/2006)

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Bioko is the largest of the four Gulf of Guinea islands (2,027 km^2) and the nearest to mainland Africa, lying only 32 km offshore from Cameroon. Four species of marine turtles (leatherbacks, *Dermochelys coriacea*; greens, *Chelonia mydas*; olive ridleys, *Lepidochelys olivacea*; and hawksbills, *Eretmochelys imbricata*) are known to nest on the 19 km of black sand beaches along the southern shores of the Island's Gran Caldera and Southern Highlands Scientific Reserve. For the past six (2000/01 through 2005/06) annual nesting seasons (October through April), the Bioko Biodiversity Protection Program, a cooperative enterprise of Arcadia University and the Universidad Nacional de Guinea Ecuatorial, has employed local patrols to record turtle activity on these beaches. Leatherback nests were the most common, and showed the greatest year-to-year fluctuation (typically between 2,000 and 6,000 nests), followed by green turtles nests (between 700 and 1,600), olive ridley nests (steadily increasing from 45 to over 150) and

hawksbill nests (fewer than 10). When combined with comparable results from other scientists for the 1996/97 and 1997/98 nesting seasons, long-term trends became evident and indicated relatively stable nest counts for green, olive ridley and hawksbill turtles. Leatherback nests increased to approximately 5,000 nests for three seasons, followed by a two season decline to approximately half that amount, and is showing an upward trend to 3,500 in the most recent season. All leatherback numbers are substantially higher than those recorded in the 1990's (approximately 1,000 per season).

ENVIRONMENTAL PROTECTION AGENCY'S (GUYANA) ROLE IN SEA TURTLE CONSERVATION

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The decline of sea turtles in Guyana began during the 1960s, when predominantly female turtles were targets for hunters for their eggs and meat. Additionally, many turtles were entangled in fishing nets. These were the two main threats which led to concern for the protection of sea turtles in Guyana. The Guyana Marine Turtle Conservation Society (GMTCS) was the first Non-Governmental Organization established for the protection and conservation of marine turtles. Established in April 14, 2000, its vision includes promoting the establishment of a proposed protected area of approximately 90-mile stretch of beach along the north-west coast of Guyana, called Shell Beach and "managing this ecosystem to promote the conservation and sustainable utilization of the resources of the area for the benefit of all stakeholders." Shell Beach is the nesting ground for four of the world's eight species of marine turtles, namely: Leatherback (*Dermochelys coriacea*), Olive Ridley (*Lepidochelys olivacea*), Green (*Chelonia mydas*) and the Hawksbill (*Eretmochelys imbricata*). In addition, a Memorandum of Understanding was signed between the Environmental Protection Agency (EPA)-Guyana and GMTCS in August 2003. This collaboration provides for data collection by the GMTCS and joint analysis of this data by the EPA. The objectives of the data analysis are to compare the activities and the number of hatchlings produced by each species of turtle throughout the nesting season (March-August annually). The analysis focuses on the number of turtles observed; number of nests; number of false crawls; number of turtles returned and the number of unseen turtles. Of the data analyzed, the greatest number of green turtle nests was noted in April of 2005 where 46 nests were counted. Leatherbacks are the most commonly observed species, and nesting remained at high levels (eg. 275 nests were recorded for 2005). The number of hawksbills are smaller in representation for this year, 17 were observed as compared to 8 in the previous year. The Olive-Ridley is rarer, only two were observed in 2004, one nest recorded. The month of June is the peak of the season where the greatest numbers of turtles are encountered and the greatest number of nests are recorded as well. Over the five years (2001-2005), the greatest number of turtles was observed in 2005 and the greatest number of nests was seen in 2004. In terms of turtles hatched, the year 2004 had the highest number of turtle hatchlings (3066). However, this number declined to 1,714 in 2005. Of all the species, leatherbacks produced the greatest number of hatchlings over the 5 year period. No hatchlings were observed in 2002. It is our hope that with continued monitoring of the beach by the GMTCS, sea turtles will continue to nest at the beach. With constant research and monitoring, there should be a decline in poaching and slaughter of adult females. The EPA of Guyana and GMTCS will continue to work closely to analyze data from the nesting beaches and to share information for decision-making and management of marine turtles in Guyana and around the

world. The EPA and GMTCS would like to express sincere gratitude to the organisations as well as to the Sea Turtle Symposium for your generous donations in order to make this day possible.

