NOAA Technical Memorandum NMFS-SEFSC-602

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

22 to 26 January 2008
Loreto, Baja California Sur, México

Compiled by:
Kama Dean & Melania C. López Castro

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, Florida 33149

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Gary Locke, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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March 2010

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For bibliographic purposes, this document should be cited as follows:

Dean, Kama. & López-Castro, Melania C., compilers. 2010. Proceedings of the Twenty-eighth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NOAA NMFS-SEFSC-602: 272p.

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PRESIDENT'S REPORT ON THE 28TH ANNUAL SYMPOSIUM ON SEA TURTLE BIOLOGY AND CONSERVATION

Wallace J. Nichols

January 2008, Loreto, Baja California Sur, México

Dear Friends,

This ISTS was a very special gathering. In 2008 we broke away from some traditions and did many things differently. Hopefully some of the positive changes will stick.

Holding the 28th meeting of the International Sea Turtle Society in Loreto paid tribute to the long relationship that Loreto and the Baja peninsula have with the sea turtle. It was here in Loreto that Jeff Seminoff and I caught our first black turtle two decades ago. We did so with the help of Juan de la Cruz Villalejos, a local fisherman and former turtle hunter. And in catching that turtle we set our careers and the collaborative approach to our work in motion.

We simultaneously celebrated the tenth anniversary of Grupo Tortuguero this year in Loreto, the place of its founding. To combine these events in Loreto is both wonderful and meaningful. A dream of sorts. These proceedings contain a series of papers from the Sea Turtles of the Californias Session.

While this size conference was a first for this *pueblito* the community embraced our meeting just as they have embraced sea turtle conservation and the protection of their ocean through the establishment of a National Marine Park.

When I was asked to name a location for the 2008 Symposium, in my mind there was no better option. In addition to the community of Loreto, special praise goes to the ISTS volunteers, Kama and Melania for compiling these proceedings, the ISTS executive committee and to Journey Mexico, our fantastic on-site organizing team, who worked hard all year on this event. I've thrown them one curveball after another, including speed sessions, a "creative" venue and an outdoor poster session. They handled each element and challenge with grace and skill.

Our theme this year was Native Oceans. As such we celebrated our rich cultural connections with sea turtles and shared some traditional sea turtle ceremonies. The 2008 ISTS logo was designed by Gabriel Hoeffer, a young conservation leader in the Seri community. He and his colleagues and family served as our cultural hosts.

The choice to hold the ISTS in Loreto and to take on the challenges this presented was made because it is in line with whom we are, what we stand for, and the set of ideals we strive to live by.

This meeting annually brings hundreds of thousands of dollars to the region where it is held. This year, that income helped to promote sea turtle conservation and is being spread around to many, many individuals, businesses and conservation organizations in the name of sea turtle conservation.

We utilized the modest infrastructure of Loreto, all of its hotels and restaurants, its municipal auditorium, and university classrooms rather than an all-in-one conference center or resort. In addition, we occupied outdoor plazas and boulevards for meals, music, events and presentations. This meant that we walked a little more and spent more time under the Baja sky—and it turns out that we had more conversations with each other and the local community.

For the first time, we worked in many ways to reduce our footprint through the LIVBLUE Challenge. ISTS members did their part by conserving energy and water during their visit, by walking and ride sharing whenever possible, by using their own bottles, mugs and utensils whenever possible, by reusing and recycling when they could, and by using the solar trailer to power up our equipment.

Several sponsors provided food and items that helped us to “LIVBLUE”. They ranged from organic tequila, coffee and cotton t-shirts to solar power, recycled paper, tote bags and reusable bottles/mugs.

Much of the equipment we used this year, including laptops and projectors, were purchased by the ISTS with technology grants and were re-granted to local sea turtle conservation organizations after the meeting.

Holding the meeting in Loreto promoted sea turtle conservation and sustainability locally, regionally and internationally. Many of the people who attended their first ISTS are working on the front lines of conservation and were able to share with and learn from our community. Others learned about sea turtle conservation for the first time. The entire Loreto community embraced this event and viewed it through the eyes of their future.

In some ways Loreto wasn’t the best place for the 2008 International Sea Turtle Symposium. In other ways, it was the only place. I hope that those who attended enjoyed the *buena onda* of Baja, its people and its nature. And that those who couldn’t make it consider this as an invitation to visit.

The new friendships, ideas and collaborations will continue to grow out of this gathering.

Abrazos,

Wallace J. Nichols, PhD
President, International Sea Turtle Society
28th Annual Symposium on Sea Turtle Biology and Conservation

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Volunteer Chairs	Elena Finkbeiner, Daniel Durazo
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Grupo Tortuguero Meeting	Kama Dean, Jesus “Chuy” Lucero
Native Oceans Coordinator	Gabriel Hoeffer Felix
Latin America (Retomala) Meeting	Omar Chassin, Alan Zavala Norzagaray
WIDECAST Meeting	Karen Eckert
IOSEA Meeting	Douglas Hykle
Mediterranean Meeting	Paolo Casale
African Meeting	Jacques Fretey and Manjula Tiwari
Marine Turtle Specialist Group	Brian Hutchinson, Roderic Mast and Nicolas Pilcher

Workshop Coordinators	Alonso Aguirre, Peter Dutton, Tomo Eguchi, Michael Frick, Brad Nahill, Rebecca Lewison, Chuck Shaffer, Sebastian Troëng
Vendor Chair	Cellene Nahill
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STUDENT AWARDS

There were 126 student presentations – 33 papers and 93 posters with $3,000 US awarded to eight recipients. The awards committee was composed of Lisa Campbell (chair), Brian Wallace, Mark Hamann, Thane Wibbels, Nicolas J. Pilcher, Marc Giorndot, Larisa Avens, Kartik Shanker, Matthew Godfrey, Kate Mansfield, Robert Van Damn, Kirsten Dobbs, Marydele Donnelly, Cynthia Lagueux, Ana Barragán, Jeanette Wyneken, Lucy Hawkes, Zoe Meletis, Larry Crowder, and Karen Arthur. The awards were financed by the Chelonian Research Foundation and the International Sea Turtle Society.

<u>Oral presentations</u>

Best Biology Oral Presentation

Kelly Stewart, Peter, H.Dutton, Suzanne Roden, Erin LaCasella, and Chris Johnson. "Colonization of Florida Nesting Beaches by leatherback turtles: microsatellites and mtDNA reveal the demographic history of this population" (Duke University Marine Lab, Beaufort, North Carolina, USA). $500

Runner Up Biology Oral Presentation

Brian Bostrom, T. Todd Jones, Mervin Hastings, and David R. Jones. "Aspects of thermal regulation in captive juvenile leatherback sea turtles (*Dermochelys coriacea*)" (Department of Zoology, University of British Columbia, Vancouver, British Columbia, Canada). $250

Best Conservation Oral Presentation

Jillian Grayson, Stephen Ambar, Helen Marsh, and Mark Hamann. "Options for sustainable use of green turtles by Hammond Islanders" (James Cook University, Townsville, Queensland, Australia). $500

Runner Up Conservation Oral Presentation

Azuka Ishizaki, Tara Teel, and Manami Yamaguchi. "Toward reducing human-caused impacts on green turtle nesting activity in Ogasawara islands: results and implications from a resident survey" (Human Dimensions of Natural Resources Department, Colorado State University, Fort Collins, Colorado, USA). $250

<u>Poster Presentations</u>

Best Biology Poster Presentation

Erin E. Seney, and Andre M. Landry Jr. "Kemp's ridley migratory paths and foraging areas in the northwestern Gulf of Mexico" (Texas A&M University at Galveston, Sea Turtle and Fisheries Ecology Research Laboratory & NOAA Sea Turtle Facility, Galveston, Texas, USA) $500

Runner Up Biology Poster Presentation

Kimberly Reich, Karen A. Bjorndal, Alan B. Bolten, Michael G. Frick, Blair E. Witherington, Michael D. Arendt, and Al L. Segars. "Oceanic and neritic foraging strategies of adult loggerhead turtles: a sexually dimorphic feeding strategy?" (ACCSTR, University of Florida, Gainesville, Florida, USA). $250

Best Conservation Poster Presentation

Mandi L. McElroy, Mark G. Dodd, and Steven B. Castleberry. "Loggerhead sea turtle nest management in Georgia: strategies that maximize hatching success" (University of Georgia, Athens, Georgia, USA). $500

Runner Up Biology Poster Presentation

Paul A. Whittock, Micahel Case, Paolo Casale, and Christopher Dean. "The impact of sea level rise on a major Mediterranean loggerhead sea turtle nesting site: Zakynthos island, Greece" (University of Edinburgh, Edinburgh, Scotland). $250

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PATHOGENIC EFFECT OF MICROORGANISMS ON LOGGERHEAD EGGS*

Elena Abella-Perez[1], Adolfo Marco-Llorente[2], Javier Diéguez-Uribeondo[3], and Luis F. López-Jurado[4]

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[2] Real Jardín Botánico de Madrid, C.S.I.C, Madrid, Spain
[3] Universidad Las Palmas de Gran Canaria, Las Palmas, Spain

Different types of fungi and bacteria have been isolated from hatched and non-hatched as well as failed and non-failed eggs in natural sea turtles nests (Marco *et al*. 2006, Phillott and Parmenter, 2001, Phillott *et al*. 2001). Microbiota infections are common in artificial incubation activities and they seem to have an important negative impact on embryo development (Phillott, 2002). However, no clear evidences of their pathogenic effects have been described. The aim of this study was to investigate whether fungi and bacteria represent pathogenic agents to sea turtle eggs, and to assess whether there exists a specific period during incubation in which eggs are more susceptible to microorganisms. In 2006 and 2007, we carried out two experiments in Boavista (Cabo Verde) consisting in infecting loggerhead eggs at different embryo development stages with: 1) live non-hatched egg shells that showed fungal spots (caused by *Fusarium solani* and *Fusarium oxysporum*), and 2) with hyphae of *F. oxysporum* and *F. solani* isolated from live non-hatched loggerhead egg. Our results show that control eggs (non-infected) and eggs infected with *Fusarium* spp. hyphae had a minor mortality rate than eggs infected only with infected eggs shells or both treatments together (Fisher exact two-tailed, $p< 0.001$). We did not find differences in egg mortality at different incubation stages of infection (Chi-square two-tailed, $p> 0.5$). Newborns from different treatments of infection time or type of infection agent did not show differences in length, weight, or incubation duration and turn over effort proof (Univariate ANOVAs, $p>0.05$). Results suggest that *Fusarium oxysporum* and *F. solani*, despite being the most common fungi found in sea turtle eggs, is not the main microbiotic agent of egg death. It seems that sea turtle eggs have no susceptible period during incubation to be infected by microorganisms. Further investigations are necessary to isolate the microorganisms that functioned as pathogens in the experiments. Acknowledgements: We acknowledge all volunteers for their enthusiasm with field work, NGO Cabo Verde Natura 2000 for hosting and project support and Andalusian Environmental Service for funding us. We also thank Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, as well as two generous individuals: Carlos Peralta Quintero and Robert N. Allen, Jr. for their donations in helping us to participate in the 2008 Symposium on Sea Turtle Biology and Conservation in Loreto, Mexico.

EXAMINATION OF THE EGGSHELL COMPOSITION FROM EGGS IMMEDIATELY AFTER OVIPOSITION USING X-RAY DIFFRACTION TECHNIQUE IN THE LOGGERHEAD, *CARETTA CARETTA*, FOR MASSIRA ISLAND, OMAN

Saif N. Al-Bahry[1], Ibrahim Y. Mahmoud[1], Khaled Melghit[2], Saif Al-Mamary[3], Abdulaziz Al-Kindi[1], and Abdulkadir Elshafie[1]

[1] Department of Biology, College of Science, Oman
[2] Department of Chemistry, College of Science, Oman
[3] Department of Earth Sciences, College of Science, Oman

Eggs were collected at random immediately after oviposition from loggerhead turtles at Massirah Island during June 2007. Powder samples were taken from three layers, the outer layer (calcareous), the middle layer (multistrata) and the inner layer (shell membrane). Each layer was analyzed separately using the powder x-ray technique with Philips 1710 diffractometer. The results revealed that the calcareous layer is made up of the crystallites which consists predominantly of $CaCO_3$ in the form of aragonite (91-95%) followed by calcite (1-4%) and chlorite (1-5%) with trace of vaterite. The middle crystallite is predominantly in the form of aragonite (95%), followed by calcite (5%) with trace of vaterite. The crystallites of the middle are mixed with amorphous material. The inner shell membrane consists of KCl sulvite and NaCl halite in equal proportions the crystals are mixed with numerous reticular fibers. The value of this investigation will be discussed.

EPIBIONTS ASSOCIATED WITH JUVENILE GREEN TURTLE (*CHELONIA MYDAS*) FROM THE FORAGING AND DEVELOPMENTAL AREA OF CERRO VERDE, URUGUAY

Luciana Alonso[1], Javier Calcagno[1], and Fabrizio Scarabino[2]

[1] Laboratorio de Ecología de Organismos Bentónicos Marinos, Departamento de Ecología, Genética y Evolución, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Capital Federal, Argentina
[2] Museo Nacional de Historia Natural y Antropología, Montevideo, Uruguay.

Marine turtles host a variety of epibiotic organisms, barnacles being the most frequent. They provide substrate and refuge for other organisms and have been considered the pioneer macroscopic epibionts in the stages of biological succession. The aim of this research is to characterize the composition of the barnacle fauna associated with juvenile green turtle (*Chelonia mydas*) that inhabits the Coastal-Marine Protected Area "Cerro Verde and La Coronilla Islands" and the adjacent area (33º56' S – 53º 29' W), Uruguay. The samples were obtained during the field season (summer 2007) carried out by Karumbé, among captured and stranded turtles on the beaches along 41 Km. Digital photographs of the turtles and their epibionts were taken. Epibionts were totally removed, and their position on the body of the turtle was recorded, samples were preserved in 70% ethanol. The percentage frequency of occurrence was estimated for the different taxa found. Cirripeds where identified and counted, and the percentage frequency of occurrence among the different sectors of the turtle body was estimated. Spatial pattern of distribution was analyzed and using analysis of variance, preference on the settlement position was determined for the most frequent taxa (*Platylepas* spp.). Finally, the proportions of occurrence between the opportunistic and obligate commensals along the summer were analyzed. All of the 87 green turtles examined were juveniles (mean standard Curved Carapace Length, CCL=39.95 cm, SD=5.33 cm, range=31.6-56 cm), 71 were captured, while 16 were stranded turtles. Only 10.34% of the turtles were free of epibionts, while 14 taxa were found among the rest of the turtles. Barnacles were the most frequent (87.36%), followed by algae (24.14%) and leeches (17.24%). The rest of the organisms found were bivalves such as mussels and oysters, gastropods, crabs, amphipods, isopods, polychaetes, polycladid worms, bryozoans and hydrozoans. The most frequent barnacle was *Platylepas* spp. (80.46%), followed by *Chelonibia*

testudinaria (16.09%), *Amphibalanus* spp. (14.94%), *Lepas anatifera* (9.20%), *Conchoderma virgatum* (6.9%) and *L. anserifera* (1.15%). This is the first report for *L. anserifera* as an epibiont of *C. mydas*. A clumped spatial pattern of distribution on the plastron was detected for *Platylepas* spp. (P*C. mydas* and *C. caretta* from other areas, being these the most characteristic epibionts from the examined sea turtles. The higher richness of taxa determined in relation to those from near areas could be related to the existence of brumation on some of the examined animals or turtles that due to their poor health condition facilitates the settlement of opportunistic organisms. Acknowledgements: We wish to thank Alejandro Fallabrino, Carlos Romero, Gustavo Martinez Souza, Melisa Morales, Karumbé technicians and the volunteers for their valuable help and co-operation in conducting this study. This research was funded by Karumbé N.G.O., Laboratorio de Ecología de Organismos Bentónicos Marinos (FCEyN, UBA) and Idea Wild. We are also grateful to Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, the Sandler Family Foundation, Carlos Peralta Quintero and Robert N. Allen, Jr. for their financial support, which enabled LA to attend the symposium.

HEAVY METAL CONCENTRATION IN THE GREEN TURTLE (*CHELONIA MYDAS)* IN FOUR ZONES FROM THE BAJA CALIFORNIA PENINSULA, MEXICO

Verónica Aurioles-López and Lía C. Méndez-Rodríguez

The Northwestern Center of Biological Research, CIBNOR

The knowledge about presence and concentrations of heavy metals in sea turtles that arrive at the coasts of Mexico is scarce so it is necessary to establish the relation between accumulation of metals and the biological processes of sea turtles. Some studies of pollution agents in green turtles indicate that maxima exposition appears in the early phases of the cycle of life and/or maternal route through transport of metals to eggs. It has been suggested that when turtles grow, the initial concentration of pollution agents is diluted and the assimilation of metals is reduced due to the change of diet. A negative correlation has been observed between metal concentrations and the size of green turtles. Also it has been demonstrated that diet is probably the main factor determining the differences in the accumulation. The coasts of the Baja California peninsula serve as forage areas for the green turtle; in this area heavy metal concentration has been reported in the stomach content with high concentration in Cd and Zn. Nevertheless, potential food collected in Magdalena Bay differs from these concentrations. The highest values in the concentration of Cd for *C. mydas* have been reported in Baja California. The objectives of this study were to determine the heavy metal concentrations in blood, skin and carapace of green turtles in four zones: Punta Abreojos (PAO), Complejo Lagunar Bahía Magdalena-Almejas (BMA), Laguna San Ignacio (LSI) and El Pardito (EPA), as well as to evaluate the differences of concentrations between zones and to evaluate if there is a correlation between the size of the turtle (SCL) and concentrations. The Cadmium concentrations (Cd), Strontium (Sr.), Iron (Fe), Zinc (Zn), Nickel (Ni) and Calcium (Ca), were determined by atomic absorption espectrophotometry. In general, concentrations descendant order is as follows: Ca>Fe>Cd>Ni>Zn>Sr. EPA displays the maximum concentrations in blood; PAO shows the highest concentrations in skin, and LSI displays the greatest concentrations in carapace. El Pardito shows significant differences between localities. The correlation with SCL in blood is negative for Cd, and positive Sr and Zn. In skin the correlation is negative for Fe and in carapace is negative for Zn and Ni. These results give us important information on the population health of green turtles and aid in the development of efficient measures for conservation.

COMPARISON OF ULTRASOUND AND LAPAROSCOPY TO EVALUATE THE REPRODUCTIVE ACTIVITY IN ADULT MALE LOGGERHEAD (*CARETTA CARETTA*) SEA TURTLES

Gaëlle Blanvillain[1], Anthony Pease[2], David C. Rostal[3], David W. Owens[1], and Al L. Segars[4]

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[4] South Carolina Department of Natural Resources, Charleston, South Carolina, USA

Because of the logistics and cost involved with live captures at sea, the reproductive biology of adult male sea turtles has not been extensively studied, and therefore many basic questions remain unanswered today. In particular, we do not know if adult male sea turtles are able to breed every year, or if they undergo multi-annual reproductive cycles, like females of most species do. Also, very little is known about their migration paths before and after the reproductive season, as well as the periodicity of these migrations. Laparoscopy has been the primary method used to assess the reproductive activity of adult male sea turtles. However, there are limitations in using this technique, including the risks inherent to any surgical procedure on wild animals, as well as the necessity of having trained scientists or veterinarians to carry out the surgery. Alternatively, ultrasonography, used extensively to study the reproductive biology of adult female sea turtles, may provide a powerful tool utilizable by a wide array of people, as long as one can become properly oriented to the anatomy and recognize the structures of interest. Ultrasonography, as opposed to laparoscopy, is also much quicker to implement, non-invasive, and portable devices are now available so that evaluations could potentially be done in any environment. In this study, we performed both laparoscopy and ultrasound analyses on 13 adult male loggerheads collected in the Cape Canaveral ship channel in April 2007. Ultrasound was performed using a SonoSite 180 with a 4-7 MHz curvilinear transducer imaging at approximately 10 cm depth. The ultrasound was oriented in a craniocaudal direction applied in the cranial inguinal region. We compared our diagnoses of the reproductive structures observed using both techniques. Testes and epididymus were visualized in all cases using both methods. During the ultrasound evaluation, kidneys were also observed, providing a point of reference when searching for the gonads. Duct diameters of the epididymus were measured using calipers built-in to the ultrasound system. To evaluate the accuracy of these measurements, we also inserted a calibrated probe during laparoscopic evaluation of 10 turtles, which allowed us to measure the epididymal duct widths internally. For each turtle, a minimum of 10 measurements using both methods was recorded. A two-way ANOVA revealed no statistical difference in epididymal duct diameters between techniques, however, duct diameter varied significantly between turtles. The average epididymal duct diameter was 27.6 mm ± 1.2 mm, and 28.5 mm ± 1.3 mm using the ultrasound imaging and laparoscopy, respectively. These results suggest that ultrasonography can be used successfully as a substitute for laparoscopic surgery to learn if adult male loggerheads are reproductively active during a given season. More work with non-reproductive males, such as on the foraging grounds, is needed.

MARINE TURTLE RESPONSE PROCEDURES: A HUSBANDRY GUIDE

Jessie E. Bluvias[1] and Karen L. Eckert[2]

[1] Duke University Marine Lab, Beaufort, North Carolina, USA
[2] Wider Caribbean Sea Turtle Conservation Network, Duke University, Beaufort, North Carolina, USA

The increased number of sea turtles housed in rehabilitation facilities, the growing demand for treatment, and the lack of ample guidelines has dictated a need for a comprehensive Sea Turtle Husbandry Guide written for both lay and professional audiences. Through literature searches (including a thorough review of existing protocols and regulations), personal interviews, and a series of internships at professional sea turtle rehabilitation facilities in the

US, we have identified the best practices and have fused and formatted them into a step-by-step, photographic manual of basic standards and recommendations. The guide will be published (toward the end of 2008) in English, Spanish and French and distributed by the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) to under-resourced Caribbean conservationists, managers, and facilities staff in order to encourage and facilitate the best professional care of sick and injured sea turtles during their rehabilitation. The guide is one of three in a professional series sponsored by WIDECAST: a first response field guide (published in 2006), a veterinary guide (in review), and a husbandry guide.

ASPECTS OF THERMAL REGULATION IN CAPTIVE JUVENILE LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*)*

Brian Bostrom[1], T. Todd Jones[1], Mervin Hastings[2], and David R. Jones[1]

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[2] Conservation and Fisheries Department, Ministry of Natural Resources, Government of the British Virgin Islands, Road Town, Tortola BVI

Leatherback sea turtles, although reptiles and by convention ectotherms, have long been thought to be capable of some form of thermoregulation either due to mass homeothermy, high levels of metabolic rate or a combination of both. Furthermore, several studies have found wild adult leatherbacks maintain internal body temperatures ≥ 8°C above ambient temperatures. While a couple of studies have predicted and modeled how this is achieved, this is the first study to measure activity, heat flux and core body temperature in leatherbacks exposed to varying environmental temperatures. Juvenile leatherbacks maintained temperature gradients 1°C (10 kg body mass) to 2.5 °C (40 kg) above ambient. These steady temperature gradients were achieved and maintained across an ambient temperature range of 14 to 30°C. This gradient is achieved by activity (measured as flipper stroke frequency). When confronted with lower ambient temperatures leatherbacks increase activity in order to maintain an elevated body temperature and compensate for the decline in resting metabolic rate. Leatherbacks exposed to a 10°C drop in ambient temperature (24 to 14°C) doubled their activity. In contrast, at water temperatures of 30°C activity ceased. Heat gain and loss through the shell were due to its intrinsic physical properties and the extent of the thermal gradient. On the other hand, heat loss through the flippers was minimal compared with the rate of heat loss through the carapace. Consequently, counter-current heat exchange or even just vasoconstriction, by restricting blood flow, prevents heat loss from the flippers. Overall, leatherbacks use activity to produce endogenous body heat and retain this heat through large mass (relatively small surface area to volume ratio) and thermal conservation mechanisms in the flipper. We thank NSERC Canada and NMFS USA as well as the Conservation and Fisheries Department, Ministry of Natural Resources, BVI, for financial support.

SKULL MEASUREMENTS OF THE GREEN TURTLE FORAGING AGGREGATIONS IN THE GULF OF VENEZUELA

Larry Bracho-Pérez[1], Ninive Espinoza[2], Maria Gabriela Montiel-Villalobos[3], and Héctor Barrios-Garrido[1,2]

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Five species of sea turtle have been reported in the Gulf of Venezuela (GV): green, hawksbill, loggerhead and leatherback. Of these, the only herbivorous species, the green turtle is the most abundant. The green turtle also has both an important commercial and magic-religious values for the Wuayuu community. The sea turtle skull is the only morphologic piece that was used by natives. This fisher's community use the sea turtles skulls, named as "Shiki" in native language, as a fertility symbol for both people and animals. 36 green sea turtles skulls were collected between 2000 (MBLUZ collection) to 2007 (GTTM-GV collection). The following measurements were taken from each skull: Maximum cranial length, measured from anterior tip of premaxilla to posterior tip of supraoccipital (LC1); Length of upper jaw (LUJ); Height of cranium (HC); Width of postorbital (WPTO); Width of cranium (WC); Width of exoccipital (WEO); Maximum diameter of orbit (DO); Height of orbit (HO); Height of nasal opening (HN); Width of nasal opening (WN); Height of premaxilla (HPM); Width of supraorbital (WSO); Width of preorbital (WPO); Width of zygomatic (WZ). A Principal Components Analysis (PCA) was applied to the data. Results showed two eingenvalues with a high variation percent for the axis 1 (LCB 91, 168%) following of the axis 2 (AON 88, 99%). Also relevant was the lesser lengths for juveniles and subadults increasing on adult individuals. However, more samples and more in-depth research is needed, using other statistical methods, as such as a canonical discriminant analysis to search for possible differences between stage or populations groups.

FREQUENCY OF ANATOMICAL DEFORMATION IN BREEDINGS OF OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*) IN PLAYA CEUTA SINALOA, MEXICO

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Inbreeding increases the probability of illnesses and anatomical deformation caused by a decrease of genetic variability. Our objective was to evaluate dead hatchlings and embryos in unhatched eggs of olive ridley turtles to determine anatomical deformations during 2 nesting seasons. Two days after hatchling emergence, nests were inventoried. Frequency of deformation was observed and a percentage of these frequencies were obtained regarding the total of incubated eggs. The most dominant abnormality was skull deformations and the least was albinism. These discoveries suggest that the population may have inbreeding and therefore decreased genetic variability; this must be verified by means of the population's genetic analysis.

PRELIMINARY RESULTS OF HEAVY METAL CONCENTRATIONS IN SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) USING EGGS AND BLOOD FROM A NESTING COLONY OF LA ESCOBILLA, OAXACA, MEXICO

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The olive ridley turtles (*Lepidochelys olivacea*) are the most numerous of all the sea turtles in the world, and are known as an important species with nesting occurring throughout tropical seas and migratory circuits in tropical and some subtropical areas. In the coasts of Mexico, olive ridleys enjoy wide distribution along the coast from Baja California to Chiapas, with mass nesting events in La Escobilla, Oaxaca. This area is a marine turtle Sanctuary, which is considered one of the more important reproductive populations of the American continent. 25 females were sampled and a total of 250 eggs were collected during 3 arribada events in the 2005-2006 (10-14th August, 2005) season. The measurements for this nesting colony were weight 34.0±4.4 kg, CCL (66.4±2.7 cm), CCW (70.7±2.9 cm) and an egg size 3.81±0.05 cm of diameter and 30.3±0.34 g. The heavy metal distribution, in the four analyzed components presented in decreasing order in the shell Ni>Zn>Cu>Pb>Cd; whereas in blood, albumen and yolk it was Zn>Ni>Cu>Pb>Cd. Also, Zn concentrations were highest in the yolk (72.3±10.9 microg/g dry wt) and the blood (58.4±4.7 microg/g dry wt). Ni concentrations were highest in the shell (48.5±12.9 microg/g dry wt). Metals in the egg were mainly present in the yolk; therefore, yolk is the most important component when considering heavy metal accumulation in sea turtle eggs. Means concentrations of Cu, Pb and Cd were generally lower than those reported for other sea turtles in the tissues analyzed. However, Zn and Ni concentrations in yolk and shell respectively had the same distribution pattern observed in loggerhead, green and olive ridley turtles. The relatively low concentration of Pb is the most notable toxicological finding in this study. According to national and international norms and maximum limits respect to toxic elements, the state of health of this population is acceptable and it corresponds at basic levels of a nearly pristine region.

ACUPUNCTURE PROTOCOL FOR SEA TURTLE RESUSCITATION

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A turtle found stranded or caught in a net may appear to be dead, in a coma, or in shock; having lost or suppressed reflexes and showing no signs of breathing. Most turtles caught by shrimp trawlers, under conditions of forced submergence, are not drowned but in a coma. (ref. 1 The decline of the Sea Turtle 1990). A 1989 study by National Marine Fisheries Service of 7 research projects spanning 12 years during which 4,397 turtles were caught in trawler nets found that for most tow times, there were more comatose than drowned turtles.) Although a comatose turtle may revive on its own after several hours on land/boat, the fate of a comatose turtle returned directly to the sea is unknown. It is reasonable to assume that they will die. (Kemmerer 1989) Applying the Acupuncture Protocol for Sea Turtle Resuscitation should revive the turtle in 30 seconds to 10 minutes, depending on the circumstances of the individual trauma. The protocol can be performed anywhere in the world; in the laboratory, in the field, or on a shrimp trawler. The procedure for using these acupuncture points is easy to learn. We are currently looking for scientists, biologists, veterinarians, and sea turtle researchers to share this protocol with those who would have access to sea turtles in shock, coma, cardiac distress; otherwise “dead” appearing turtles. A published bibliography of 138 books/clinical trials by Philip Rogers D.V.M. documents the effects and clinical efficacy of stimulation of acupoint GV26 in humans and animals. It is the most used emergency point in acupuncture. Stimulation of GV26 resuscitated to consciousness humans and animals (some that were pronounced clinically dead) in acute emergencies, narcosis and shock. It had potent anti-shock effects and decreased mortality rates in haemorrhagic, surgical, post partum, endotoxic, anaphylactic, and other forms of shock. It countered exhaustion, enhanced hepatic metabolism and adrenocortical function, promoted membrane transport, and helped recovery in prostration. It regulated the central nervous system and had anti-convulsive effects and reversed the depressive effects of general anesthesia on the central nervous-, autonomic-, cardiovascular-, and respiratory systems. It enhanced cardiovascular and cerebrovascular function: it enhanced heart function, had sympathomimetic (cardiostimulant) effects on the cardiovascular system, had pressor effects in hemorrhagic shock and ischemic hypotension. It was effective in acute brain and cerebral emergencies and in treating their sequels. It enhanced brain perfusion and hastened clinical recovery after cerebrovascular accident. It enhanced brain perfusion and hastened clinical recovery after cerebrovascular accident. It enhanced respiratory functions and reversed neonatal and anesthetic apnea, increased neuronal activity in the respiratory center and increased amplitude of phrenic nerve discharges. Four additional acupuncture points are suggested for drowned/comatose turtles; cardioactive points PC6 and PC9 and points used for revival from drowning, K1 and tail tip point. These points were extrapolated to the sea turtle from humans and other animals based on the underlying anatomy and physiological structure/function. Philip Rogers published review of GV26 in animal resuscitation and veterinary acupuncture is at casatortuga.org.

POLYBROMINATED DIPHENYL ETHERS AND ORGANOCHLORINE CONTAMINANTS IN LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*): DISTRIBUTION AMONG BLOOD COMPONENTS AND TEMPORAL TRENDS

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The loggerhead sea turtle, *Caretta caretta*, is a threatened species that forages off the southeastern U.S. coast, rendering individuals vulnerable to human impacts, including exposure to pollution and contaminants. In addition to well-studied industrial and agricultural contaminants such as polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs), polybrominated diphenyl ethers (PBDEs) are a category of contaminants of emerging concern to which *C. caretta* may be exposed. PBDE concentrations in wildlife increased exponentially during the last three decades, but currently appear to be stabilizing as PBDE use decreases; the European Union banned the use of most PBDEs in 2005 and California will follow in 2008. This study builds on previously reported data (Carlson *et al*. 2006), which analyzed loggerhead samples from multiple capture sites, and more extensively examines PBDE, PCB, and OCP contamination in *C. caretta*, including distribution among blood compartments and temporal trends. Paired whole blood, plasma, and red blood cell (RBC) samples from five juvenile *C. caretta* captured from Core Sound, North Carolina and coastal South Carolina in 2006 were analyzed by gas chromatography/mass spectrometry (GC/MS) for 28 PBDEs, 83 PCBs, and 14 OCPs. Distributions of PCBs and 4,4'-DDE among blood compartments were similar to those observed previously (90.0 and 69.0% in plasma, 10.0 and 31.0% in RBCs, respectively) by Keller *et al*. (2004). Preferential distribution of PBDEs into plasma was also observed (95.0% in plasma, 5.0% in RBCs). Temporal trends were assessed using 45 juvenile loggerhead samples collected from Core Sound, NC. Five samples from each year (1998-2006) were analyzed by GC/MS for the same compounds described above. With respect to year, mean concentrations (pg/g wet mass) were: 156, 42.0, 65.7, 63.7, 10.5, 139, 90.6, 14.8, and 62.4 for ΣPBDE, 2340, 6130, 2950, 2730, 1440, 8710, 3030, 1150, and 9580 for ΣPCBs, and 251, 159, 182, 262, 117, 663, 171, 117, 312 for 4,4'-DDE. No significant temporal trend was observed in PBDE, PCB or OCP concentrations. These findings differ from previous preliminary results (Carlson *et al*. 2006), which analyzed loggerhead samples from multiple capture sites. Other temporal trends of these compounds described in the literature appear to be site and species specific; it is likely that the preliminary results were skewed due to site differences. The lack of temporal trends in the current study, which is similar to what has been observed for oysters in the nearby area (NOAA 2006), indicates that loggerhead turtles in Core Sound, NC may serve as bioindicators for future monitoring of PBDEs, PCBs, and OCPs.

DIGESTION TIME OF WILD PREYS IN THE LOGGERHEAD SEA TURTLE, *CARETTA CARETTA*

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Thirty turtles captured by bottom trawlers were monitored in captivity and the time range of defecation of wild preys was recorded. Results indicate that digestion time for healthy turtles with an average curved carapace length of 60.2 cm and feeding upon benthic preys is 2.5-3 days at 25°C. Comparison with available data on very small individuals fed with artificial food suggests that digestion time does not increase with turtle size. Results also indicate that samples from faeces collection or necropsy correspond to several meals taken in a few-day span, an important factor to be considered in studies on diet. Acknowledgements: We wish to thank all the generous donators that allow us to participate, and especially: Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, as well as two generous individuals: Carlos Peralta Quintero and Robert N. Allen, Jr.

SEX-SPECIFIC MORPHOLOGY OF NEONATE SEA TURTLES: METHODS FOR IDENTIFYING SEX IN FORMALIN-PRESERVED AND FRESH DEAD HATCHLINGS AND POSTHATCHLINGS*

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Historically, identifying the sex of neonate sea turtles has been problematic since they lack external sexually dimorphic characteristics and gross gonadal morphology alone may not be indicative of sex in most species of sea turtles. Histological examination of the gonad is considered to be the most reliable method for sex identification in hatchlings. Assessments of sex for sex ratio documentation or other applications are limited in the field because histology is usually unavailable or logistically difficult. Sea turtle sex ratios are often based on limited samples since most studies are field-based and marine turtles are protected in most locations precluding destructive sampling. We compared the morphology of the gonads and reproductive ducts of 57 formalin-preserved and 104 unpreserved (fresh dead) hatchlings and post-hatchlings of three sea turtle species (loggerheads, *Caretta caretta* L.; green turtles, *Chelonia mydas*, L. and leatherbacks, *Dermochelys coriacea*, V.) and identified suites of sex-specific characteristics that allow for gender assignment. We compared the gross morphology of the same structures (gonads and reproductive ducts) in these three species to (i) identify sex-specific characteristics, (ii) determine if the sex-specific characters were similar across species, and (iii) identify any variation in diagnostic criteria between preserved and fresh dead specimens. The accuracy of the gender assignment based on gross morphology was verified by histological examination. In fresh specimens, the characters, which together are sex-specific, were the

paramesonephric duct size, duct mobility, the form of the duct lumen, gonad mobility and attachment to the body wall. Additionally, in the cheloniids, gonad shape and edge form contribute to the suite of sex-specific characters, and add accuracy to sex identification. The same characteristics are sex-specific in preserved specimens, with the exception of the gonad attachment to the underlying mesentery; its identification was prevented because of tissue hardening due to fixation. The techniques we describe may be used to reliably identify the sex of dead hatchlings (typically dead-in-nest) without extensive histological procedures and can be performed in the lab or on the field using hand-held magnification or the naked eye. The ability to discriminate sexes grossly allows for easier and more widespread empirical documentation of hatchling sex and thus has the potential to expand assessment of dead hatchling ratios at the nesting beaches where analysis of post-emergent nests is common. The capacity to track sex ratios based on dead-in-nest may allow for more widespread identification of sex bias in hatchlings that die in the nest and allow identification if the sex ratio bias shifts over time. Such information may be important for understanding population level responses to environmental change in these species with environmental sex determination. Acknowledgements: This study was supported by the Nelligan Sea Turtle Fund, the University of Milan, and personal funds. Attendance of SC to present this work at the International Sea Turtle Symposium was funded in part by Carlos Peralta Quintero, Robert N. Allen, Jr., Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation.