INCUBATION SUCCESS AND EMERGENCE SEQUENCES OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) NESTS ON PEJEPERRO BEACH, OSA PENINSULA, COSTA RICA (EASTERN PACIFIC)

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Studies of incubation success and emergence sequence of sea turtle nests are more accurate when conducted on the beach than in hatcheries where incubation conditions are not natural. This study was carried out on Pejeperro Beach, an olive ridley (*Lepidochelys olivacea*) solitary nesting beach in Costa Rica, from July to September 2006. A total of 20 nests were marked along the beach, 10 of them were *in situ*, and the other 10 relocated on the beach. On the 40th day of incubation a plastic cylindrical cage was placed around the nests to retain hatchlings for size and weight measurements, to establish emergence sequences, and to know the exact number of hatchlings from each nest. The mean incubation period was 48.7 ± 3.51 days (mean + SD). From the 1,883 incubated eggs, a total of 1,624 hatchlings were produced, with mean curved carapace length (CCL) and width (CCW) of 44.26 ± 1.65 mm and 44.89 ± 1.89 mm respectively; mean CCL and CCW of 35.60 ± 0.87mm and 29.30 ± 1.67 mm and mean weight of 20 ± 2.87 g. The number of emergences per nest was 1.75 ± 0.96, with 90.36% of the hatchlings emerging in the first emergence. Sixty percent of the emergences were at night. The total hatching success for the beach was 95.47% with an emergence success of 85.48%.

THE MALUANE COMUMUNITY-BASED CONSERVATION PROGRAMME IN MOZAMBIQUE

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Maluane was created in order to ensure the sustainable conservation of marine biodiversity of global value in northern Mozambique through a partnership between the private sector, communities, the government and the Zoological Society of London (ZSL), an international conservation organization. The project areas include two islands, Vamizi and Rongui, which will be shortly gazetted within a protected area linking up with the Mnazi Bay/Rovuma Estuary National Park in southern Tanzania into a Transfrontier Area. The sustainability of the Maluane conservation program will be ensured financially through the development of an up-market tourism product in each Project area, socio-economically by involving local communities in all aspects of management and ensuring that they benefit directly and indirectly from all activities, and ecologically through scientifically-based management. The marine turtle program began in 2002 with the training of local fishermen in the monitoring of turtle nesting activity and the protection of nests. Not a single nest has been poached within the concession area since that time and over 350 nests from green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles have been marked, protected and monitored. Although the majority of the nests are from

green turtles, 15% (54 nests) of the nests were from hawksbill turtles, emphasizing the conservation value of the area. Community-based monitoring activities allowed for determination of the mean incubation period (63±9.1, n=321 for green; 59±6.8, n=27 for hawksbill), which also showed a strong seasonal pattern: 75% of nesting activity was detected between February and July. Mean hatching success for green and hawksbill was 85.1±21.1% (n=321) and 86.31±14.0% (n=27), respectively. Mean emergence success for green and hawksbill was 80.5±24.2% (n=321) and 84.73±16.90% (n=27), respectively. During the regular night patrols of nesting beaches, 46 green turtles were tagged on Vamizi Island. Results showed a mean clutch frequency of 2.5±0.9 nests per turtle (n=46) and a mean inter-nesting interval of 17.4±4.2 days. Nesting females showed strong site fidelity and the choice of the nesting beach was significantly correlated with the predominant winds. Other activities in the Maluane Turtle Program include an on-going education program with the local communities and an incentive program with the local fishermen to bring turtles caught incidentally in their nets to tag and to collect samples for genetic analysis. The Maluane project illustrates the benefit of developing a partnership with local communities.

ESTIMATING ARRIBADA SIZE: GOING GLOBAL

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The olive ridley presents a pantropical distribution, nesting solitarily and en masse throughout its distribution range. Because of this wide distribution and the large number of conspecifics that participate in mass nesting events, it is very difficult to generate a preliminary picture of the global abundance of this species. However, given that a large proportion of the adult population is thought to participate in discrete mass nesting events at well known beaches, it is possible to focus census efforts on this relatively accessible fragment of the life cycle of these turtles. The objective of this paper is to report estimates of mass nesting olive ridley numbers of most major arribada beaches around the world. Specifically, we report on numbers of nesting turtles on Nancite and Ostional Beaches, Costa Rica, and La Escobilla, Mexico. Efforts are underway to collect data also at Gahirmatha and Rushikulya, India. Our approach is to apply the same methodology (strip-transect in time or instantaneous count procedure) at every beach so as to generate robust, reliable and directly comparable estimates. Preliminary results confirm that the Nancite Beach nesting population has undergone a crash relative to nesting levels in the 80's and the robustness of the Ostional assemblage. It is expected that, if applied consistently over the years at every major arribada beach, conservationists and managers will be able to use arribada estimates as a relative index of health of every major olive ridley assemblage.