GEOGRAPHIC AND SEASONAL VARIATION OF REPRODUCTIVE STEROIDS IN DIAMONDBACK TERRAPIN, *MALACLEMYS TERRAPIN*

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The diamondback terrapin, *Malaclemys terrapin*, is the only turtle in North America that exclusively inhabits the brackish environments of bays and estuaries. Studies have examined reproductive steroid levels in several turtle species but not in the terrapin. This information has been crucial in the elucidation of certain physiological and ecological aspects such as reproductive activity, stress levels, and sex ratios. Testosterone and estrogen levels were measured via radioimmunoassay (RIA) of blood samples of two populations of diamondback terrapin. One population is relatively stable and is located in the salt marshes of the Patuxent River region of Maryland. The other population is located in the salt marshes surrounding Dauphin Island, Alabama and has experienced a significant decline from historic levels. Seasonal cycles of reproductive steroids were examined within population as well as between the geographically separated populations. The sexual dimorphism observed in terrapin greatly reduces the misidentification of sex in adults; however, the sexing of juveniles is quite difficult and thus could lead to inaccurate ratios. Juvenile sex ratios were predicted from testosterone levels, and these data will be useful in developing optimal management strategies. The results of this study will be compared to those of marine and freshwater turtles to better understand how the physiology of the diamondback terrapin has evolved to adapt it to its unique marine niche.

COMPOSITION OF THE MUCUS SECRETED BY *ERETMOCHELYS IMBRICATA*

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This work consists of two phases: (1) to determine the composition of the mucus secreted during the egg laying process by *Eretmochelys imbricata*, and (2) to determine if the secreted mucus has any effect on the growth of plant roots during the incubation process of the eggs in this species. As part of the conservation of sea turtle initiatives in Humacao, P.R., sea turtle nests are sometimes relocated. Large amounts of roots from sea shore plants grow in the relocated nest; sometimes impairing the incubation process and/or hatching from the nest. When compared to natural nests the effect of the roots is observed to a lesser extent. Some of the tests used to determine the composition of the mucus are: GC-MS analysis, HPLC, Carbohydrates, and proteins. In addition, solubility tests were performed using various solvents. Preliminary results show that the mucus has 0.05 g of carbohydrates per 100 ml of mucus and 2.85 mg/ml of proteins. When mixed with certain solvents the viscosity of the mucus increases making some of the tests difficult.

CAUDAL VERTEBRAE VARIATION ACCORDING TO INDIVIDUAL'S SEX IN LOGGERHEAD JUVENILES

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Knowledge of the population's sex-ratio is essential for the management and conservation of wild populations. However, sea turtles do not show sexual dimorphism until their adult or sub-adult stages. Only after entering puberty, sex-diagnosing criteria such as the much longer tails that males develop allow distinguishing males from females. Like all turtles, sea turtles have 2-3 sacral vertebrae and 12 or more caudal vertebrae. The caudal vertebrae of females are short and decrease in size distally; those of mature males are large with robust lateral and dorsal processes. Thus, in this project, we addressed the variation of the number of caudal vertebrae on juvenile loggerheads *Caretta caretta*, in order to develop a sex diagnosing technique that would not harm the animals. Twenty one dead loggerheads originated from by-catch were necropsied and gonads were observed under binoculars for sex identification. Tails were withdrawn right above the sacral vertebrae and frozen for posterior X-ray imaging and quantification of caudal vertebrae. Seventeen turtles were females and 4 were males, making a 4.25F:1M sex-ratio. Dorso-ventral radiographs of the tails were performed using 40 Kv, 50 Mas and 0.02 seconds, using standard film and rare-earth intensifying screens. Vertebrae quantification was performed blindly by two different observers over a light box and, when needed, with the help of a magnifying lens. Vertebrae were quantified assuming the distal-most sacral vertebrae as #0. Every discrepancy in number of vertebrae was discussed till a consensus was reached. Our radiographic study revealed a variation on the number of vertebrae ranging from 19-20 for males (n=4) and 17-20 for females (n=17). A Chi-square test was performed to test for differences on the expected number of vertebrae. Although the expected frequencies of distribution are different between sexes (Chi2=8.048; p=0.004), the reduced number of males, which reflects this population's biased sex-ratio, does not allow us to use the number of vertebrae as a sex-diagnosing criteria. We plan to increase the sample size in the future, namely the number of males, in order to detect the suspected differences between the sexes.

STRESS AND ANTI-APOPTOTIC PROTEIN EXPRESSION IN GREEN TURTLE FIBROPAPILLOMATOSIS*

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Fibropapillamatosis (FP) is a herpes-associated, neoplastic disease that induces cutaneous tumors found most commonly on soft tissue of marine turtles. Prevalence of this disease is highest among juvenile turtles in near-shore ecosystems, particularly in bays and estuaries that have been impacted by agricultural, urban, and industrial development. Previous research in our lab has shown a significant increase in the concentration of stress protein HSP70 in juvenile green turtles from the impacted Indian River Lagoon (IRL) in Melbourne Beach, Florida compared to juvenile green turtles from the more pristine Trident Submarine Basin (TSB) in Cape Canaveral, Florida. To better understand the patterns of this up-regulation and other molecular mechanisms involved in FP, this study explores stress protein expression as well as anti-apoptotic protein expression in juvenile green turtles. Stress proteins are highly conserved and constitutively expressed proteins that act as chaperons in cells. They assure proper folding during protein synthesis and assist in the repair and/or degradation of damaged proteins. Certain HSPs are up-regulated in response to stress (such as heat, pollutants, and viral or bacterial infections) in response to an increase in damaged proteins. Some also act as immune stimulators, presenting antigenic peptides derived from virally infected cells or tumor cells to the immune system. This study examines two inducible HSPs, HSP70 and GRP96, that are up-regulated by cellular stress, and mammalian studies have shown them to be potent inducers of the T-cell mediated immune response. Samples of blood, healthy skin, and tumor tissue were collected from turtles captured in the IRL and TSB. Animals were included with a range of tumor severity and morphologies. Tissue proteins were analyzed by Western blot for markers of cellular stress and survival. An up-regulation in HSP72 and GRP96 was found in tumor biopsies compared to healthy skin samples, which increased with increasing tumor severity. The data indicate that animals in the IRL are under more physiological stress than those of the TSB, and that increased tumor burdens are associated with an elevated intracellular response. Morphological characteristics of tumors ranged from cauliflower-like tumors with bumpy, finger-like projections to more fibrous tumors with a smooth, flat surface. Preliminary results indicate the highest concentrations of HSP72 and GRP96 are found in cauliflower-like tumors, a lower expression in smooth tumors, and little expression in healthy skin biopsies. We also examined the levels of Bcl-2, an anti-apoptotic protein. An up-regulation of the anti-apoptotic Bcl-2 has been implicated in a number of mammalian tumors, and contributes to uncontrolled growth and immortality in tumor cells. Preliminary results indicate an up-regulation of Bcl-2 in tumor biopsies vs. healthy skin. As elevated HSP72 is also associated with cell survival, the up-regulation of both HSP72 and Bcl-2 implies that growth at the molecular level in FP tumors resembles mammalian systems, and opens potential avenues for future treatment, as both Bcl-2 and heat shock proteins are targets of investigation in human cancer treatment. Acknowledgements: I would like to thank the Sea Turtle Symposium and all the generous donors (Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, as well as two generous individuals: Carlos Peralta Quintero and Robert N. Allen, Jr.) for awarding me a travel grant.

ULTRASOUND GUIDED VASCULAR CATHETERIZATION IN SEA TURTLES

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In sea turtles the cervical sinus and jugular vein is commonly used for blood collection and administration of bolus fluid therapy, but placement and maintenance of intravascular catheters in these sites is difficult. In these species radio humeral venous plexus catheterization is commonly used after a deep cut down incision in the dorsal surface of the fore flippers. For this painful and stressful procedure, sedation or anesthesia may be necessary; moreover, these techniques can be dangerous in critically ill patients. In this study the authors describe a non-traumatic and easy procedure for placement and maintenance of cephalic vein catheterization with the aid of ultrasound guidance. The ultrasound examinations were performed with a GE Logiq 400 machine connected to a multifrequency (7–11MHz) linear array transducer with the frequency set at 11MHz. Turtles were placed on foam-rubber blocks on an operating table; one forelimb was extended and restrained manually. In order to find the cephalic vein, longitudinal and transversal color doppler ultrasonographic examination of the flipper's dorsal surface was made, along the caudal margin of the humerus and ulna. Once the vein was located, a needle catheter (20-22 gauge, depending on the size of the animal) was inserted in the skin beneath the ultrasound probe, distoproximal and dorsoventral, inclined at 10-15 degrees to skin surface. The catheter's progress was monitored with ultrasound until successfully inserted into the vein. After placement, the catheter was secured to the skin with a suture (two single surgical stitches with 2-0/1-0 braided polyester or polyamide monofilament), and an injection cap was connected to the catheter hub. When it was necessary to maintain the catheter in situ for an extended period, it was covered and secured with noncompressing self-adhesive elastic bandage that encompassed the flipper. The authors think that an ultrasound guided catheterization of the cephalic vein allows an easy, non-traumatic and durable vascular access for drug administration, re-hydration and emergency therapy in sea turtles, compared with other previously described techniques. The first author wishes to thank Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, as well as two generous individuals: Carlos Peralta Quintero and Robert N. Allen, Jr. and the Sea Turtle Symposium for their generous support.

A PROCEDURE FOR ISOLATION OF THE MICROFLORA OF THE OVIDUCTAL FLUID DURING OVIPOSITION OF THE GREEN TURTLE, *CHELONIA MYDAS*

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In this new procedure the oviductal fluid samples were taken while the turtle was in the process of egg laying. The samples were collected after the turtle had laid several eggs and has already discharged 2-3 times oviductal fluid on its eggs. The samples were collected by inserting sterile swab ≈10cm into the evaginated cloacal chamber during oviposition after the flushing process. Thus the oviductal fluid which is coming directly from the oviduct glands has minimal contamination due to flushing process and because during the process of oviposition, the sphincter muscle closed and there is no direct contact between the cloacal chamber and the GI tract. A total of forty turtles were examined. From each turtle three swabs were taken, and each swab was used to inoculate tubes containing selective media. Sampling of oviductal fluid from previous studies was carried out when the turtles were over turned on their back and the external opening of the cloacae was disinfected by alcohol soaked gauze. A sterile swab of 10 cm long was used to collect sample from the oviduct. It was impossible to insert the swab deep enough to collect samples.

The swab went in for only 2-3 cm in the cloacal chamber because of the strength of the closure of the sphincter muscles. Moreover, swabbing was carried out while the turtle was not in then process of egg laying. The new procedure resulted in isolation of the following microflora from the oviductal fluid: *Citrobacter* spp (53.5%), *Pasteurella* spp (16.3%), *Pseudomonas* spp (11.6%), *Salmonella* spp (11.6%), *Proteus* spp (4.7%), *Shigella* spp (2.3%), while the old procedure resulted in the isolation of a microflora which were predomionantly *E. coli*.

EPIBIONTS IN FEMALES OF *LEPIDOCHELYS OLIVACEA* THAT NEST ON THE COAST OF JALISCO, MEXICO

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We collected epibionts from 50 female nesting Olive ridley sea turtles (*Lepidochelys olivacea*) on 3 nesting beaches along the coast of Jalisco, México, during the years of 2005 and 2006. Epibionts were separated according to the location where they were found: hard parts (shell and head), and soft parts (neck and fins). Also, the shell was divided by zones with the objective to determine which zone had the greater amount of epibionts adhered. The preliminary results indicate the presence of at least 6 species of epibionts, with *Podocerus chelonophilus* being the most abundant.

EVALUATION OF TEMPERATURE-DEPENDENT SEX DETERMINATION IN THE HAWAIIAN GREEN TURTLE

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During 2006 a study was initiated to investigate temperature-dependent sex determination in the Hawaiian green turtle. The purpose of the study was to determine the range of incubation temperatures that produce all females, all males, or mixed sex ratios, including the pivotal temperature that produces a 1:1 sex ratio. This knowledge is useful from a management viewpoint, since it provides insight for predicting hatchling sex ratios produced on the natural nesting grounds at French Frigate Shoals. During 2006 three incubators were installed at Sea Life Park, Oahu, Hawaii. Based on previous studies of beach temperatures at French Frigate Shoals, we hypothesized a relatively low pivotal temperature in the Hawaiian green turtle, so we chose relatively low incubation temperatures ranging from approximately 26.5° to 29.0°C in the three incubators (in one degree intervals between incubators). Over an approximate two-month period, eggs were obtained from captive, pre-Endangered Species Act, Hawaiian green turtles that nested on the artificial nesting beach at Sea Life Park. Hatchlings were raised in captivity until they grew to a size at which they could be examined by laparoscopy to verify their sex. Any embryos, hatchlings, or posthatchlings that died during the study were preserved, and their gonadal tissues were examined by histology to verify sex. During December of 2006, laparoscopy was used to examine 70 turtles that had been raised in captivity. The histology data and the laparoscopy data were similar and indicated that the three temperatures used in the 2006 study produced mostly males. Additionally, clutch effects were detected in which some clutches produced significantly more females. The results do not support the hypothesis that the Hawaiian green turtle has a lower pivotal temperature in comparison to other green turtle populations.

SEA TURTLE STRANDING RESPONSE AND REHABILITATION IN URUGUAY: SPATIO-TEMPORAL EXPERIENCES

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Incidences of sea turtles washing ashore or stranding due to natural and/or anthropogenic activities is not an uncommon occurrence along coastlines across the world. The eastern Atlantic Uruguayan seaboard is also witness to such stranding incidents around the year. We at Karumbé, an established NGO in Uruguay, launched the sea turtle stranding and salvage network in 2001 to respond to stranding incidents across the Uruguayan coast. While strandings have occurred throughout the year, spring (Oct-Dec) and summer (Jan-Mar) seasons have had more occurrences, with a peak during the month of January. Of the total number of the strandings attended to in the past six years, only 17% (n = 569) were found alive. While both natural (eg. cold stunning) and anthropogenic causes have been implicated in sea turtle strandings, a large proportion of our stranding response has been due to anthropogenic reasons, specifically traumatic and infectious causes which includes capture in fishing nets, massive epibionts on their carapace, loss or damage of limbs, entanglement in marine garbage, entanglement in longline fishery (both line and hook), buoyancy problems due to obstruction of the intestinal tract with plastics, pneumonia, among other reasons. Green turtles (*Chelonia mydas*) have most often been encountered (range 29 – 75 events per year, median = 53) than other sea turtle species. Juvenile sea turtles [median CCL 41.8 cm (range: 30.0 – 61.5 cm; SD= 6.3; n=251)] have always been encountered in all of our stranding responses in the last six years. Occasional live strandings of loggerhead (*Caretta caretta*) turtles have also been tended to (n=3) and juveniles have again been involved in these incidents with buoyancy problems, and loss of limbs. All the live sea turtles has been brought to the Center. Our current strategy has included strengthening both the stranding response and husbandry care & management efforts for effective rescue and rehabilitation of sea turtles. While the collaboration with International Fund for Animal Welfare has enabled us to improve the facilities for the rehabilitation (X- Rays, hematology and chemistry, microbiology culture, etc.) and increase training for the veterinary treatment at the Sea Turtle Rescue Center, effective field partnerships with coastal communities, artisanal and trawl fishermen, rangers, and onboard observers of PNOFA (Uruguayan Tuna Fleet onboard Observers National Programme) has enabled us to teach emergency response, transferring technical knowledge and empowering grassroots staff for quicker efficient response.

OSTEOPATHOLOGY, OR WHAT BONES CAN TELL US ABOUT CAUSE OF DEATH AND HEALTH HISTORY OF STRANDED SEA TURTLES

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Osteopathology is a very useful tool to derive information about growth history, alimentation, health status, trauma injuries (e.g. from shark bites) and cause of death of an organism by examining its bones. In the Gulf of California and Pacific coast of the Baja California peninsula, with over 5000 km of coastline, many sea turtles strand mostly due to interactions with gillnet, longline and trawl fishing gear. However, only few conservation NGO's, Universities and government institutions collect data on strandings on a very limited scale in the region. Therefore we lack important information, not only on the spatial and temporal distribution of strandings, but especially data on each individual turtle. Due to the usually advanced decomposition of the carcasses, it is almost impossible to conduct a necropsy and determine cause of death or gather information on the health history of the organism. Therefore, the objective of this study was to learn more about the history of each stranded turtle and, ideally, determine cause of death applying osteopathological methods. Several beaches in the Gulf of California were searched for turtle carcasses, which were identified, photographed, georeferenced, and taken to the lab for further examination. Here we propose a standard protocol for sampling, cleaning, examination and analysis of bones from sea turtles and argue for the creation of a network that eventually leads to an osteopathological atlas that can be used to analyze bone structures from sea turtles worldwide. In 2006, two workshops were conducted at Playa Ceuta in Sinaloa, and in Loreto, BCS to train local conservationists and researchers in the basic methodology. We believe that the proposed methodology can help to gather detailed information on each stranded organism and will allow us learn much more about the ecology and health status of endangered sea turtle populations.

TOWARD A MECHANISTIC MODEL FOR TEMPERATURE-DEPENDENT SEX DETERMINATION IN MARINE TURTLES

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Here, we propose a new thermal model of TSD using a mechanistic approach. We built this model from collection of published data of physiological processes (i.e. the growth of the embryo, the growth of gonads and the activity of the enzyme aromatase) underlying the TSD mechanisms, for the European pond turtle (*Emys orbicularis*). This new approach provides integration of incubation temperature fluctuations, as well as the cumulative and differential effect of high and low temperatures on sexual differentiation to embryo sex determination. The significant consistency obtained between observed and predicted sex-ratios both at diverse constant and fluctuating incubation temperatures provides hope to develop an efficient method to predict sex-ratio under natural conditions. This model has been then adapted to be used in marine turtles.

HEALTH AND DISEASE IN CAPTIVE REARED LEATHERBACK TURTLES, *DERMOCHELYS CORIACEA**

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Rearing a new species in captivity presents special veterinary challenges as the animals grow and develop. Historically leatherback turtles have proven to be difficult to rear, however the UBC group has succeeded in maintaining turtles from hatchling to 50 kg body weight through a variety of innovative husbandry techniques that take into account the pelagic habit and coelenterate/ gelativore diet of this species. Juvenile leatherback turtle hatchlings raised in a closed recirculating seawater system displayed unique lesions and disease entities at various points in the growth cycle, including early wasting/failure to thrive syndrome in newly hatched turtles, rostral abrasion and complications, pink spot ulcerative dermatitis and aspiration bronchopneumonia complex. The etiopathogenesis, clinical signs, gross and clinical pathology, histopathologic lesions and therapeutic approach to these disease syndromes in juvenile leatherbacks will be described.

HEAVY METALS AND PESTICIDES IN THE BLOOD AND EGGS OF FLATBACK TURTLES (*NATATOR DEPRESSUS*)*

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The presence of heavy metals and pesticides was investigated in the blood of 20 nesting flatback sea turtles and in 60 eggs collected from Queensland, Australia. The toxicology analysis was carried out using GS-MS techniques. In the blood we detected a variety of organochlorines (OCs) including alpha-hexachlorocyclohexane (HCH), dieldrin, aldrin, heptachlor and p,p'-Dichlorodiphenyldichloroethane (DDD). However, no polychlorinated biphenyls (PCBs) were detected. Moreover, we detected traces of OCs and PCBs in flatback eggs. Heavy metals were also detected in the blood and eggs of flatback turtles. In the blood, zinc was present at the highest concentration of 152.53 ± 1.45 μg/L, followed by copper (7.74 ± 0.09 μg/L) and lead the lowest detected heavy metal at 0.08 ± 0.05 μg/L. We suggest that both heavy metals and pesticides are maternally transferred to the eggs. In the eggs we found Cr, Mn, Cu, Zn, As, Se and a non-quantifiable trace (<0.1-0.01 μg/L) of Co, Ni, Mo, Cd, Sn, Sb, Hg, Ti, and Pb. The concentrations of heavy metals found to exist in the blood and eggs of flatback turtles were found to be within the reference ranges for human whole blood. The presence of the environmental contamination in marine animals in pristine areas such as the Great Barrier Reef is of great concern because of the sensitivity of this unique marine environment. Environmental toxicants interfere with the endocrine system of nesting sea turtles and their presence is likely to adversely affect development, reproductive function, health and ultimately population status. We suggest that further studies should be conducted in different organs and in the foraging areas of nesting flatback turtles to identify the degree and the source of pollution. Acknowledgements: MI gratefully acknowledges travel support from Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, US Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, as well as two generous individuals: Carlos Peralta Quintero and Robert N. Allen, Jr., provided through the Symposium Travel Committee.

MATURATION OF FEMALE LOGGERHEAD TURTLE AND DISCOVERY OF NEW HYMEN-LIKE CHARACTER

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Loggerhead turtles in the North Pacific are born in Japan, grow in the eastern North Pacific, and return to Japan for breeding before reaching their sexual maturity. Although they inhabit the coastal waters of Japan, we have little chance to encounter them except while nesting. This has impeded the study to reveal the reproductive conditions of non-nesting turtles and maturity process of the loggerhead turtles. For investigating non-nesting turtles, there are two ways; one is to examine stranded turtles and the other is to examine incidentally captured turtles. Stranded turtles were mostly well-decomposed and as such the gonads were inadequate for analysis. On the other hand, the gonads collected from turtles incidentally captured by fisheries are fresh. We collected gonad samples from 39 female loggerhead turtles, through June 2003 to October 2006. Most of the turtles were captured by pound nets set around Cape Muroto, Kochi, Japan. Straight Carapace Length (SCL) was measured. Then gonads were removed and Ovary Weight (OWt), maximal Follicle Diameter (FD), maximal Oviduct Width (OdW) and existence of corpus luteum and/or corpus albicans were recorded. Presence of corpus luteum and/or corpus albicans means turtles have ovulated once or more. We defined that adult females were the turtles with corpus luteum and/or corpus albicans for that oviposition follows ovulation, and that sub-adult females are the ones without a sign of ovulation. As a result, five females (834 ± 52 [SE], range; 780-919 mm) were regarded as adult and 34 females (731 ± 43 [SE], range; 636-810 mm) as sub-adult. The range of SCL of adult and sub-adult partially overlapped. The sizes of matured females from this study corresponded to the sizes of nesting females in Japan. Thus, it seems that a female loggerhead turtle of North Pacific reaches its maturity in about 80 cm SCL. In the process of this study, we perceived that some turtles had membranes that expanded over the orifice of oviducts. None of the turtles with the membranes (n=21, range: 667-795 mm) had the sign of ovulation. For those without the membrane (n=5, range: 780-919 mm), all except one had the sign of ovulation. (i.e., membranes on orifice of oviduct existed in almost all the sub-adult females but none in the adult females.) Note that one of the sub-adult female did not possess the membrane but the SCL was 810 mm, which is considered to be the size of matured females. FD of this sub-adult, 4.8 mm, was relatively larger when compared with the other sub-adults. Therefore, we deemed that the sub-adult female without the membrane had nearly reached its sexual maturity. Overall, the membranes were tiny if sub-adult females were relatively small (n=18, SCL: 729 ± 34 [SE]), and were inflated like a balloon if sub-adult females were relatively large (n=3, SCL: 732, 785, 795mm). These suggest the membrane develops as a turtle approaches its sexual maturity, and disappears just before first ovulation starts. It seems that the membranes covering the orifice of oviduct are the hymen of sea turtles.

HIGH RESOLUTION MAPPING OF NESTING LEATHERBACK BODY TEMPERATURES IN COSTA RICA: ENVIRONMENTAL AND METABOLIC HEAT EXCHANGE

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The high metabolic rate of leatherback sea turtles (*Dermochelys coriacea*) manifest especially upon their body surface after leaving the sea to nest. In 2006 and 2007 high resolution measurements of surface body and egg temperatures were recorded from a large number of nesting females within the Pacuare Reserve in Costa Rica. Results from surface body measurements were compared to individual morphology, and seawater, beach sand, and air temperatures. Body temperature measurements were obtained from 37 discrete locations along one half of the body while individuals were nesting. Higher temperatures were recorded from fore and rear limbs, and the tail regions of individuals. The forelimbs were characterized by strong thermal gradients with highest values at proximal anterior locations grading to lowest at distal posterior locations, probably related to metabolic heat generated by muscular effort during beach assent. Although limb temperatures were higher than the carapace surface, limb temperatures were much more variable than the carapace and were correlated to water and sand temperature. Measurements obtained along carapace ridges were lower and relatively invariable but demonstrated gradients to higher temperatures toward the posterior and marginal to the mid-line. Certain body regions such as the head, anterior forelimb area, and anterior and posterior ridge terminus, correlated to estimated cylindrical body volume (sensu: Paladino *et al*., 1990), suggesting the importance of individual size in influencing surface body temperatures. Egg temperatures were higher than external body measurements but were not correlated to any morphology or environmental temperature metrics.

CONTAMINANT LEVELS AND POTENTIAL HEALTH EFFECTS IN *CHELONIA MYDAS* IN SAN DIEGO BAY, CA

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Many heavy metals, polychlorinated biphenyls (PCB's), polycyclic aromatic hydrocarbons (PAH's), and chlordanes have been found to exceed the "probable effects levels" in the San Diego Bay (Fairey 1998). The bay is home to a population of green turtles (*Chelonia mydas*) that are known to forage and reside most of the year in these polluted waters. This study investigates the levels and possible health effects of these contaminants in *C. mydas* and their food web. The recent development and validation of non-invasive blood and scute sampling was used to measure contaminant loads in the live San Diego Bay population without relying on tissues from opportunistic strandings. Samples of water, sediment, *Zostera marina*, *Gracilaria* spp., *Ulva* spp. and various invertebrate epifauna were also analyzed to investigate bioaccumulation patterns in the food web of *C. mydas* at eight sites throughout the San Diego Bay. Samples were analyzed for (15) heavy metals and organic contaminants (PCB's, PCB's, and chlordanes) via ICP-MS and gas chromatography, respectively. Visual health assessments and blood biochemical assays were conducted from all individuals sampled. Results of relationships between toxin levels, growth rates and fitness offer insight into what individual and synergistic effects these contaminants have on *C. mydas* and other organisms in the eelgrass ecosystem.

MACRO AND MICROSCOPIC ANATOMY OF THE ESOPHAGUS OF THE GREEN TURTLE

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Knowledge on the anatomy of the esophagus is an important issue that enables the understanding of the digestive process of possible diseases that can affect this organ in marine turtles. This study aims to describe aspects related to gross anatomy and histology of the green turtle (*Chelonia mydas*) esophagus. Ten animals that were found dead by a researcher of Projeto Tamar (the Brazilian Sea Turtle Conservation Programme) in the State, Rio Grande do Norte north- eastern Brazil, composed of this study. After the opening of the plastron, the digestive organs were withdrawn. Fragments of the cranial and caudal portions of the esophagus were fixed on 10% of formaldehyde solution for 24 h. After this, they were dehydrated in increased ethanol concentration and were diafanized in xylol included in paraffin according to conventional histological methods. The esophagus of the *C. mydas* is presented as a tubular muscular-membranous organ. The mucous of the esophagus is plaited and has point corneal papillae. These inclined in the caudal direction and increase in size until it reaches the medium esophageal area and decrease in the caudal region. In histological terms, the mucous presented itself with keratinized and stratified squamous epitheliums, with its aglandular propria lamina that was composed by loose conjunctive tissue (LCT). The muscular layer of the mucous and submuscular was not evidenced. The muscular layer is composed by striated muscles organized in parallel beams in a unique layer; they are in a longitudinal manner and present abundant loose conjunctive tissue between the beams. The external layer presented itself advanced in the cranial portion and serose in the caudal portion. The esophageal papillae followed the same microscopic structure of the esophageal mucous. Howerever, in their propria lamina the infiltrated linfocites could be visualized as well as adipous tissue, lymphatic and blood vessels. The esophageal papillae facilitate deglutition and avoid food reflux. The absence of glands in the mucous of the esophagus indicated that this organ has a mechanical function only. The presence of queratine protects the esophageal mucous against attrition that occurs once food goes through esophagus.

ULTRASTRUCTURAL FEATURES OF THE EGGSHELL FROM FRESHLY LAID EGGS IN THE LOGGERHEAD, *CARETTA CARETTA*, FROM MASSIRAH ISLAND, OMAN

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Eggs were taken at random from 10 nests immediately after oviposition for examining the ultrastructural features of three separate layers of the eggshell: the outside (calcareous), the middle (multistrata) and the inner (shell membrane) layer. The samples were examined under low vacuum and viewed with back scattered electron detector at 20 kv or at high vacuum (gold coated eggshell) with secondary electron detector at 5 kv suing JSM 5600 Lv. Qualitative and quantitative analysis elements of eggshell were determined by energy dispersive x-ray analysis (EDX). The calcareous layer consists mainly of nodular units of different shapes and sizes without any interlocking attachment between the units. This resulted in numerous spaces or openings of different sizes between the units.

Each unit is characterized predominantly by the presence of $CaCO_3$ crystallites in the aragonite form of folding or unfolding spicules. Also other forms of crystallites are also present. Each nodule is predominantly made up of several groups of specules with each group arranged in a stack. After incubation the spicules of each stack become separated from each other to give a radiate appearance. Each specule contain several pits with a micronodule in each pit which gives nodules a granular appearance. The middle layer which is the platform of the calcareous layer have several strata with different crystallite forms. Several openings are found here for communication with the top and bottom layers. The innershell membrane has several reticular fibers and supposes to be the nucleation side for the crystallization process. The value of this investigation will be discussed.

MARBOFLOXACIN SERUM KINETICS IN LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) AFTER SINGLE INTRAVENOUS INJECTION

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Marbofloxacin, an antibiotic, is a new fluorinated quinolone developed only for veterinary usage. This study was undertaken in order to generate pharmacokinetic data, strictly related to the therapeutic dosage regimens usually employed, in a particular and rare animal species: the loggerhead sea turtle (*Caretta caretta*). Three turtles were intravenous administered 2 mg/kg b.w. of marbofloxacin (Marbocyl®) in a single-dose. Blood samples were collected by venipuncture of a jugular vein into vacutainer tubes. Samples were taken at 0, 10, 20, 30, 45, 60 min., and 2, 4, 8, 12, 24, 48, 60 h. Animal care and experimental procedures were conducted according to Directive 86/609/EEC (1986). The study was performed according to ISO 9001:2000 requirements. After centrifugation, plasma aliquots (1 ml) were frozen (-18°C) until assayed. Marbofloxacin concentration in plasma was determined by a setted up and validated high performance liquid chromatographic (HPLC) method (U.V. detection). Plasma concentrations of marbofloxacin were subjected to compartmental analysis using WinNonlin program (5.2 version). The elimination half-life ($t1/2\beta$), total plasma clearance (Cl), the volume of distribution (Vd) and the area under the curve (AUC) were calculated. During the experimental period all the animals were healthy. Marbofloxacin levels halved rapidly in two turtles (about 20-30 min.), but the 3rd one showed a slow decrease, and the plasma levels halved at about the 2nd hour. In all the animals marbofloxacin was still recovered at the last experimental time (60 h). This low elimination rate agrees with data obtained in several animal species, most of them mammals. The kinetic study and the definition of the kinetic data after single intramuscular injection are in progress.
Acknowledgements: The Authors thank Fatro S.p.A. Industrie Farmaceutiche Veterinarrie and Vétoquinol S A.

PROJECT PROPOSAL AND PRELIMINARY RESULTS OF SPATIAL AND TEMPORAL TRENDS OF PERFLUORINATED CONTAMINANTS IN LOGGERHEAD SEA TURTLES ALONG THE EAST COAST OF THE UNITED STATES

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Fluorinated organic compounds persist in the environment long after they have been used commercially, and perfluorinated compounds (PFCs) are found in a range of goods such as stain-repellents on cookware, leather, clothing, paper, and carpet. PFCs bioaccumulate in blood plasma and liver, and have been found to cause toxicity to the liver and suppression of the immune system. The concentrations of two notable compounds, PFOS and PFOA (perfluorooctane sulfonate and perfluorooctanoic acid), have been increasing in the environment over the last three decades. Due to increasing concern, PFCs have been examined in a range of wildlife, including birds, fish, invertebrates, and marine and terrestrial mammals. However, little has been done to measure these compounds in reptiles, and only within the last few years have scientists examined how these contaminants move through the environment by using food web, temporal, or spatial studies. One such study examined the spatial distribution of PFCs in Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtles along the East coast of the United States from northern Florida to North Carolina, and found that plasma PFC concentrations were higher in sea turtles captured farther north. This poster will present a proposed project that broadens the previous study and will provide available preliminary results. PFC concentrations will be measured in juvenile loggerhead turtles that were captured over a larger geographical area to determine if the concentrations are even higher in turtles captured in Maryland, north of the area encompassed by the previous study. Ten plasma samples will be analyzed per location. These samples were collected from turtles captured in 2005 and 2006 from Cape Canaveral, FL, Charleston Harbor, SC, Core Sound, NC, and Chesapeake Bay, MD. To investigate potential responses to a major manufacturer's voluntary phase-out of PFOS in 2000, temporal trends of PFC concentrations will also be measured in ten plasma samples per year from turtles captured in Charleston Harbor, SC, from 2001-2007. Samples will be extracted for 14 PFCs by a solid-phase extraction and quantified using liquid chromatography tandem mass spectroscopy. By broadening the knowledge of how these perfluorinated compounds behave in the environment, this study will help assess the environmental risks posed to loggerhead sea turtle populations by these contaminants along the East coast of the United States. Acknowledgements: I would like to thank the Sea Turtle Symposium as well as the following generous donors for making my trip to the 28th Sea Turtle Symposium possible through a student travel grant: Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, as well as two generous individuals: Robert N. Allen, Jr. and Carlos Peralta Quintero.

THE IMPORTANCE OF SAND QUALITY FOR THE EMBRYONIC DEVELOPMENT OF THE LEATHERBACK SEA TURTLE

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Incubation environment of leatherback clutches is very heterogeneous, including different moisture levels or types of sand. We studied the characteristics of sand, embryonic development and hatching success of leatherback sea turtle (*Dermochelys coriacea*) nest sites, located at 3 important nesting beaches in the southern Caribbean of Panama (SC1) and northwest of Colombia (NC1, NC2). The sand generally differed in grain-sizes, colours and compositions among the nesting beaches. The observed mean hatching success of natural in-situ nests (43.8% (SC1), 69.3% (NC1) and 75.7%(NC2)) was significantly different among nesting sites (ANOVA $F_{2,128} = 20.0$, $p < 0.0001$). During 2007 we investigated the influence of these different sand substrates in leatherback hatching success. Eggs were experimentally incubated in sand of six different grain-size, colour and composition. Each dry sand treatment was rehydrated at 3% gravimetrically. We used 15 eggs (3 per female) in each closed plastic containers that were incubated in the hatchery at 60 cm depth. Each treatment had three replicates. Hatching success varied from 0% in black, small grain-size sand to 68% in white big grain-size sand (ANOVA $F_{5,12}= 7.19$, $p < 0.0001$). The egg mass variation (Measured Repeated ANOVA $F_{10,166} = 21.68$, $p < 0.0001$), hatchling mass (ANOVA $F_{4,115} = 3.98$, $p < 0.005$) as well as hatching success are related with variation in sand types as shown by principal components analysis. Incubation duration was not affected by the sand substrates. The incubation sand environment could be a key of successful conservation programs in determining high-risk nests. These results are relevant for conservation strategies that involve moving all clutches from inundated-beach areas to high-beach areas. This can contribute in reduction of loss of many nests laid in a low quality substrate.