LOGGERHEAD (*CARETTA CARETTA*) NESTING ON VIRGINIA KEY: A 15-YEAR OVERVIEW

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Marine turtle nesting surveys have been conducted on Virginia Key, Miami-Dade County, Florida from 1990-2006 with survey methods evolving over time. Total number of nests laid has varied considerably over this timeframe, with no apparent increasing or decreasing trend. Hatching success has also varied, with environmental conditions caused by tropical storm and hurricane activity and predation by raccoons having the largest apparent impacts.

EFFECTS OF EGG POACHING ON THE POPULATION OF LEATHERBACK TURTLES THAT NEST AT PARQUE NACIONAL MARINO LAS BAULAS, COSTA RICA

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The population of leatherback turtles (*Dermochelys coriacea*) that nest at Parque Nacional Marino Las Baulas was the subject of an organized system of poaching that removed approximately 90% of all the eggs laid for about 15-20 years. Poaching and high mortality rates of adults in the Ocean are believed to have caused a rapid and precipitous decline in the number of nesting turtles that might lead to the extinction of this population in 40-60 years. Using 15 years of demographic data for comparison we simulated the effect of only poaching on the population structure and numbers of nesting leatherback turtles at Parque Nacional Marino Las Baulas. Using the demographic data we set a stage-based population structure at 35% recruits, 30% second time nesters, 20% third time nesters, 10% fourth time nesters and 5% fifth time nesters. We simulated and compared (1) the impact of continuous poaching at 90% level on the population, (2) the impact of reducing poaching to lower intensities and the expected extinction times and (3) the effect of eradicating poaching at different stages after it was introduced. Finally, we compared the population simulations to the real trends observed during the last 15 years. Our analysis demonstrated that poaching could be the most important single cause for the fast decline of the population of leatherback turtles that nest at Parque Nacional Marino Las Baulas. This may indicate that factors influencing nesting and reproductive output may have been a major and important factor in rapid stepwise declines of the Pacific leatherback populations along with the additional impact of increased adult mortalities at sea due to fishing practices. The analysis suggests that elimination of poaching should result in noticeable recovery in the population in 20-25 years.

A PRELIMINARY STUDY ON THE MORPHOMETRIC VARIATION OF *CHELONIA MYDAS* IN THREE DIFFERENT BEACHES OF TURKEY

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The aim of this study was to compare SCL, SCW, CCL and CCW measurements of green turtles, *Chelonia mydas*, among the Kazanli, Akyatan and Samandag beaches, located in the east Mediterranean coast of Turkey. A total of 105 green turtles measured during the 1994, 1996 and 2006 breeding seasons, were compared with Canonical Variance (CVA) and Cluster Analyses. Analysis results (Wilk's lambda: 0,8665; df1: 8; df2: 198; F: 1,838; p: 0,07195) verified that it is hard to report that sea turtles nesting on these beaches were totally different. However, further data from other Turkish nesting beaches is required to make a more reliable conclusion.

GREEN TURTLE (*CHELONIA MYDAS*) NESTING ON AKYATAN BEACH, TURKEY

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In this study, Akyatan Beach was examined during the 2005 nesting season. Akyatan Beach is the most important nesting beach in the Mediterranean (Kasparek *et al*. 2001). Our research was conducted between 7 June-15 September. The 22 km beach was monitored by foot everyday and nesting and non-nesting emergences were recorded. A total of 1,421 emergences were recorded with 562 (39.55%) resulting in nests. A total of 60,962 eggs were laid, however, 13.97% of the eggs were depredated by jackals and foxes. A total of 40,686 (66.74%) hatchlings were produced. Of these hatchlings, 32,524 (79.94%) were able to reach the sea. The peak nesting activity occurred in June. The average incubation duration was 54.5 days.
Acknowledgements: This study was realized within the framework of collaboration protocol between WWF-Turkey and Environment and Forestry Department Adana Province. The authors also would like to thank Semih Barabaros and Ozgur Ozardıc for their help in the field. The senior author would like to thank WWF-Turkey, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service and Sea Turtle Symposium whose donations helped to participate 2007 Sea Turtle Symposium for their financial support. References: Kasparek, M., Godley, RJ., Broderiek, A.C., 2001. Nesting of the green turtle, *Chelonia mydas*, in the Mediterranean: ci review of the status and eonservation needs. Zoology in the Middle East, 24:45-74.

NESTING OF GREEN TURTLES IN AVES ISLAND WILDLIFE REFUGE. 2006 SEASON

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Ministerio del Ambiente, Caracas, Distrito Capital, VENEZUELA

A project “Monitoring and conservation of green turtle (*Chelonia mydas*) population in Aves Island Wildlife Refuge” was developed in the most important sea turtle nesting area of Venezuela. Beach patrols were performed from 4 to 6 hours each night, except when weather conditions did not allow to stay at the beach. Turtles were tagged during ovoposition in both fore flippers with inconel and monel tags and they were measured with a flexible tape. The time, location, and any particular characteristic of the animal were also registered. If there was a nest too close to the shore, it was translocated to a safe place on the beach. All the information was ordered, analyzed and compared with previous data. During June to October 2006, I identified 450 green turtle females. From that number, new tags were applied to 400 females, a number higher with respect to the last year and many other past seasons. The remigrants were mainly from 2002 and, the oldest recaptures were observed from 1985 and 1986. Also, it is really remarkable that for the first time in Aves Island, the recapture of two turtles tagged in different foreign beaches from Caribbean Sea were recorded. With respect to the body measurements, the mean determined for the standard curved length and curved carapace width (112,4 cm. and 102,2 cm., respectively) were minor to those established for the last season, but it is similar to previous years. The explanation for this result can be related to the observation of a higher percentage of recruits coming to nest during the 2006 season. The majority of the animals demonstrated a preference to nest in the southern zone of the island, which indicates that the precautions to decrease the effect of artificial light in that sector had good results. However, the negative impact of lighting continues affecting the animals and the monitoring work and it is crucial to eliminate the negative effects of the artificial lights on the females and the hatchlings. These results confirm that on this index beach for the Caribbean, green turtles seem to be stable and in good health.

LONG-TERM NESTING TRENDS OF LOGGERHEAD SEA TURTLES: 34 YEARS OF CONSERVATION ON WASSAW ISLAND, GA, USA

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The *Caretta* Research Project has conducted a saturation-tagging and nest protection project on Wassaw Island, GA since 1973. Yearly trends in nest numbers and population structure were analyzed. Preliminary analyses reveal that while the number of turtles nesting has only slightly increased in 34 years, there has been a marked increase in nest numbers. Our results are compared to two other long-term datasets: Little Cumberland Island, GA and Bald Head Island, NC.

FIRST RECORD OF JUVENILE OLIVE RIDLEY TURTLES (*LEPIDOCHELYS OLIVACEA*) IN NORTHERN SINALOA, GULF OF CALIFORNIA, MEXICO

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The Gulf of California Region is recognized as an important developmental and forraging habitat for three of the five species of sea turtles known to occur in the Eastern Pacific. Monitoring and conservation programs in this region are focused primarily to the Baja California Peninsula and northern Mexican Pacific (both coasts identified in the States of Baja California Sur and Sonora) to date. We begun the first sea turtle prospective surveys in bays and lagoons located in northern Sinaloa during 2004. Our study sites are found in the insular complex of San Ignacio-Navachiste-Macapule, Municipality of Guasave, Mexico (25° 15'; 25° 35' N and 108° 30'; 109° 03' W). This converging insular complex is formed by 25 islands protected under the Flora and Fauna Protection Area “Islas del Golfo de California”. Our project has different objectives including to: a) determine sea turtle species diversity b) determine temporal and distributional patterns of sea turtles, c) obtain basic biological parameters of sea turtles (size, weight, length, sex), d) Identify primary threats to sea turtles due to anthropogenic change, and e) build the basis for an integral conservation program including full participation of the local communities. During summer 2005, we initiated suirveys and patrolled the coastal permiter of the island complex supported by volunteer fishermen and students. To date, we have documented 35 live and dead sea turtle strandings. The preliminary results confirm the presence of three species of sea turtles: Olivey ridley (*Lepidochelys olivacea*, 83%), black turtle *Chelonia mydas agasizzi*, 14%), and hawksbill turtle, *Eretmochelys* imbricada, 3%). We are documenting for the first time the presence of juvenile olive ridley turtles in our monitoring sites. The first turtle had a curved carapace length (CCL) of 12.9 cm. During our survey efforts we also rescued a juvenile olive ridley (21 cm CCL and 1.165 kg) that was found tangled in synthetic marine debris used by the local shrimp and bone fish fisheries. This sea turtle presented severe, deep lacerations of both front flippers, with dehydration and anemia. The sea turtle was brought into captivity for four months for rehabilitation purposes prior to release to its natural habitat. We like to emphasize that incidental and illegal fisheries are recognized as the most severe threats for local sea turtle populations both resident and migratory at the monitoring site. These monitoring and conservation efforts need to be reinforced with an effective management plan complemenitng the conservation programs developed in southern Sinaloa, where the primary nesting sites for sea turtles are found in northeastern Mexico. Thanks to Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service for the travel grant.