DO MATERNAL BLOOD CHARACTERISTICS PREDICT NEST SUCCESS AND HATCHLING MORTALITY IN THE LEATHERBACK SEA TURTLE (*DERMOCHELYS CORIACEA*)?*

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Leatherback sea turtles (*Dermochelys coriacea*) on the Western Atlantic coast in Florida have particularly low emergence success (mean = $41.45 \pm 23.24\%$, modal range = 30-39% & 50-59%). Postmortem examinations of dead-in-nest, as well as hatchlings that died in the laboratory shortly after hatching, revealed degenerative changes in the heart muscle. These observations were similar to those seen in bovine neonates whose mothers were selenium deficient. Ingested mercury is detoxified by the liver through the formation of a mercury-selenium compound. Persistently elevated mercury levels may eventually exhaust the liver's ability to detoxify, especially if dietary selenium levels are not compensatory. In some marine species whose diets are primarily fatty fish with high levels of mercury and selenium, we expect both mercury and selenium levels to be elevated. However, we have not explored this relationship in a species whose diet consists mostly of invertebrates (e.g. jellyfish), a zooplankton

consumer. We examined nesting female leatherbacks to determine selenium and mercury levels and looked for correlations between those and other blood parameters with nest success. Females can pass selenium deficiencies on to their young via the yolk. We analyzed blood mercury and selenium levels from 40 nesting females in Juno Beach and Jupiter Beach, FL, USA. Blood was also collected from a subset of hatchlings as they emerged from the nests (from 32 nests). Nests were excavated three days after hatching to determine hatch and emergence success and seek correlations with maternal health. We also established baseline blood values from 38 turtles in this population. Our sample population had mercury levels that ranged from 1.1 – 76.6 ppb (n = 36, mean = 20.51 ± 2.37 ppb, modal range = 10 – 19 ppb) and selenium values that ranged from 0.39 – 19.98 ppm (n = 47, mean = 7.74 ± 0.81 ppm, modal range = 2.0 – 2.9 ppm). Mercury levels in leatherbacks from Juno Beach were lower than those see in Gabon, Africa, where the concentrations ranged from 100 – 400 ppb (Deem *et al*. 2006). However, the mercury values were similar to those (range = 0.50 – 67.3 ppb) seen in Kemp's ridley sea turtles (*Lepidochelys kempii*) from the Gulf of Mexico (Kenyon *et al*. 2001), but lower than those (range = 40 – 306 ppb) seen in loggerheads (*Caretta caretta*) from the South Carolina, Georgia, and Florida coasts (Day *et al*. 2005). Selenium levels have never been documented in leatherbacks; however, loggerheads from the South Adriatic Sea were found to have tissue (liver) selenium ranges of 1.0 – 24 ppm (mean = 4.86 ± 0.85) and corresponding tissue (liver) mercury levels of 0.37 – 1.10 ppm (Storelli *et al*. 1998). Hematological values were comparable to published values identified in two other populations, Gabon and Trinidad, while plasma protein fractions were slightly divergent. Average blood chemistries were most dissimilar from published leatherback values in creatinine, lactate dehydrogenase, amylase, and lipase (differed in an order of magnitude). There was no strong correlation between overall nest success and gross assessment of maternal health. This study was funded by a Florida Sea Turtle License Plate Grant to Dr. Debra L. Miller and Dr. Jeanette Wyneken.

THE HEMATOLOGIC CHARACTERISTICS OF THE OLIVE RIDLEY MARINE TURTLE

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In order to arrive at an understanding of the hemogram values and the morphological characteristics of the blood cells of the olive ridley marine turtle (*Lepidochelys olivacea*), blood was taken from 22 such turtles living in the wild at the Barra de la Cruz Beach, municipality of Santiago Astata in the state of Oaxaca, Mexico. A hemogram was carried out on each of the samples using conventional techniques for reptiles, from which the following results were obtained: hematocrit (0.30±0.40 L/L), total solids (47.14±5.85g/L), mean corpuscular volume (891.79±291.93 fL), total erythrocyte count (0.37±0.12x1012/L), total leukocytes (4.51±3.03x109/L), differential count of leukocytes: heterophils 2.87±1.88x109/L, eosinophils 0.89±0.68x109/L, basophils 0.08x109/L, lymphocytes 0.64±0.59x109/L, monocytes 0.07x109/L and the estimated number of trombocytes (127±47). Nucleate erythrocytes, 5 different types of leukocytes (heterophils, basophils, eosinophils, lymphocytes and monocytes) and nucleate trombocytes were detected. The erythrocytes presented classic reptilian characteristics and measured 19.55±1.68µ in length and 12.89±1.25µ in width and the nuclei measured 5.82±0.79µ in length and 4.35±0.72µ in width. The heterophils are round to oval in shape and in some cases are amorphous. The cytoplasm contains eosinophil granules (a bright orange color), fusiform-shaped. The cytoplasm is colorless, the shape of its nucleus is round or oval and it is off-centered. In length, it measures 16.58±2.55µ and, in width, 14.10±2.20µ and the nuclei measures 8.10±1.95µ in length and 5.55±1.41µ in width. The eosinophils are round or oval cells which contain small, spherical-shaped cytoplasmic eosinophilic granules. The nucleus is somewhat oval in shape, its position is centered, and its edges are irregular. They measure 18.31±1.84µ in length and 15±2.48µ in width. The nuclei measures 7.77±1.83µ in length and 5.85±1.28µ in width. The basophils are small cells which contain small, pink granules in their cytoplasm. The cytoplasm is colorless and its nucleus may be lobed. They measure 13±3.98µ in length and 10.75±2.86µ in width. The monocytes and lymphocytes present morphological characteristics similar to those described in the other species of reptiles, birds and mammals. The monocytes measures 17.10±4.7µ in length and 13.60±2.65µ in width and the lymphocytes measures 9.98±2.5µ in length and 7.33±2.01µ in width and the

nuclei measures 7.81±.1.65µ in length and 6.01±1.40µ in width. The trombocytes are elliptic-shaped cells. The nucleus is centered and has a dense chromatin that gives it a purple tint. The cytoplasm is small in relation to the nucleus. It only has a little color if any at all and can contain some cytoplasmic vacuoles. They measure 9.18±2.22µ in length and 7.33±1.83µ in width. The nuclei measures 7.81±1.47µ in length and 6.20±1.27µ in width.

MORPHOLOGIC FEATURES OF THE CELLS IN THE BLOOD OF THE SEA TURTLES: OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA)*, BLACK TURTLE (*CHELONIA AGASSIZII)*, AND LEATHERBACK (*DERMOCHELYS CORIACEA)*

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The blood of sea turtles is composed of plasma and blood cells; these are classified as erythrocytes, leukocytes granulocytes: basophils and acidophils (heterophils and eosinophils), leukocytes agranulocytes: lymphocytes, monocytes and nucleate trombocytes. Materials and Methods: Blood was taken from sea turtles living in the wild, twenty two olive ridley, *Lepidochelys olivacea*, one black turtle, *Chelonia agassizii*, and six samples of the leatherback, *Dermochelys coriacea*. The blood samples were contained and drawn into lithium heparin tubes according to the 1996 technique by Dutton. The blood films were made by the push-slide technique; they were stained according to the 1990's Wright technique by Benjamin. For the microphotographs we used a photographic camera (Mini VID LW SCIENTIFIC, Inc.) and an optic microscope. Results: The erythrocytes present morphological characteristics similar to those described in the other species of reptiles which are blunt-ended ellipsoidal cells which are permanent, centrally positioned, oval nuclei containing dense purple chromatin. The cytoplasm stains uniformly with the Wright's stain. The heterophils are round or oval in shape, in some cases they are amorphous. The cytoplasm contains eosinophil granules (a bright orange color), and are fusiform-shaped. The cytoplasm is colorless, the shape of its nucleus is round or oval and it is off-centered. The eosinophils are round or oval cells with colorless cytoplasm which contain small, spherical-shaped cytoplasmatic eosinophilic granules less than heterophils. In the eosinophils the granules are of variable size and different in quantity according to each sea turtle species, there are more and of smaller size in the *Lepidochelys olivacea*, for *Chelonia agassizii* they are in less quantity than in the *Lepidochelys olivacea* but of similar size, in the *Dermochelys coriacea* the size is bigger but there are less. The nuclei are smaller containing dense chromatin of purple stain. The basophils are small cells which contain small and pink granules in their cytoplasm. The cytoplasm is colorless and its nucleus may be lobed. The monocytes and lymphocytes present morphological characteristics similar to those described in the other species like reptiles, birds and mammals. They vary in shape from round to amoeboid, it's nucleus may vary in shape from round to lobed, the cytoplasm has quite a bit of a blue-gray color and may appear slightly opaque with vacuoles or fine dust like eosinophilic granules. The lymphocytes are round cells varying in size and have a round, occasionally slightly indented, centrally or slightly eccentrically positioned nucleus. The chromatin is heavily clumped or reticulated in mature lymphocytes. The cytoplasm appears homogeneous, generally lacks vacuoles and granules, and is slightly basophilic (pale blue) in the typical small mature lymphocyte. Large lymphocytes have more cytoplasmic volume compared to small lymphocytes and its nucleus is often a pale stain. The trombocytes are elliptic-shaped cells. The nucleus is centered and has a dense chromatin that gives a purple tint. The cytoplasm is small in relation to the nucleus. It only has a little color if any and can contain some cytoplasmatic vacuoles.

FIBROPAPILLOMATOSIS IN OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) FROM ESCOBILLA BEACH OAXACA

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The descriptions to identify cutaneous fibropapillomas in *Chelonia mydas* date since 1930 in Florida U.S.A. The prevalence of the illness increased since the 80's around the world. It is characterized by multiple fibro-epithelial tumors in the body surface. The turtles show weight loss, weakness and blindness. At present, the agent of the fibropapillomatosis in sea turtles has not been characterized in all cases. In this study biometric data were taken from 30 female *Lepidochelys olivacea* of Escobilla Oaxaca, to monitor the size of the nesting season and the approximate age of the animals. According to the location of fibropapillomas, the incidence was determined and the tumors were classified as mild (1), moderate (2) and severe (3). Thirty representative biopsies from 2 to 5cm of diameter were taken, with local anesthesia. They were fixed in buffered formalin at 10% for histopatologic (HP) and inmunohistochemical (IHQ) analysis. For the electron transmission microscopy (MET) analysis, eighteen samples were fixed in 2.5% glutaraldehide. Samples for PCR were taken and maintained in dry ice at -20°C. The results showed: Curve carapace length (CCL min): 67.5 cm and straight carapace length (SCL max): 70.5 cm = adult turtles from 10 to 20 years. Size of tumor: 2-16.9 cm. Tumor score: 17 tumors were grade 2, 10 tumors were grade 1 and 3 tumors were grade 3. The most affected zone was: the right anterior flippers (13), followed by the "soft zones" (9) and left anterior flippers (8). Tumors were grossly classified as: 20 tumors with cauliflower aspect, 6 with warts aspect and 4 mixed. By light microscopy it was founded: moderate to severe epidermal hyperplasia, diffuse and multifocal in 28 cases, mild multifocal acanthosis in 26 cases, diffuse orthokeratosis in 16 cases, mild basal cell degeneration in 16 cases and of the spinosum stratum in 14 cases, moderate intraepidermal pimples in 15 cases, mild heterophil infiltrate in 6 cases, mild multifocal lymphocyte infiltrate in 13 cases; 5 suspects of inclusion bodies, 11 with bacteria and 22 with ectoparasites. The final diagnosis was cutaneous fibropapillomas (29/30) and one fibroma in olive ridley (*Lepidochelys olivacea*). Ultrastructurally we observed: 14 cases with iridovirus-like particles. 18 cases had epithelial and dermal neoplasm cells. In 11 cases there was effect of the parasite in the first and second stratum of the epidemis. In order to characterize the firopapillomatosis agent, PCR and IHQ will be realizing and the results will be shown at the symposium. It is concluded that the fibropapillomatosis in olive ridley turtles in Escobilla Oaxaca, México was characterized macro and microscopically. It's necessary to continue with these kind of studies supported by specific and sensible techniques that show the causal agent because in these cases the Iridovirus-like particles are not conclusive of their participation in the development of the fibropapillomatosis in olive ridleys (*Lepidochelys olivacea*).

SEA TURTLE FIBROPAPILLOMATOSIS IN MEXICO: IS IT A VIRAL ETIOLOGY?

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For the past 25 years many sea turtle populations have been affected by a tumor-forming disease known as marine turtle fibropapillomatosis (MTFP) that has no treatment and the main etiologic agent has not been determined. It was first diagnosed in the early 1940s in Florida then in late 1950s in Hawaii, where it reached epidemic proportions by the mid 1980s. Since then it has been diagnosed in many pantropical parts of the world and extensive research has been the focus in the isolation and characterization of the primary etiological agent, thought to be a virus. Specimens of tissues from sea turtles diagnosed as fibromas and fibropapillomas were collected. These tissues were sectioned in three pieces; one was kept in 2.5% glutaraldehyde for TEM processing, a second one in 10% buffered formalin for histopathology, and a third was maintained at -70°C for genetics, viral isolation and PCR analysis. We found three cases of MTFP in Mexico: one olive ridley (*Lepidochelys olivacea*) and one Kemp´s ridley turtle (*Lepidochelys kempii*) kept at Mexican Center of the Turtle in Mazunte, Oaxaca and one green turtle (*Chelonia mydas*) found stranded in a turtle reserve in Campeche that presented gross lesions compatible with MTFP. Additionally, we sampled wild sea turtles at Puerto Lopez Mateos, Baja California Sur. The histopathology results are inconsistent, but hyperplasia and fibrosis are the most common lesions in tissues examined. We observed cytopathic effects when tumor extracts were inoculated in Vero cells. We performed a PCR assay using protocols previously described (Quakenbush *et al*. 2000). Preliminary results by TEM provide evidence of the presence of the fibropapilloma herpesvirus in apparently healthy skin samples. Vesicles that seem to be viral particles, besides bacteria in the inner layers of the tumor were identified. This finding has not been reported previously. These results suggest that healthy turtles carry the herpesvirus and a bacterial agent probably is involved in the disease etiology.

PARASITES IN LOGGERHEAD (*CARETTA CARETTA*) TURTLES FROM THE SOUTHERN ITALIAN WATERS

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As part of a larger project evaluating the health status of Mediterranean loggerhead (*Caretta caretta*) turtles along the coast of southern Italy, a systematic study was performed to assess the presence of infective agents in this area. A total of 35 stranded turtles (curved carapace length [CCL] ranging from 32 to 73.5 cm), including 21 individuals from Sicilian coast and 14 from Naples Gulf (Campanian coast) collected between 2006 and 2007 were studied in respect to their metazoan parasites. The alimentary tracts (including esophagus, stomach and upper and lower intestines), and heart and great vessels were carefully examined for parasites following standard procedures. Digenetic trematodes were fixed in 70% ethanol, stained with Mayer's acid carmine and mounted in Canada balsam. Nematodes were preserved in 70% ethanol with glycerin then mounted in lactophenol. Helminths were examined

under a light microscope for identification. Gastrointestinal helminths were collected in 31 (88.6%) of the 35 examined loggerheads. Differences in species, prevalence, abundance, and intensity of infection were found in turtles from the two geographical sites. Only 1 core species (prevalence of infection >50%) was recovered from the gastrointestinal tract of all studied turtles. The most commonly detected species were the digenetic trematodes *Enodiotrema megachondrus* (Plagiorchidae, 67%) in Sicilian turtles, and *Calycodes anthos* (Auridistomiidae, 36%) in chelonians from the Naples Gulf. *Pleurogonius trigonocephalus* (Digenea: Pronocephalidae), *Sulcascaris sulcata* (Nematoda: Anisakidae), and an unidentified nematode belonging likely to Kathlanidae were recovered only in Campanian individuals with CCL>55 cm. *Pachypsolus irroratus* (Digenea: Pachypsolidae) was collected only from Sicilian waters. Geographical sites and turtle age/size were likely the most important factors influencing the composition of the gastrointestinal helminth communities of loggerheads in southern Italian waters. No cardiovascular flukes (Digenea: Spirorchiidae) were found. In addiction the leech *Ozobranchus margoi* (Hirudinea: Ozobranchidae) was collected from the skin of 3 Campanian chelonians.

SPATIAL AND TEMPORAL VARIATIONS IN THE ACTIVITY OF ANTIOXIDANT ENZYMES IN BLACK TURTLE (*CHELONIA MYDAS*) BLOOD IN TWO LOCALITIES OF BAJA CALIFORNIA, MEXICO

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Seasonal changes in food supply, reproductive status, temperature, pollutants, and other factors, can increase production of reactive oxygen species (ROS) and induce oxidative stress in many aquatic organisms. Oxidative stress has been related to the ethiopathogenesis of numerous diseases, including tumors and cancer. In order to analyze the seasonal changes of the antioxidant defense system of the black turtle (*Chelonia mydas*) blood samples were collected from live turtles captured during a routine population survey in 2005 and 2006 in Punta Abreojos and Bahía Magdalena, Baja California Sur, Mexico. Turtles were tagged and released after samples were taken. The activities of the antioxidant enzymes superoxide dismutase (total, tSOD; manganese-dependent, Mn-SOD; copper and zinc-dependent, Cu,Zn-SOD), catalase (CAT), glutathione-S-transferase (GST), glutathione peroxidase (GPX), and lipid peroxidation (TBARS, as an index of oxidative damage) were measured using spectrophotometric techniques. In turtles sampled in Bahia Magdalena TBARS levels were lower during spring than in summer and winter ($p < 0.05$). We did not find differences in the activities of the enzymes between localities ($p > 0.05$). Changes in diet during spring could contribute to differences observed in the antioxidant enzyme activities in blood from black turtles in Bahia Magdalena. GST is an inducible enzyme involved in detoxification processes. An increase in environmental contaminants associated to changing patterns of dominant currents and upwelling during summer in Punta Abreojos could contribute to the higher GST activity found in these turtles. Further studies should address the possibility of a relationship between blood antioxidant enzyme activities and the biochemical and nutritional composition of algae consumed by black sea turtles, as well as the possible relationship between oxidative stress markers and contaminants in these turtles.

CONSERVATIONAL IMPLICATIONS OF TEMPERATURE-DEPENDENT SEX DETERMINATION: WHICH TEMPERATURES ARE BEST?

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A variety of reptiles, including all species of sea turtles, have temperature-dependent sex determination (TSD). This form of sex determination has significant conservational implications since it has the potential of producing highly biased sex ratios which can affect the reproductive output of a population. TSD is of particular interest to conservation programs that use hatcheries to artificially incubate eggs. Such programs need to select specific incubation temperatures in an effort to produce a desired sex ratio. The purpose of the current study was to evaluate optimal temperatures for incubating eggs in hatchery programs. For example, if a 1:1 sex ratio is desired, is it better to incubate all the eggs at the pivotal temperature or is it better to incubate half the eggs at a male-producing temperature and half at a female-producing temperature? Ideally, this question could be answered by examining the reproductive success of adult turtles derived from eggs incubated at known temperatures. However, this is not logistically possible in short term experiments. In the case of sea turtles, this would require several decades and possibly thousands of hatchlings. In the current study, the red eared slider turtle was used as a model to address this question since its TSD is similar to that of sea turtles. A short-term experimental protocol was utilized in which reproductive tracts were compared between late-stage embryos incubated at temperatures that produced either 1) all females, 2) mostly females, 3) mostly males, or 4) all males. The gross morphology and histology of the reproductive tracts (gonad and paramesonephric duct) of these four groups were compared. The results indicate significant variation between the groups. This suggests that certain incubation temperatures may be optimal for producing the most reproductively-fit individuals.