THE ROLE AND NATURE OF THE SEA TURTLE IN PREHISTORIC CARIBBEAN AND LUCAYAN CULTURE: EVIDENCE FROM ARCHAEOLOGY AND ETHNOGRAPHY

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Excavations at North Storr's Lake on San Salvador, Bahamas yielded a dense deposit of sea turtle (Cheloniidae). Approximately 1300 fragments of sea turtle were recovered representing plastron, carapace, vertebrae, and other skeletal elements. Sea turtle remains weighed three times more than other vertebrate fauna recovered, which included numerous reef fishes. Utilizing archaeological, historical, and ethnographic records, the role of the sea turtle in prehistoric Caribbean and Lucayan culture is investigated. Zooarchaeologists typically categorize sea turtle only to the family level, but this practice raises the issue of which of the half-dozen or so Cheloniidae are represented in the archaeological deposits. Green turtle (*Chelonia mydas*) is culturally preferred worldwide, loggerhead (*Caretta caretta*) has been previously recovered on San Salvador, and hawksbills (*Eretmochelys imbricata*) are common in the waters of San Salvador today. It is hoped that ongoing stable isotope and DNA analyses will shed light on the identity of the archaeological sea turtles recovered from the North Storr's Lake site and other sites on San Salvador.

SOCIAL FACTORS AFFECTING COMMUNITY-BASED CONSERVATION OF SEA TURTLES IN BAJA CALIFORNIA, MEXICO AND CARIBBEAN NICARAGUA

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The goal of this research is to assess the factors that lead to the success of community-based conservation and research initiatives in the Baja Peninsula and Nicaragua. Model-communities with community-based conservation initiatives in Baja California, Mexico, and Caribbean Nicaragua will be examined for societal and program factors that contribute to or impede program success. These factors will be placed within the context of historical interactions between humans and sea turtles at each study-site. This analytical research will determine if successful community-based projects are discovered, designed, or resultant of specific internal and external factors. From this research and analysis, we will be able to determine the factors that contribute to the success of community-based conservation initiatives in coastal communities with a history of human-sea turtle interactions.

PUBLICITY TO THE RESCUE OF SEA TURTLES IN THE GULF OF VENEZUELA: A CASE STUDY CALLED 'PROYECTO SHÄWA'

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Marine turtles are endangered worldwide and Venzuela is no exception. The Marine Turtle Work Group of the Gulf of Venezuela (Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela: GTTM-GV) has developed a grass roots, non-profit project named Proyecto Shäwa Proyecto in 2002 with the goal of educating the public about turtles, conducting research on local turtle populations and compiling much-needed data that can be used to formulate and implement useful management strategies for turtles in Venezuela. Despite our lack of office-space or the traditional ammenities usually associated with a research group, we have successfully estabished a working conservation organization soley using publicity as our major vehicle for defining and running our organization. Advertising has helped to generate interest in our program and we hope that it will help us to attract and organize volunteers to participate in the activities of our organization, as well as establish a major network dedicated to the preservation of sea turtles in Venezuela. By continuing our advertising campaign we hope that our organization will continue to grow and, as a result, allow us to educate more people each year on the dangers facing sea turtles in Venezuela.

PERSPECTIVES ON SEA TURTLES AT THE LA FLOR RESERVE BY MEMBERS OF THE JOSE ADAN CALDERON COOPERATIVE, OSTIONAL, NICARAGUA

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The La Flor Reserve in southwestern Nicaragua is one of the eastern Pacific's most important nesting sites for olive ridley sea turtles. Over the past decade, the local community of Ostional has been a major source of nest predation. In addition, fishermen have increasingly resorted to killing adult turtles in the coastal waters as a means of easily extracting turtle eggs. Intense conflicts between community members and managers at the reserve area have developed. In the absence of the Nicaraguan army serving as guards at the reserve, the reserve would likely be completely overtaken by local community members during nesting season. In an effort to bridge the divide between conservation efforts and the community of Ostional, Paso Pacifico initiated a series of meetings with members of the principle cooperative in Ostional, the Cooperativa Jose Adan Calderon. The San Juan del Sur municipal government has also participated in these meetings. The Jose Adan Calderon cooperative directly and indirectly

benefits over ninety families in the Ostional community. Members of the cooperative currently participate in illegal raids of nesting beaches and other types of sabotage of conservation efforts. We carried out semi-structured interviews with cooperative members regarding their perspectives on their rights and access to marine resources, particularly sea turtle eggs. We present the results of these interviews and perspectives on marine conservation. Results of these interviews and community meetings demonstrate that cooperative members are concerned about the negative impacts of their actions on both sea turtles and near-shore fisheries, but that the social conflicts surrounding turtle egg protection deter the community members from changing their behavior. Cooperative members see the potential for income generation through eco-tourism activities, but they disbelieve that they can become beneficiaries of such activities. We conclude that given the level of tensions between park authorities and members of the Ostional community, a long-term program aimed at conflict resolution should be developed. By developing collaborative relationships between the reserve managers and the local fishing and ranching community, local people may be more willing to make changes in their behaviors, especially with regards to killing adult sea turtles. Additionally, given the huge increase in tourism activities, there is tremendous potential for income-generation in this community through the non-extractive use of marine resources (i.e. turtle viewing, dive and snorkel trips, etc).

TOWARD REDUCING HUMAN-CAUSED IMPACTS ON GREEN TURTLE NESTING ACTIVITY IN OGASAWARA ISLANDS: AN APPROACH TO UNDERSTANDING THE SOCIAL DIMENSIONS OF TURTLE CONSERVATION

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Ogasawara Islands are the largest breeding ground for green turtles (*Chelonia mydas*) in Japan. The recent promotion of ecotourism and the UNESCO World Natural Heritage Site nomination planned for 2008 in the area are expected to contribute to increased visitor numbers, which is raising concerns over the potential increase in negative impacts of human activities on sea turtle nesting. Currently, there are no regulations in place on the islands to limit access to important nesting areas or to manage visitor behavior in these areas. In addition, sufficient guidelines for sea turtle viewing have yet to be established on the islands. Given the potential for increases in human-turtle interactions in Ogasawara, management actions to minimize human impacts on sea turtles will likely be needed in the future. Examples of management actions around the world to minimize human impacts on sea turtle nesting include establishment of marine protected areas and regulations prohibiting access to nesting beaches. However, these actions have been implemented in countries such as the United States and Greece, where culture and approaches to wildlife conservation differ from that of Japan. Thus, management actions shown to be effective in these countries may not necessarily be suitable for Ogasawara. It is critical that any management action is not only biologically effective, but also appropriate for the local cultural context. In addition, the success of future management actions may depend on the level of support by the local population as well as visitors. Information about visitor and local resident perceptions of sea turtles and their management in Ogasawara is needed to inform future conservation efforts. The purpose of our research is to provide an understanding of the social dimensions of sea turtle conservation in Ogasawara to aid in minimizing potential negative impacts of human activities on sea turtle nesting. An exploratory phase of this research, involving interviews with a small sample of local residents and researchers, was conducted

during the summer of 2006 to enhance understanding of sea turtle conservation issues in Ogasawara. This research confirmed the need for a more in-depth investigation and, in particular, highlighted the need for information to assist with sea turtle education efforts. Our presentation will draw from these findings to provide an overview of the context for sea turtle conservation in Ogasawara. In addition, we will offer a conceptual approach to understanding public support for sea turtle conservation. This approach, rooted in social science theories that have been adapted for use in exploring wildlife and other natural resource issues, will be applied in the summer of 2007 in Ogasawara to examine (1) visitors' and local residents' support for sea turtle management actions, and (2) beliefs that form the basis for visitors' and local residents' attitudes and behaviors regarding sea turtles. This information will be critical to ensuring the success of future sea turtle conservation efforts in Ogasawara and will aid in informing conservation education programs. We would like to thank the Sea Turtle Symposium and their generous donors for financial assistance to participate in the symposium.

HOW VALUABLE ARE VOLUNTEER TOURISTS? AN ASSESSMENT OF THE LABOR AND CAPITAL PROVIDED BY PAYING PARTICIPANTS AT BEACH-NESTING PROGRAMS IN COSTA RICA

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Sea turtle conservation in Costa Rica has become closely associated with "volunteer tourism," as more and more projects are recruiting international participants who pay a program fee to volunteer their time at nesting beach sites. Using a political ecology framework, this paper looks at how critical the labor and capital provided by paying-participants are to the operation of these programs. The results are drawn from a survey of identified nesting programs on the Pacific and Caribbean coasts of Costa Rica, as well as earlier interviews and participant observation at a beach-nesting program in the community of San Miguel, Guanacaste province. These initial findings show that the project directors and coordinators value the increased presence paying-participants create on the beach for deterring poaching, but there is a great deal of variation in the amount of work and types of tasks volunteers do between projects. This poster analyzes these issues, as well as the timing of the peak volunteer tourist season with turtle nesting, the amount of capital generated by participants, and the proportion of fees that go toward conservation and local communities. Acknowledgments: I gratefully acknowledge travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, and U.S. Fish and Wildlife Service, provided through the Symposium Travel Committee.