HELMINTH COMPONENT COMMUNITY OF THE LOGGERHEAD SEA TURTLE, *CARETTA CARETTA*, FROM MADEIRA ARCHIPELAGO, PORTUGAL

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In the last decades the occurrence of parasites have been used not only to assess the health status of their hosts, but also as an important tool to understand aspects of the biology of the host, namely their migratory behaviour, distribution and feeding ecology. However, the helminth fauna of the pelagic stages of loggerhead sea turtles is still poorly known. Thus, the objective of the present work was to describe the helminth component community of juvenile loggerhead sea turtles accidentally captured in waters around Madeira Island. Fifty-seven specimens of *Caretta caretta* accidentally caught by long line black-scabbard fishery or found dead offshore Madeira Archipelago were used in this study. The range of SCLnt and weight were 135-557mm and 0.243-27.97 Kg, respectively. Turtles were necropsied and the oesophagus, stomach, intestines, liver, gallbladder, spleen, kidneys, trachea, bronchi, urinary bladder, heart, left and right aortas and coelomic cavity were macroscopically inspected and washed in a sieve (mesh=180µm). A search for parasites was performed under a stereoscopic microscope and parasites were fixed and stored in 70% alcohol until staining and identification. Prevalence, mean intensity and mean abundance values were calculated. A total of 156 parasites specimens belonging to nine species were found in the stomach or intestines of 57 turtles, and 45.6% were infected with at least one parasite species. The species found were (1) Nematoda: Anisakis simplex s.l. (larvae) and unidentified species; (2) Digenea: Enodiotrema megachondrus,

Rhytidodes gelatinosus, Pyelosomum renicapite, Calycodes anthos; (3) Acanthocephala: Bolbosoma vasculosum, Rhadinorhynchus pristis ; (4) Cestoda: Nybelinia sp. No helminths were found in the oesophagus, spleen, kidneys, trachea, bronchi, urinary bladder, heart and left and right aortas. Since most marine parasites are usually transmitted through the ingestion of an infected prey, the scarce parasite infections found in this study could be explained by the oligotrophic condition of the pelagic ecosystem. From the parasite species found in our study, only the four digeneans are typical of marine turtles. Low species richness in parasite infrapopulations of juvenile and subadult *C. caretta* was also found in the western Mediterranean population. In this study, the authors attributed this fact to constraints on parasite acquisition and other host factors that could limit parasite recruitment. The migratory flux of loggerhead turtles near and through the Strait of Gibraltar has been reported in both directions indicating that the Atlantic and Mediterranean loggerhead populations share developmental habitats in the western Mediterranean and in the northeastern Atlantic. This flux of juvenile turtles between both marine ecosystems could be responsible for the partial similarity between parasite component communities of the oceanic loggerhead sea turtles in Madeira Archipelago and western Mediterranean turtles. This work provides reliable information of parasite fauna of oceanic stage of loggerhead sea turtles in the Macaronesian region and highlights the use of parasite information as a tool to identify mixing between ecological stocks of juvenile loggerhead sea turtles from this area and western Mediterranean.

BLOOD AND CARAPACE AS NON-LETHAL METHODS FOR PREDICTING INTERNAL TISSUE CONTAMINATION IN THE GREEN SEA TURTLE, *CHELONIA MYDAS*

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Monitoring of heavy metals in sea turtles provides important information about the health of individuals and populations. Past studies have been confined to opportunistic sampling of the tissues of dead and stranded individuals, and more recently, blood and carapace sampling have been attempted to non-lethally assess metal contamination of live populations. However, due to the ethical and conservation constraints of obtaining tissue samples from live sea turtles, there is currently little information on the accuracy and precision of blood and carapace samples in representing the contamination burdens of the internal tissues. There is therefore a current need to further develop blood and carapace sampling as effective non-lethal methods for determining heavy metal contamination. The Sea World Sea Turtle Rehabilitation Centre (SWSTRC) on the Gold Coast, Queensland, Australia receives 30-50 green turtles (*Chelonia mydas*) each year and provides a unique opportunity to investigate the fluctuations in blood contamination over time and the relationships between the contamination of blood and carapace samples with internal tissues. Monthly blood samples were collected from *C. mydas* at the SWSTRC between January 2005 and April 2006. For individuals that died during rehabilitation, carapace and internal tissue (liver, kidney and muscle) samples were taken immediately post mortem. All samples were analysed for cobalt, copper, zinc, selenium, arsenic, mercury, cadmium and lead using inductively coupled plasma mass spectrometry and cold vapour atomic absorption spectrometry. There was a high degree of variation in metal concentration between individuals and elements over time for the seven *C. mydas* sampled three times or more. This variability has been attributed to factors such as dietary intake, stage of rehabilitation and the timing of sampling in relation to last feeding. Metal concentrations of the blood sample taken at the time of death for 9 individuals showed strong correlations ($P < 0.05$, R2: 0.59 – 0.96) with the concentrations in the muscle, liver and kidney for arsenic and selenium and in the kidney and liver for mercury, cadmium and cobalt. The relationship between carapace and tissue samples was generally poorer than the blood samples and only significant for arsenic ($P < 0.02$, R2 > 0.60) and selenium ($P < 0.003$, R2 > 0.75). These results indicate that although significant variations exist in *C. mydas* blood samples over time, blood seems to be a relatively good method for estimating the contamination of internal tissues

for a number of the important essential and toxic metals. This information supports the future use of blood samples to give a reliable indication of internal tissue contamination, which will allow a more accurate assessment of the health of wild populations of *C. mydas*. Acknowledgements: I would like to thank the organisers of the 2008 International Sea Turtle Syposium and the generous donations from Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, the Sandler Family Foundation, Carlos Peralta Quintero and Robert N. Allen, Jr. for the travel grant to attend the 2008 symposium.

THE USE OF SATELLITE TELEMETRY TO IDENTIFY SITES FOR THE UPTAKE OF MERCURY IN THE LOGGERHEAD SEA TURTLE

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Elevated mercury concentrations found in sea turtles raise the question of how to determine sites where uptake occurs. Although, mercury is highly volatile and ubiquitous, elevated levels have been related to specific regions affected by point and non-point sources of pollution. This study presents the preliminary results of mercury concentrations for loggerhead sea turtles that were identified by satellite telemetry to forage in different locations within the Gulf of Mexico and the Caribbean. Five turtles, Genie, Luna, Tuttle, Talulah, and Calypso had satellite tags attached after ovideposition. Following incubation and hatching, unhatched eggs were collected and analyzed by a direct mercury analyzer. All samples were collected along the Gulf coast of southwest Florida to distinguish whether the concentrations represented the nesting locations or the foraging location. Mercury concentrations in egg yolks ranged from 0.0047 to 0.0743 µg g-1dry weight. Using satellite telemetry Genie's last known location was near Louisiana in the northern Gulf of Mexico. Luna, Tuttle, and Calypso were identified in several coastal areas along the southwest coast of Florida and Talulah was identified north of the Island of Cuba in the Caribbean. Mercury concentrations in yolks taken from Talulah exhibited the lowest for the group; however, Luna's egg yolk concentrations were 15 times greater. This suggests that sea turtles accumulate their metal burdens from their foraging locations as opposed of their nesting locations. Furthermore, though satellite telemetry we can discriminate locations where mercury is acquired in the loggerhead species.

QUANTIFICATION OF VITELLOGENIN (VTG) AS BIOMARKER OF ENDOCRINE DISRUPTION IN PLASMA OF PACIFIC GREEN TURTLES (*CHELONIA MYDAS AGASSIZII*) IN BAJA CALIFORNIA SUR (MEXICO) USING ELISA: A PRELIMINARY WORK

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The animal embryo develops successfully if it is provided with a sufficient amount of nutrients (K. Rüdiger Mewes *et al*, 2002). An important component of these nutrients is represented by proteic substances which the oviparous animals store in the oocites (Okuno *et al*., 2000). The precursor of these proteins is vitellogenin (VTG), a phospho-glycoprotein which is mainly synthesized in the maternal liver and carried in the blood stream to the ovary (Rüdiger Mewes *et al*., 2002). VTG is normally produced only in females as a response to the physiological variations of 17 b-estradiol (E2) during oogenesis. In males VTG is usually absent because the gene responsible for its synthesis is silent (Denslow *et al*., 1999). However, VTG synthesis takes place both in males and immature individuals exposed to exogenous estrogens or to substances that mimic estrogen actions (endocrine disruptors, ED) (Fukada *et al*., 2003). Therefore, VTG is a useful biomarker of pollution and exposure to ED. Enzyme immuno-sorbent assay (ELISA) has been used to quantify VTG in fishes (carp, trout), in reptiles (crocodiles) and in amphibians (frog). VTG quantification in plasma samples of sea turtles has not been possible due to the lack of a specific antibody and pure VTG. Sifuentes *et al*. (2006) purified the VTG from plasma and prepared an antibody antiVTG of Pacific green turtles (*Chelonia mydas agassizii*). For this study 61 plasma samples were collected in three different sites (Bahia Magdalena, Punta Abreojos and Laguna San Ignacio) along the coasts of Baja California Sur from March 2005 to April 2007. ELISA was run, including a standard curve with known concentration of pure VTG (from 0.5 µg/ml to 0.001 µg/ml) to quantify the VTG levels. Low levels of VTG (0.624 ± 0.042 mg/ml) were found in these samples confirming the high specificity and sensitivity of the antibody. No statistically significant differences in VTG concentration were found between sampling sites ($p > 0.05$). There was no apparent effect of sex or size on VTG levels in Pacific green turtles ($p > 0.05$). The combined results suggest that the Pacific green turtle population of Baja California Sur is not exposed to ED, and can be regarded as healthy. However, further investigations are needed to explain the presence of small amounts of VTG in plasma from immature specimens and males.

Behavior and Movements

POST-EMERGENCE RETENTION AND PERFORMANCE OF BLACK TURTLE (*CHELONIA AGASSIZII*) HATCHLINGS

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Every year thousands of sea turtle hatchlings emerge from their nests all over the Pacific coast, unfortunately only a few survive to adulthood. A frequent protection practice as part of the conservation activities at the sea turtle camps is the retention of hatchlings for periods ranging from a few hours to days before being released to the sea, losing valuable time to reach the offshore waters and move away from the zone with a high predation rate. Little is known about the effects of post emergence retention on the performance of black turtle (*Chelonia* agassizi) hatchlings in their run to the sea, and how it is related to the frenzy period. Considering the existing knowledge of the frenzy period of sea turtle hatchlings, it is hypothesized that the higher the time of retention, the lower the terrestrial and/or acuatical displacement speed they will have. Field research was carried out at Colola, Michoacán in February 2006. The speed of black turtle hatchlings submitted to different retention times (treatments) was measured after emergence from the nest. Thirty-five hatchlings were collected randomly from a nest in emergence. This 35 hatchling sample was divided in 7 sub-samples with 5 hatchlings in each one. Every sub-sample was maintained in a plastic half-liter container with ventilation holes. Every sub-sample did correspond to a treatment. In total there were 7 treatments: hour 0 (H0), hour 1 (H1)... hour 6 (H6). At hour zero (immediately after emerging from the nest) the hatchlings were transported to the test area. For the terrestrial evaluation, a corridor with wood walls and natural sand floor, 10 m long, with 15 cm width and 20 cm high. For the aquatic evaluation, the hatchlings were transported to a 15 cm width PVC water channel 10 m long filled with 80 liters of sea water. The corridor and the channel were positioned perpendicular to the coast line and about 15 m from the hatchery, where the sand surface was flat and the 5 hatchlings from treatment 0 (h0) were evaluated. The time that every hatchling took to cover the 10 meters was registered. At the end of the evaluations the hatchlings were released to the sea. The same proceeding was followed for the remaining treatments. Five replications were established for each treatment; 5 different nests for a total sample of 25 hatchlings per treatment. The speed of 175 hatchlings (5 hatchlings per treatment x 7 treatments x 5 replications) was measured on sand and 175 hatchlings on water. There was no statistically significant difference among the different treatments (ANOVA: $F = 0.2678$, $P > 0.05$, on sand, and ANOVA: $F = 0.8003$, $P > 0.05$, on water).

LINKING MICRONESIA AND SOUTHEAST ASIA: PALAU SEA TURTLE SATELLITE TRACKING AND FLIPPER TAG RETURNS

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Migrations of turtles to and from the Republic of Palau have been documented with satellite tracking and tag returns. Two green turtles that nested in Palau's Southwest Islands were tracked with satellite transmitters to the Aru Islands of Indonesia. A hawksbill tagged in Palau was caught in the Philippines. One green turtle tagged in Palau's remote Southwest Islands was caught in Sulawesi, Indonesia and another near the main island of Palau. A turtle tagged in the Ulithi Atoll of Yap was also caught close to Palau's main island. These tagging and tracking efforts have changed how Palauans perceive their turtle population, now recognized as an internationally shared resource. This work has also been used to support a ban on hawksbill harvesting that the Palau National Government is considering. Similar to traditional Micronesians who were among the world's greatest seafarers, this tracking and tagging information demonstrates that Palau's marine turtles navigate vast stretches of open-ocean. Tracking turtle migrations with flipper tags and satellite transmitters has been a catalyst leading to increased exchanges of information among Palau and neighboring countries. This research highlights how turtles are a shared resource in the Pacific and responsibility for their management must also be shared.

STOMACH TEMPERATURE RECORDINGS PROVIDE EVIDENCE OF FEEDING DURING THE INTERNESTING INTERVAL FOR LEATHERBACK TURTLES, *DERMOCHELYS CORIACEA*, FROM THE ST. CROIX, USVI NESTING POPULATION

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Studies of the foraging ecology of leatherback sea turtle *Dermochelys coriacea* are limited by the logistic difficulties of monitoring feeding behavior at sea. Aside from the rare direct documentation of surface feeding events, inferences made from alterations in diving patterns and broad scale movements with relation to oceanographic features provide some insight as to when and where feeding occurs. We used a combination of stomach temperature pills (STPs) and satellite-linked data recorders (Wildlife Computers) to monitor changes in stomach temperature (T_S) indicative of prey ingestion. Leatherback turtles maintain internal body temperatures several degrees higher than ambient water temperature (T_W) in both tropical and temperate seas, and ingestion of prey at ambient T_W has the effect of rapidly lowering T_S. The magnitude of the decrease in T_S and time necessary for T_S to recover to previous levels following prey ingestion reflects both prey size and ambient T_W. We deployed instruments on nesting leatherback females on Sandy Point National Wildlife Refuge, St. Croix during May 2007. Satellite-linked data recorders (model Mk10-AL) were attached to the carapace with orthopedic mini anchors while the turtle nested, and STPs were fed to turtles after they completed nesting. The STP emits pulse-coded acoustic signals (2 m range) that correspond to the T_S detected by the instrument's four thermistors. Acoustic signals are intercepted by a receiver within the Mk10-AL and stored in the archive. In addition to archiving T_S values at 10-second intervals, the Mk10-AL also records dive depth and external temperature every 10 seconds. This additional information allows us to assess the diving patterns and thermal conditions associated with successful foraging. We retrieved Mk10-AL tags from five turtles that returned to nest on Sandy Point after an internesting period of eight to nine days. Preliminary

analyses show rapid fluctuation in T_S for two turtles, which are indicative of ingestion events based on our laboratory simulations. We are analyzing T_S fluctuations along with associated dive profiles in order to investigate correlations between feeding, time of day, and dive patterns so that we may refine our understanding of foraging patterns and behaviors during the internesting interval.

EFFECTS OF PROLONGED RETENTION IN OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) SEA TURTLE HATCHLINGS ON ORIENTATION, LOCOMOTION ON LAND

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Some studies show that prolonged retention of hatchlings can have a negative effect on their survival (Piltcher & Enderby 2001; Pritchard 1980) while other programs may include retention as part of their husbandry methods. More specifically, Pilcher & Enderby (2001) used green sea turtle (*Chelonia mydas*) hatchlings to test how prolonged retention affected their swimming speed. They found that the hatchlings would use up valuable energy stores from their yolk sacs while in captivity. The swimming speed of the hatchlings decreased by 12% over the 6 hours experimental period. They predicted that this decrease in speed would affect their survival. In Mortimer's (1999) suggestions for hatchery procedure, she agreed that programs should be wary of holding hatchlings overnight to avoid exhaustion. However, in light of past studies, some hatcheries still hold hatchlings for short periods of time. Therefore, it is important to understand the effects of even small amounts of retention in hatcheries. I will be studying the affect of prolonged retention of olive ridley sea turtle (*Lepidochelys olivacea*) hatchlings on their orientation, and locomotion on land. The results may lead to implications for improving the current husbandry methods for sea turtle hatcheries. There will be 5 groups (control, Group 1, Group 2, Group 3, and Group 4) each containing 5 hatchlings. Twenty total nests will be used for sufficient numbers for statistical analysis. The control group will be released immediately and the following groups will be held for 1, 2, 3, and 4 hours respectively. Times to cross measured markers will be used to observe the variables. The data will be analized by an Analysis of Varience.

SATELLITE TELEMETRY TO ELUCIDATE HAWKSBILL´S SECRETS IN THE YUCATAN PENINSULA*

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The Yucatan Peninsula harbors the biggest hawksbill nesting populations in the Atlantic. Following conservation and protection measures starting in the mid-70s, a significant increase in nests was observed in the 90s, reaching about 6,000 for the entire Peninsula. However, from 2000 a dramatic decline ensued, continuing until the current season with a final estimate at less than 40% of the 1999 maxima. Several critical information gaps in our knowledge of hawksbill turtles in the region were identified, prominently among them was lack of information on the location of foraging grounds for post-nesting hawksbill females. We have used satellite telemetry to address these unknowns and to answer specific questions- where do the post-nesting females go after laying their eggs?, which route do they take?, do the post-nesting females leave Mexican waters?, how extensive are the feeding grounds?, and how long does it take to get there? By answering these questions we increased the basic ecological knowledge for those populations and help to focus the research and conservation next steps to approach the continuing challenges for the species' conservation in the region. Now, after tracking 10 post-nesting females in the region, and taking into account two previous studies in the region we know that the females migrate close to shore (< 30 km) and in waters shallower than 30 m. We identified the location and extension of internesting home range as well as the presence of anthropogenic activities in the area. Six of the eight tracked females (75%) from the west and south-west coast of the Peninsula migrated towards the north-east corner and the central coast of the Mexican Caribbean; four of those stayed in the exact same spot close to Isla Mujeres in the north coast of Quintana Roo. The other 25% remained in the Bank of Campeche at the center and north of it. On the other hand, one of two post nesting females tracked from Holbox Island at the north-east corner of the Peninsula migrated towards the west, reaching different banks at the west of the Peninsula, and the other is still in front of its nesting beach. Such behavior is consistent with previous hawksbill females tracked from Las Coloradas and El Cuyo at the north-east of the Peninsula. The evident residency of breeding female hawksbills in Mexican waters would imply that if nesting declines of these populations are caused primarily by pressure factors impacting on their feeding, mating and/or development habitats, those factors would need to occur within Mexican territorial waters. All that information has derived knowledge of the internesting and feeding home ranges features, the conflicts with human activities, the definition of migrating corridors along the west and north coast of the Peninsula, and showing that such technique is effective and higly recommended for medium and long distance migrations, definition of internesting and feeding grounds. However, there are technical difficulties that limit its applicability for detailed habitat utilization assessments.