WANTED: DEAD AND ALIVE. LOCAL PERCEPTIONS OF TURTLE CONSERVATION AND TURTLE-BASED ECOTOURISM IN TORTUGUERO, COSTA RICA

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Tortuguero, Costa Rica is widely considered a successful example of turtle-based ecotourism that benefits both sea turtles and local residents. Tourism to the area, in which turtle tours play a vital role, now draws over 80,000 tourists a year and generates an estimated six million dollars

in gross revenues (Harrison *et al*. 2004; Troëng and Drews 2004). The mantra 'a turtle is worth more alive than dead' is often used to suggest that local appreciation for turtle tourism-generated revenues in Tortuguero (and other places) has led to local support for turtle conservation efforts, and for the end of extractive uses of turtles. Using qualitative data derived from in-depth interviews with local residents and on-site observations during 7 months of fieldwork in Tortuguero during 2003 and 2004, this paper interrogates the extent to this has occurred in Tortuguero. When discussing their perceptions of turtle conservation and turtle-based tourism in the village, local respondents reveal complex and sometimes ambiguous and/or conflicting views of tourism, conservation, and the direct consumption of turtle products. Results show that local people simultaneously: 1) appreciate increased revenues and the 'easier lifestyle' brought to the village by ecotourism development; 2) recognize the role and importance of turtles in the new economy; and 3) are critical of conservation in practice in Tortuguero. Furthermore, some local respondents continue to want to use turtle meat and eggs as food. Based on these results, we describe an emerging 'made in Tortuguero' conservation narrative that deviates from Western conceptions of turtle conservation and ecotourism in that it affords legitimacy to/appreciation for both ecotourism and the direct consumption of turtle products (e.g. meat; eggs), simultaneously. The existence of this local conservation counter-narrative, or adapted turtle-related culture, represents a challenge to current assumptions about the power of ecotourism to act as an incentive for local support of non-extractive policies.

THE CULTURAL VALUE OF MARINE TURTLES TO AN ETHNIC GROUP WAYUU (GUAJIROS) FROM THE ATLANTIC COLOMBIAN COAST AND THE VENEZUELAN GULF: AN EARTH-WATER ANALOGY

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An extensive investigation was conducted by bibliographic research, interviews and field surveys with the aim of determining the cultural value of sea turtles to the ethnic group 'Wayuu' (composed of two groups: the Water Guajiros and the Earth Guajiros) in Venezuela and Colombia. This study also sought to estimate the impact of Wayuu activities on the annual number of dead turtles observed in the Venezuelan gulf and the Straits of Maracaibo. The dietary importance of sea turtles to the Wayuu (Guajiros) was emphasized by a man of the Water Guajiros, who considered turtle the "most exquisite food in their diet". For Water Guajiros, a community poorer than their upland neighbors: the Earth Guajiros, there's an earth-water analogy between a rich Wayuu's (Earth Guajiro) cattle and sea turtles, for both feed upon grasses - the cattle on the earth and the turtle in the sea. The cattle lives in the mountains on land and the turtle in the mountains under the sea (reefs). In this way they reduce the economic differences between the two types of animals. Thus, turtles are simply available resources similar to cattle. Nevertheless, cattle are often used to negotiate purchases by the Guajiros, even for acquiring spouses. So, because turtle meat is much more revered, the Guajiros have favored turtle harvesting since its meat is more valuable than that of cattle. For instance, an adult carey turtle (*Eretmochelys imbricata*) might bring a fisherman as much as 280 American dollars. As a result, this economic situation has led to the formation of commercial fisheries for turtles using non-traditional hunting techniques by the Guajiros. In fact, our research has determined that 45% of the dead turtles in our study area were killed by Wayuu communities, approximately 25 turtles per year.

COMBINING SATELLITE TELEMETRY AND QUALITATIVE SURVEY METHODOLOGIES TO ASSESS NESTING LOGGERHEAD (*CARETTA CARETTA*) FORAGING AND OVERWINTERING HABITATS IN NORTH CAROLINA WATERS

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Nesting populations of loggerhead sea turtles in North Carolina are crucial for the larger population that nests throughout the southeast U.S. Because sea turtles undergo temperature-dependent sex differentiation, loggerheads that nest on the cooler beaches of North Carolina are responsible for a high percentage of the males in the southeast population. In spite of this importance, little is known about their habitats in coastal North Carolina waters. Sea turtles are highly migratory and cryptic, making research initiatives difficult. To gain more insight into the migrations and habitat uses of sea turtles, researchers are increasingly relying on satellite telemetry to record spatial and temporal distributions of these animals. These data can aid in conservation by identifying critical sea turtle habitat and the multiple jurisdictional boundaries they cross during their migrations. Researchers have implemented this methodology to study loggerheads that nest on Bald Head Island in North Carolina. In spite of its success as a research tool, there are limitations in the accuracy of the telemetry location data, and data provide limited habitat information. In order to ground-truth the satellite data and gain further insight into the habitat features that characterize foraging and over-wintering sites for nesting North Carolina loggerheads, we developed a survey to target recreational dive shops, scientific divers and charter boats that operate in these areas. Survey respondents answered a series of questions regarding sea turtle observations, habitat characteristics, and potential threats to turtles within these sites. Preliminary results indicate that divers and boaters posses a wealth of knowledge about the turtle habitats we are interested in. The extent and value of their knowledge of the marine environment is comparable to the traditional ecological knowledge that researchers often seek from fishermen. While initial enthusiasm about the project was high among respondents, the mail-based methodology first used incited less participation than expected. New efforts expanded the study to include respondents other than just dive operators, and to employ new social science survey methods other than the initial mail-based survey such as face-to-face surveys. Survey methodology represents a unique opportunity to bridge the gap between the public and scientific community. It also allows for a richer exploration of satellite data that is often not possible for pelagic environments that do not overlap with human uses. This project is important in identifying the strengths and limitations of such a methodology to achieve this goal. This survey methodology could be adapted to other areas where satellite telemetry has been used to track migratory animals, and the qualitative information could complement the quantitative satellite data for more comprehensive habitat assessments.

TO EAT, OR NOT TO EAT? PERCEPTIONS REGARDING THE SAFETY OF SEA TURTLE CONSUMPTION IN NORTHWESTERN MEXICO

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Sea turtles have historically been an important resource for many coastal inhabitants of northwestern Mexico, used throughout the region for food, medicine, and decoration. Today, sea turtles remain a coveted item in northwestern Mexico despite being afforded complete legal protection since 1990. Consuming the meat and eggs is not only illegal, but also may be harmful to human health due to environmental contaminants such as heavy metals and organochlorines (e.g., DDT; DDE; PCBs). Sea turtles may also carry parasites and bacteria that, when consumed, may cause deleterious health effects. In addition, sea turtle meat is often sold on the unregulated black market where its processing and transport may be of dubious sanitary quality. Therefore, the objectives of our study were: (1) to better understand perceptions the general public may have regarding potential risks associated with consuming sea turtles; (2) to better understand perceptions regional doctors may have regarding potential risks associated with consuming sea turtles; (3) to gain a better understanding of the significance associated with locals becoming sick from consuming sea turtles; and (4) to provide a foundation for effective communication of these risks. Surveys and interviews were performed in Baja California Sur (BCS), Mexico. In 2005, 165 local people, including 36 health professionals, were randomly surveyed in Puerto San Carlos and Ciudad Constitución. More males (71%) than females were interviewed, with the majority (75%) between 20 and 39 years of age. Non-professionals were the largest group (64%) followed by professionals (21%) and students (15%). Most respondents (67%) had obtained a high school or above education and the majority (91%) were interested in sea turtle conservation, regardless of gender, level of education, or occupation. When asked if consuming sea turtle meat and/or eggs was bad for their health, most locals (68%) responded ‘no’, regardless of gender, education, or occupation, with the exception of students that showed no difference. When asked whether or not they would consume sea turtle meat and/or eggs if their physician told them it was unhealthy, most (81%) responded negatively, regardless of gender, education, or occupation. Detailed information on whether or not locals had knowledge of possible contaminants present in regional sea turtles will be presented. Of 36 doctors surveyed, 31% treated multiple patients for various forms of food poisoning resulting from consuming turtle meat and/or eggs. However, this number may be conservative given that some doctors most likely consume or have consumed sea turtle and some mentioned that they were unwilling to share such sensitive information. In Puerto San Carlos, a relatively small coastal community, 40% of doctors believed that sea turtle was a healthy food source. Comparatively, in the larger urban center of Ciudad Constitución, only 6% of doctors believed that sea turtle was a healthy food source. *Acknowledgements*: Travel support for J. Senko was provided by the Sea Turtle Symposium, Disney’s Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, US Fish and Wildlife Service, and the University of Connecticut Department of Natural Resources Management and Engineering.

LOCAL KNOWLEDGE VERSUS SCIENTIFIC DATA

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The collection of sea turtle eggs, whether it be for consumption or sale, is a tradition undertaken by many coastal inhabitants in Costa Rica. Years of custom have made it so that these people are well acquainted with sea turtle nesting behavior, to the point where they claim to know the best conditions during which to encouter nesting sea turtles according to specific dates, times, tides and moon phases. Is it true that decades of living near nesting beaches has taught local inhabitants a sure method for encountering nesting turtles? We, PRETOMA (Programa Restauración de Tortugas Marinas), began sea turtle conservation efforts at nesting beaches on the Pacific Coast of Costa Rica in 1996 and are able to identify the optimal dates, times, tides and moon phases for encountering nesting sea turtles. By conducting coastal inhabitant interviews regarding the aboved mentioned variables and comparing them with the data collected at our projects, we have determined whether or not there exists a correlation between popular coastal beliefs and our nesting beach project results.

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