A COMPARISON OF STABILITY IN SWIMMING LOGGERHEAD (*CARETTA CARETTA*) AND GREEN (*CHELONIA MYDAS*) SEA TURTLE POSTHATHCLINGS

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Adult loggerhead (*Caretta caretta*) and green sea turtles (*Chelonia mydas*) possess morphological differences believed to affect their swimming performance. For instance, slower and less maneuverable loggerheads have been found to display more frequent evidence of shark-inflicted injuries than sympatric green sea turtles, suggesting that green turtles possess greater escape ability. Once they reach their nursery habitat in the Sargassum, loggerhead and green hatchlings occupy slightly different ecological niches. The two species also differ morphologically as hatchlings. From a dorsal perspective, hatchling loggerheads have a tear-drop shape, while greens are more oval shaped. Furthermore, loggerhead hatchlings possess a keel, while greens lack a keel and are more dorsoventrally flattened. While readily apparent, little is known about how such morphological differences affect swimming performance. The goal of this study was to compare swimming performance (measured as stability) between the two species and to correlate differences in stability with differences in shell shape. We examined five parameters of stability: yaw, pitch, roll, heave, and sideslip. Synchronized lateral and ventral-view videos were collected from individuals of both species as they swam along a linear path in an aquarium. We used two 2-D digital point analyses to quantify yaw, pitch, roll, heave, and sideslip. We then compared the values for each parameter of stability between the two species. We also compared three morphometric measures (ratios) between the two species: (1) straight carapace width (SCW)/straight carapace length (SCL), (2) body depth (BD)/SCL, and (3) BD/SCW. Along with these morphometric parameters, centers of gravity and buoyancy were also determined for individuals of each species. Metacentric height (vertical distance between the centers of mass and buoyancy) was calculated from these values and was correlated with yaw, pitch, roll, heave, and sideslip. We discuss the combination of the data collected from the swimming turtles and the morphometric measurements as potential explanations for the differences in stability between loggerheads and greens.

FIRST REPORT OF AN INTERACTION BETWEEN A LEATHERBACK SEA TURTLE (*DERMOCHELYS CORIACEA)* AND ROUGH-TOOTHED DOLPHINS (*STENO BREDANENSIS)* OFFSHORE MADEIRA ISLAND (PORTUGAL), NE-ATLANTIC

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Interactions between marine turtles and other vertebrate species are seldom reported in the literature. Leatherback sea turtles (*Dermochelys coriacea)* are currently the most endangered sea turtle species, as leatherback populations are decreasing drastically over the last years and are considered critically endangered (IUCN). Although it is the second most common marine turtle around Madeira Island (Portugal), right behind loggerheads (*Caretta caretta)*, these animals seem to be extremely rare as only 5-10 sightings were registered since 1994, within nearly 1,700 registered sightings of *Caretta caretta*. The rough-toothed dolphin (*Steno bredanensis)* is a poorly known delphinid whose true distribution remains unclear. In Madeiran waters is also a rare species with only a few sightings, occurring mainly during the summer months. Marine turtles and marine mammals co-occur in the waters around Madeira Island, where 28 cetacean species have been registered and which also serves as habitat for the Mediterranean monk-seal (*Monachus monachus)*. Inter-specific interactions between sea turtles and cetaceans are

known worldwide and seem to be mainly investigatory non-aggressive. However, a group of about 10 individuals of rough-toothed dolphins was observed harassing one leatherback (total length around 150 cm) offshore Madeira Island by a local whale-watching company. The interaction took place at noon on August 3rd at the position 32º34'.932"N/16º59'.763"W. For at least 20 minutes the rough-toothed dolphins were seen chasing the turtle, trying to flip it over. They tossed the turtle out of the water several times. When the commercial tour vessel abandoned the place the interaction continued. To our knowledge interactions between leatherbacks and marine mammals are rare and reports refer only interactions with bottlenose dolphin (*Tursiops truncates)* and killer whale (*Orcinus orca)*, making this the first report of an interaction between these two species.

WILD MOVEMENTS OF A MALE HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA)* TRACKED IN THE GULF OF MEXICO WITH AN ARGOS-LINKED GPS TRANSMITTER AFTER 14 YEARS IN CAPTIVITY

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A male hawksbill turtle (*Eretmochelys imbricate)* incidentally captured by commercial fishing in October 1992 and transferred to the Veracruz Aquarium for its recovery, was maintained in the Oceanic Tank with a total capacity volume of 1,250 thousand liters of marine water. After 14 years and 7 months in captivity, this turtle was equipped with an Argos-linked Global Positioning System (GPS) transmitter (MK-10AF, Wildlife Computers), and released on May 15, 2007 in coastal waters of the Gulf of Mexico. The turtle was transferred on a motor boat at the "Anegada de Adentro" reef in the Veracruz National Park Reef System (PNSAV, Parque Nacional Sistema Arrecifal Veracruzano), for its release at 19°13'48"N, 96°03'46"W coordinates. Subsequent to release, this turtle moved north in the Gulf of Mexico and occupied coastal reefs ca. 100 km from its release site. At the time of writing, over 300 transmissions have been received by this turtle, and it continues to transmit from coastal waters in the Gulf of Mexico. The 14+ year durating in captivity is to our knowledge the longest captive duration for any sea turtle prior to its tracking by satellite telemetry. The movement of this turtle to previously documented foraging habitat for hawksbills suggests that prolonged captivity of hawksbills may not impact their ability to find and select quality foraging habitat once released. A reciprocal situation has been observed in Pacific loggerheads and Cayman Island Green turtles, both of which have been able to navigate to natal nesting areas after prolonged captivity.

SPATIAL AND BEHAVIOR ANALYSES OF POST-NESTING HAWKSBILL FEMALE MIGRATION IN THE YUCATAN PENINSULA (MEXICO)

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In addressing the drastic decline in the hawksbill populations in the Yucatan Peninsula (Mexico) one of the most prominent information gaps identified was the lack of knowledge on the location of critical marine habitats and the migratory routes used by breeders. As part of a regional effort to improve our understanding we deployed seven satellite transmitters on equal number of post-nesting hawksbills from the western and northeastern coast of the Yucatan Peninsula. The specific objectives of the study were to (1) locate and spatially define the inter-nesting and feeding areas, (2) identify migrating corridors and (3) characterize the diving patterns along the routes used. As decline rates have varied between nesting populations of the three states within the Peninsula, we also wanted to compare migratory patterns and destinations for nesting females after breeding in one of the two regions. Four of the five females from west coast beaches migrated to the Mexican Caribbean, three of which reached a similar site near Isla Mujeres in Quintana Roo, while the fourth continued moving towards Bahia Ascencion on the southern portion of the Mexican Caribbean. The fifth female migrated to a feeding ground off the northwest corner of the Peninsula, but within the Campeche Bank. Post-Breeding females satellite-tagged in the other end of the Peninsula showed a prevalence to move in the opposite direction. One of two females tagged in the NE migrated westwards, and settled on a coralline bank off the NW of the Peninsula. The other is still wandering in front of the coast of Isla Holbox, its nesting beach. The mean time taken to reach feeding grounds was 47 days. All movement was close to shore, never more than 25-40 kms from the shoreline and following depths of between 20-30 m. Internesting home ranges for five females ranged from 0.83 km^2 to 178.17 km^2. The home ranges at the feeding grounds varied from 9.37 to 87.67 km^2 for the four females that settled at feeding sites. The feeding grounds themselves were at different distances off-shore, ranging between 3 and 190 km. There were marked differences in the diving behavior along day and night, as well as between their internesting period, migratory trip and when they reached their feeding area. Our results suggest a general eastward migratory pattern for females after nesting on the west coast, contrasting with a generally westward migratory movement for the post-nesting females from the east. Given the contrasting foraging destinations, if variation is also found in the general health and level of impacts to hawksbills in the marine habitats at opposite ends of the Peninsula, adjustments to the conservation strategies for populations nesting in different portions of the Yucatan Peninsula will be necessary.

MOVEMENTS OF MATURE AND IMMATURE HAWKSBILL TURTLES IN THE GULF OF MEXICO AND THE CARIBBEAN

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Hawksbill turtles have been considered the less migratory species with short movements between their different habitats. However, long term mark-recapture information has accumulated showing that long distance movements also occur, sometimes between territorial waters of many countries as in other species. Knowledge on patterns of migratory movements is highly relevant for focusing regional conservation actions, particularly when the Yucatan breeding population is the largest in the Atlantic basin and one of the largest worldwide. To begin understanding the migratory and internesting patterns, results from flipper tagging and satellite telemetry were compiled from a total of 5,937 mark-recapture records accumulated from nesting females 1990-present in Yucatan and Quintana Roo, 1992-present in Veracruz and Campeche, as well as from 18 immatures held in captivity for less than 1 year after being captured by local fishermen. In particular, we intended to determine (1) whether or not hawksbills leave Mexican waters either post-nesting or (2) during immature stages after recruiting into foraging habitats in Mexico, and (3) the degree of site fidelity in nesting females. Forty-two percent of all tagged nesting females were recaptured, of which 11% translocated to a different nesting beach within 33 - 614 kms. The most frequent routes (involving 82% of all translocations) were the shortest: Las Coloradas-El Cuyo in Yucatan (15 km maximum; 75 % of all translocations), Isla Aguada-Isla del Carmen in Campeche (40 km; 8 % of all translocations). The longest were very infrequent and involved Celestun-El Cuyo, Isla aguada-Holbox and Isla del Carmen-Coloradas (300 km, 625 km, 590 km; involving barely 0.15 % of all translocations). Most of the immature hawksbills released off Veracruz remained within the Veracruz Reef System; however, three turtles exhibited long-distance movements- 480 and 800 km within Mexican waters, while the last one reached Nicaragua and became the only international track from this dataset. Satellite tracking of the post-nesting migratory movements of 10 females and one male post-capture showed that five females from Campeche (42% of the total) recruited into foraging habitats around Isla Mujeres, Mexico in the Caribbean,; another three (two from Campeche and one from Veracruz) stayed within Campeche Bank; two (one each from Veracruz and Quintana Roo) moved to foraging sites off the Yucatan coast. These results suggest that the majority of post-nesting and immature hawksbills studied do not leave Mexican waters, despite sporadic exceptions; at least once they recruit into critical habitat within Mexico. While the degree of nesting site fidelity is high a small percentage of translocation does occur and sometimes involves beaches from more than one State in the Yucatan Peninsula. This suggests the existence of three major regional nesting areas involving beaches along the southwestern, the northwest and northeast corners of the Peninsula, where the vast number of translocation involves movement within the regions but very scarcely between. These results highlight the concentration of hawksbills within Mexican waters, implying that declines observed for the species here must be primarily the result of impacts occurring within national jurisdiction.

EPIBIONT COLLECTION FROM SEA TURTLES IN THE ESTUARINE WATERS OF NORTH CAROLINA

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The Core and Pamlico Sounds of North Carolina's estuarine waters are an important foraging ground for juvenile loggerhead (*Caretta caretta*), green (*Chelonia mydas*) and Kemp's ridley (*Lepidochelys kempii*) sea turtles. During the fall, when the temperature of these waters drops below the turtle's tolerance level, they migrate to warmer, southern waters, returning to northern foraging grounds in the spring. It has been suggested that the analysis of carapace and body epibionts may serve as a possible tool for studying the movements and habitat preference of sea turtles, since sessile epibionts can attach to the carapace only when the ranges of the turtle and the epibiont overlap. Therefore, the territory of the turtle may be reflected in the carapace community, thus providing insight into the migration routes of sea turtles. Of all the species of marine turtles, the loggerhead turtle hosts the most diverse assemblage of epibionts. However, the existing knowledge on epibionts of the loggerhead turtle and other species of sea turtles in North Carolina is limited. Since 1987, an in-water sea turtle program at the NOAA Beaufort Laboratory has been collecting morphometric, biological, and physiological data from sea turtles incidentally captured in pound net and long haul fishing gear in North Carolina estuarine waters. These sampling trips provide an opportunity to collect information on the epibiont assemblage associated with sea turtles, particularly loggerhead turtles, as they are the most common sea turtle captured in pound net gear. In May of 2007, we began collecting a representative sample of epibionts from incidentally caught sea turtles. For each epibiont sample, we recorded the corresponding geo-coordinates, date, and species of turtle. Upon returning to the laboratory, epibionts were preserved in 70% ethanol for later identification. Species collected thus far include the Goose barnacle (*Lepas* spp.), *Platylepas* spp., Turtle barnacle (*Chelonibia testudinaria*), Ivory barnacle (*Balanus eburneus*), oyster (*Crassostrea* spp.), an unspeciated clam, mussel (*Geukensia* spp.), Black-fingered mud crab (*Panopeus* spp.), Columbus crab (*Planes* spp.), skeleton shrimp (*Caprella* spp.), bryozoans (*Bugula* spp.), red algae (Rhodophyta), green algae (Chlorophyta), and polychaete worms (*Marphysa* spp.).

NEW TRACKING PROJECT PROVIDES INTERESTING DATA ON MIGRATORY BEHAVIOUR AND HABITAT USE OF EASTERN CARIBBEAN HAWKSBILL TURTLES

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In August 2006, the Caribbean Conservation Corporation (CCC) formed a partnership with the Nevis Turtle Group and the Four Seasons Resort Nevis to establish a research and conservation project to study the migration patterns of "critically endangered" hawksbill sea turtles (*Eretmochelys imbricata*) nesting on the Caribbean island of Nevis in the West Indies. The objective of the project is to reveal important information about the hawksbill's migratory behavior. The results will help both conservationists and natural resource managers improve protection efforts for this endangered species within the wider Caribbean. Despite threats such as habitat degradation from coastal development, illegal take of nesting females and eggs, and a seasonal turtle fishery in St Kitts & Nevis, Nevis manages to retain a significant population of nesting hawksbill turtles. Nesting density can reach 200 nests annually, and the Nevis Turtle Group reports an increase in nesting activity since their monitoring efforts began in 2001. These residual island populations are of particular investigative worth, for they may be critical to the continued

survival of hawksbills in the region. In 2006 and 2007 CCC researchers joined volunteers from the Nevis Turtle Group and the Four Seasons Resort Nevis to look for hawksbill turtles on the northwestern nesting beaches of the island. Using the protocol of Schroeder, Balazs and Rogers (1998), Telonics and Sirtrack satellite transmitters were attached to adult females. To date four individuals have been satellite tagged and tracked through the program. In 2006, the two turtles that were tracked showed very disparate migration behavior. Following her release, one turtle traveled over 2,500 cumulative kilometers to the Miskito Coast of Nicaragua, where she has remained for the last 10 months. The other female stayed close to her release site, traveling over 900 cumulative kilometers around the neighboring islands, but always remaining within 100 km of her nesting beach. It is still too early to determine where the two females satellite tagged in 2007 will travel. Preliminary data show that one is heading southeast away from Nevis, in the opposite direction of either turtle from 2006. The second turtle from 2007, however, remains just a few kilometers off-shore from the nesting beach, in the shallow-water channel between Nevis and St Kitts, possibly utilizing an inter-nesting habitat until she completes her nesting season. Data from just the first year of this project have been extremely enlightening. First, they reveal the extensive migrations being conducted by hawksbills nesting in the Eastern Caribbean. Second, they provide further proof that Nicaragua's Miskito Cays are important foraging grounds for hawksbills from various rookeries throughout the wider Caribbean, supporting evidence from previous hawksbill satellite tracking projects conducted by CCC and Drs. Peter and Anne Meylan, in Costa Rica and Panama. Such findings will ultimately strengthen the case of turtle conservationists working to develop regional strategies aimed at improving protection and enforcement in these vital turtle feeding habitats. Hopefully the results from 2007 will further broaden our knowledge of the migratory behavior of Eastern Caribbean hawksbill turtles.

STABLE ISOTOPES 101: WHAT ARE THEY AND WHAT CAN THEY TELL US ABOUT SEA TURTLE ECOLOGY?

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Stable isotope analysis (SIA) has become a widely used tool in field-based ecological studies, and recently has demonstrated great utility in sea turtle research. Generally, stable isotope signatures of animal tissues reflect characteristics of food web dynamics and nutrient flow in trophic systems, and can also provide information about diet composition, foraging location, migratory patterns, and population structure. Seven elements have naturally occurring stable isotopes, which differ in their atomic masses from the more abundant lighter isotopes due to additional neutrons in their nuclei. Stable isotope signatures are measured using mass spectrometry, a technique that quantifies the mass-to-charge ratio of ions generated from a biological sample, thereby determining its isotopic composition. Delta notation is used to represent the value (in parts per thousand) of the difference between tissue sample SI signature and that of a standard for the element of interest. Heavy and light isotopes of an element differ in their behavior, reactivity, and ultimate fate during biochemical processes, such that isotopes of an element become non-uniformly distributed in animal tissues according to their mass differences, a process called fractionation. For example, due to selectivity of heavier isotopes during metabolic processes, animal tissues tend to be enriched with heavier nitrogen isotopes (15N) relative to their diet, thus allowing for 15N values to be used to determine an organism's tropic status. However, the degree to which the SI signature of consumer tissue reflects that of its prey depends on several factors, including analytical error (e.g., 'drift' in mass spectrometry readings), isotopic turnover time of tissues, which depends on metabolic activity of different tissue types (e.g., fast turnover: liver, brain; slow turnover: skin, bone), the lack of universal isotopic discrimination values (i.e., enrichment factors between consumer and prey tissue SI signatures), and variation in both a consumer's diet and its prey SI signatures, among others. Understanding the extent to which these factors influence SI signatures is absolutely critical to correct interpretation and application of results. Thus, we strongly recommend validation studies (e.g., Seminoff *et al*., 2006; 2007) and adequate analyses of SI signatures from environmental samples to improve our ability to accurately characterize variation in SI signatures and its significance. With these issues addressed, applications of SIA hold enormous potential for elucidating numerous aspects of sea turtle biology. For example, in addition to determining species- or population-specific trophic status of sea turtles, SIA can reveal oceanographic processes that affect food webs involving sea turtles (e.g., Wallace *et al*., 2006) and ontogenetic shifts in habitat use by juvenile sea turtles (Reich *et al*., 2006). In addition, the combination of SIA and other important tools such as genetic stock information and telemetry data on movement and behavior could enable exciting and powerful discoveries of sea turtle ecology and life history and for conservation management of threatened and endangered sea turtle populations.

A HYPOTHESIS ABOUT THE EFFECT OF COASTAL CURRENTS ON THE REPRODUCTION OF THE KEMP´S RIDLEY TURTLE

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We propose that coastal currents help the Kemp´s ridley turtle (*Lepidochelys kempii*) during migration between the feeding and nesting grounds and define the interval when females arrival to the vicinity of Rancho Nuevo. This hypothesis is based on the analysis of the occurrence of consecutive nests of multiparous females as an indicator of population reproductive behavior and the circulation of the continental shelf off Tamaulipas, western Gulf of Mexico, during nesting seasons in 1996 and 1998. Some authors had described the seasonal changes of the coastal currents (southward during autumn-winter and northward during spring-summer), however there were not in situ coastal currents measurements in front of the nesting beach, therefore these were described with a numerical model that includes sea surface temperature (SST) satellite imagery, winds and location of anticyclonic rings. The frequency distribution (FD) of the first nesting suggested that most females lay between the first week of April and the first or second week of May; on the other hand, it did not overlap with the FD of second nesting. In contrast, it was difficult to distinguish between the second and third nesting because their frequency distributions overlapped, possibly because the individuals´ different recovery time between clutches and the difficulty to observe all females and differentiate each nesting. Currents on the Tamaulipas shelf flowed southward during winter until the last week of April and northward since the second or third week of May, with a transition period in the first two weeks of May. We suppose that the winter current pattern favors migration from the feeding grounds on the Louisiana and Texas shelves to the nesting beach decreasing the turtles´ expenditure of energy. Also, the winter coastal current in the south of the Bay of Campeche changed direction between March and April and this could ease the migration of the females that are feeding in this area towards the nesting beaches in the north of Veracruz and Tamaulipas. This scenario introduces the possibility that females arrive at Rancho Nuevo in two stages: the females from the north arrive first and those from the southern Gulf of Mexico second. The change in the direction of the coastal currents coincides with the end of the period when the multiparous females deposit their first clutch, and this suggests that the majority of turtles arrive at the nesting ground within an interval that may span from the end of February to May, in agreement with the winter coastal currents patterns. The summer pattern favors the return of the females and dispersal of hatchlings. On the other hand, Collard and Ogren (1990) supposed that the little turtles swam across the Tamaulipas' shelf to incorporate to a boundary current traveling off continental shelf, however they can be pushed up to that by the coastal currents.

PELAGIC HABITAT CHARACTERIZATION OF LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN THE NORTH PACIFIC OCEAN (1997-2006): INSIGHTS FROM SATELLITE TAG TRACKING AND REMOTELY-SENSED DATA*

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We analyzed satellite track data for 186 loggerhead sea turtles in the North Pacific Ocean using remotely-sensed environmental data to characterize pelagic habitat. A large number of candidate habitat variables were merged to the satellite track data and statistically compared to background values over a large spatio-temporal grid which bounded overall occupancy. Five statistically significant variables were identified out of the sixteen environmental variables examined. Two of these variables have strong seasonal, interannual, and spatial patterns (sea surface temperature and chlorophyll-a concentration), while three others were primarily spatial (earth magnetic force, earth magnetic declination, and earth magnetic inclination). Habitat selectivity for these variables was quantified using preference curve methodology established in the foraging literature. The output from the selectivity curves was utilized to predict a multivariate loggerhead sea turtle habitat index across the pelagic North Pacific. This predicted habitat was ground-truthed with newly-available satellite track data.

DISTRIBUTION OF OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA)* OFF THE SOUTHERN COAST OF ORISSA, INDIA DURING THE 2006-2007 BREEDING SEASON

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Information on the spatio-temporal distribution of a globally important population of olive ridley sea turtle (*Lepidochelys olivacea)* in the offshore waters of the Rushikulya rookery, southern Orissa was collected from November 2006 to May 2007. This was carried out as part of a larger study on “Determining the offshore distribution, migration and movement of the olive ridley sea turtle along the east-coast of India”. An area of approx. 120 sq. km in front of the Rushikulya mass-nesting beach was systematically monitored for turtle presence through line transects running parallel to the coastline and up to five km offshore. A total of 52 transects in 35 sampling days was carried out during which 3,106 surfacing turtles were seen. A single large congregation of turtles in the area was identified and was located within one and three km from shoreline. The congregation was located in front of the sand bar at the mouth of the Rushikulya River and close to the mass-nesting beach. Further, the congregation patch was observed to be dynamic across the months (from January to May), and the extent of the patch was largest during the month of January, approx. 25 sq. km. The surface density of turtles at this site was also estimated across the

months and the maximum density was observed in March with 68.1 turtles per sq. km. A preliminary investigation on the location of the turtle congregation in the area during the study appears to be related to sea floor depth there.

MOVEMENTS AND DIVING BEHAVIOUR OF LEATHERBACKS INCIDENTALLY CAPTURED BY URUGUAYAN INDUSTRIAL AND ARTISANAL FISHERIES IN THE SOUTH-WESTERN ATLANTIC OCEAN*

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Leatherback turtles (*Dermochelys coriacea*) are the most widely distributed of reptiles occurring throughout tropical and temperate oceans of the world, but the incidental killing of leatherbacks by fisheries has been implicated in the dramatic decline of major leatherback populations around the world. It is known that this highly migratory species can perform trans-Atlantic migrations from tropical nesting beaches to temperate foraging areas where they remain for prolonged periods. Incidental capture numbers of leatherbacks in the SW Atlantic (off the coast of Brazil, Uruguay and Argentina) are alarming as documented in several studies in the region (Domingo *et al*. 2006). However, information on how leatherbacks utilize oceanic and coastal areas along the SW Atlantic Ocean is still scarce. To the date, information on the distribution and movements of leatherbacks in the region was restricted primarily to fishery bycatch data, flipper tag recoveries, strandings and anecdotal observations; but the recent use of satellite transmitters has provided new insights about the movements and behaviour of this species at sea. Here we present the movements and diving behaviour of four leatherbacks (two females, one male and one subadult) fitted with satellite transmitters in 2005 and 2006. One deployed on an individual after being incidentally captured by a coastal gillnet in the Rio de la Plata estuary, and the other three deployed by scientific onboard observers (PNOFA-DINARA, Uruguay) on leatherbacks incidentally captured during pelagic longline fishing operations in the SW Atlantic. Turtles displayed different diving patterns (spatial and temporal variations) influenced by oceanographic features of the utilized regions. High-use areas of leatherback turtles delineated by using fixed Kernel Home Range analyses will be presented for the first time for the SW Atlantic. This study is part of a Trans-Atlantic Leatherback Conservation Initiative (TALCIN), to increase the knowledge of movements of leatherbacks in the Atlantic basin in order to contribute towards the identification of hot-spots of interaction between leatherbacks and fisheries.
Acknowledgements: Special thanks to the PNOFA, National Direction of Aquatic Resources (DINARA), the artisanal fishermen from Kiyú and Zoe Di Rienzo. Financial Support to attend the Symposium was generously contributed by the Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, Carlos Peralta Quintero and Robert N. Allen, Jr.

MOVEMENTS, MIGRATIONS AND WINTERING HABITAT OF VIRGINIA'S (USA) IMMATURE LOGGERHEAD SEA TURTLES

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Virginia's Chesapeake Bay provides important developmental habitat for immature loggerhead sea turtles. Genetically, northern and southern nesting stocks are well represented among Virginia's seasonal loggerhead residents. These turtles are only resident in Bay waters from approximately May through October. They migrate into the Bay when sea temperatures rise to at least 16º to 18ºC in the spring, and migrate south when temperatures drop in the fall. Long-term movements and behavior of 12 immature loggerheads were examined between 2001 and 2006 using satellite telemetry. Movement data were analyzed for site fidelity, and composites were generated using sea surface temperature, primary productivity and sea surface height. With the exception of one animal, all turtles remained in Virginia or North Carolina waters during all or a significant portion of their track. Most loggerhead turtles remained north of Cape Hatteras, establishing significant site fidelity ($p<0.001$) within Bay or coastal foraging grounds during the spring and summer. Southern fall migratory movements for these turtles typically began when sea surface temperatures dropped below 20º. Most turtles migrated just south of Cape Hatteras where, during the fall and winter months, they established significant fidelity ($p<0.001$) to the waters between North Carolina's Outer Banks and the western edge of the Gulf Stream along outer continental shelf. While most tag transmissions ceased after approximately one year, two turtles were observed to return to Bay waters the subsequent summer, one of which returned to the shelf waters south of Cape Hatteras for a second winter. These data indicate strong seasonal site fidelity to the waters of both Virginia (summer foraging habitat) and North Carolina (winter habitat). These data also reinforce the importance of North Carolina and Virginia's waters as immature loggerhead developmental foraging and wintering habitat, as well as for seasonal migration routes. Special management consideration should be given to this region. Turtles were found within mean depths of 15.7 m (+/- 11.2 m SD) to 56.6 m (+/- 281.6 m SD), remaining, on average, between 11.7 km (+/- 12.6 km SD) to 337.1 (+/- 250.5 km SD) from the nearest shoreline. Two turtles spent significant time farther from the continental shelf: both entered the Gulf Stream near Cape Hatteras, following the current to the northwest Atlantic. After a summer of Bay foraging followed by a winter south of Cape Hatteras, one of these turtles remained in the north Atlantic gyre south of the Grand Banks for over three years. The ability of large benthic sub-adults to resume or readapt to a pelagic lifestyle for extended periods suggest plasticity in habitat selection and migratory strategies. This behavior will likely result in a reevaluation of existing life history models. Both juveniles were found in water depths up to 4,650.0 m (+/- 1400.5m). All turtles remained within mean surface water temperatures of 19.1º C to 26.2º C. Northern movements were associated with both increased sea surface temperatures and increased primary productivity within northern waters.

MID-WATER FORAGING BEHAVIOUR OF LOGGERHEAD TURTLES REVEALED BY VIDEO AND 3-D DATA LOGGER*

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Loggerhead turtles (*Caretta caretta*) are one of the most common sea turtles observed in Japanese coastal waters. Feces and gut content analysis suggested that loggerhead turtles at subadult and adult stages are generally considered as benthic feeders ingesting a wide range of invertebrates, such as mollusks and crustaceans. But it is also considered that loggerhead turtles sometimes feed on jellyfish and salps in mid-water, which are difficult to find from feces because they are easily digested. Therefore, it is necessary to observe their underwater foraging activities in the natural environment to understand their foraging behaviour and ecology. In this study, we monitored foraging behaviour of free-ranging loggerhead turtles at Sanriku coastal water, Japan. As there is no nesting grounds around Sanriku, loggerhead turtles migrating through our study area are considered to be in a foraging period. To obtain three-dimensional behavioural data and video data at the same time, we used 2 types of animal-borne recorders: 3-D data logger (3MPD3GT: Little Leonardo, Japan) and video recorder (Crittercam: National Geographic Society). After deploying the recorders, turtles were released from Otsuchi Bay (39°20N, 141°56E). At a scheduled time, the recorders were automatically detached from the turtles and retrieved within a day. As a result, we obtained a total of approx. 73 hours of 3-D data and approx. 19.5 hours of video data from 5 loggerhead turtles (mean SCL: 75.1 ± 7.2 cm), and some mid-water foraging events ingesting jellyfish and salps were recorded. Turtles sometimes encountered prey when actively swimming at depths of <20m, and gradually approached the prey to feed. Many foraging events occurred during dives characterized by the presence of gradual ascent phase (i.e. S-dives), which have been considered as resting or traveling dives. Although swim speed, headings and body angle of turtles greatly changed during the foraging event, there were no changes in depth during that period. Using video recordings and 3-D behavioural data, it is possible to analyze mid-water foraging events.

BEHAVIORAL PATTERN OF JUVENILE HAWKSBILL TURTLES AT YAEYAMA ISLANDS, JAPAN

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Acceleration data logger was deployed on juvenile hawksbill turtles at the Yaeyama Islands, Japan, to examine daily behavior pattern. Diving and active profiles of 5 day durations were obtained from four turtles ranging in carapace length from 40.0 - 60.9 cm. Behavioral patterns were divided by active data profile into 3 groups; "stroke swimming behavior", "resting behavior" and "other active behavior". The results showed that the juvenile hawksbill turtles at the Yaeyama Islands spent about 60% of their day doing "stroke swimming behavior", about 35% doing "resting behavior", and about 5% doing "other active behavior". Foraging behavior is included in "other active behavior", because their principal diet was considered sponges and some vertebrates. Therefore, this result indicates that juvenile hawksbill turtles do not spend very much time foraging. Vertical areas where each behavior is carried out were not significantly different. The turtles spend a lot of time conducting "stroke swimming behavior" and "other

active behavior" in the daytime, while "resting behavior" in the nighttime. The amount of their activity had a negative correlation with dive duration.

OCEANOGRAPHIC INFLUENCES ON THE POST-NESTING MIGRATION OF FEMALE EASTERN PACIFIC LEATHERBACK SEA TURTLES*

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The oceanography of the region used by female leatherback sea turtles (*Dermochelys coriacea*) following nesting efforts at Playa Grande, Costa Rica (10°18'N, 85°50'W), is described using remotely sensed oceanographic data. A total of 46 satellite-linked tags were deployed on leatherback sea turtles over three years in January-February of 2004 (n = 27), 2005 (n = 8), and 2007 (n = 11), yielding a mean of 263 tracking days (range = 55-562 days) and a mean distance of 8,070 km (range = 2,161-17,133 km). Mean travel speed for all turtles was 2.4 km/h (range = 1.7-3 km/h). The region used by the turtles during the first year after nesting encompasses the eastern tropical and eastern South Pacific between latitudes 10°N and 40°S, and between longitude 130°W and the Central and South American coastlines. Upon departure from the neritic internesting grounds, the turtles take a southwest heading (~200°) toward the Galápagos Islands, following a well-defined corridor in the vicinity of the Cocos Ridge. Migrating turtles must negotiate a system of alternating zonal currents in the equatorial belt (10°N-10°S), including the westward Costa Rica Coastal Current, the eastward North Equatorial Countercurrent, the westward South Equatorial Current, and the eastward Equatorial Undercurrent. In this region, the turtles repeatedly adjust their heading to cross each current at a normal angle and then resume their original heading in the areas with weak flows between currents. South of 10°S, turtles disperse in the oligotrophic gyre of the eastern South Pacific. This area is characterized by very weak mean and eddy kinetic energy. Interannual variations in the strength of the equatorial current-countercurrent system strongly influences the spread of the dispersal habitat in the eastern South Pacific. The clear influence of current variability on turtle migration route during the pelagic phase should be considered in conservation and management strategies for this highly endangered species.

IN THE SPOTLIGHT: HATCHLING SEA-FINDING ORIENTATION VS. COASTAL DEVELOPMENT & LIGHT POLLUTION AT THE LARGEST TURTLE NESTING ROOKERY IN THE MEDITERRANEAN

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Loggerhead hatchling sea-finding ability following emergence from the nest primarily depends upon vision; being most accurate on remote, dark beaches. Mis/disorientation away from the most direct route to the sea may affect hatchling natural behaviour, and may negatively impact energy expenditure at this crucial phase of the life-cycle thus compromising survival. The 23 km coastline of Laganas Bay, within the National Marine Park of Zakynthos, includes a 10 km section of lit urbanized (residential-tourism) development adjacent to 13 km undeveloped dark coastline containing 5.5 km loggerhead nesting beaches. In this study we investigate the impact of light-pollution on hatchling sea-finding ability, using the proximity and differing orientations of the 6 nesting beaches to the urbanized stretch of coastline. The study was divided in 2 phases to record light-pollution and hatchling orientation bearings. (1) We measured light-pollution through monthly night-surveys at 19 stations across all nesting beaches. At each station we recorded the 360º bearing of: night-glow, coastal-lighting, and brightest light-source. We also collected light-metre readings and conducted visual surveys of light-intensity. (2) Hatchling orientation from the nest to the sea was measured for nests with at least 20 tracks, using a compass to record: main-track angle, modal-direction, ocean-direction and number of loopings/outliers. We followed Salmon & Witherington's (1995) method to confirm mis/disorientation when (a) angular range is >90º and (b) angular range between modal and ocean direction >30º. We calculated the distance crawled to the sea using the main track angle in correlation to the energy spent in the sea-finding process to evaluate mis/disorientation impact. Finally, we combined the two data-sets to determine if there was a correlation between light pollution associated with coastal development and the disruption of hatchling sea-finding ability. We found that coastal lighting ranged from 210-330º, night-glow from Zakynthos town ranged from 270-020º, and airport lighting occurred at 0º (nesting beach range: 320-110º; 240º). From a sample of 121 nests (25% of total nests) we found that the main track angle increased with greater proximity of nesting beach to the adjacent urban development (average track angle: furthest beach 39º, range:30-55º; closest beach 55º, range:20-85º). We also found a similar trend in the angle between modal and ocean-direction (average track angle: furthest beach 6.8º, range:0-20º; closest beach 22.1º, range:0-40º with 3 nests >30º). Our results indicate that the impact of current light-pollution from the adjacent development on all nesting beaches appears to be low, according to Salmon & Witherington (1995). However there is a degree of light-pollution impact from the urbanized area of coastline, depending on beach proximity; causing hatchlings to crawl longer distances and hence expending crucial energy. Therefore this issue must be monitored and addressed. Controlling the impact of such a broad development area is complicated; stronger collaborations with local municipalities to provide incentives for all inhabitants to modify lighting use may serve to manage future light pollution problems. Acknowledgements: We thank the National Marine Park of Zakynthos Field and Research Assistants for their contribution: Dionysios Ambelas, Michael Grantsiotis, Dionysios Kalamvresos, TyAnn Lee, Domenico Enrico Marcon, Irini Margari, Veneranda Petta-Bika.

LONG-TERM SATELLITE TRACKING OF A JUVENILE GREEN SEA TURTLE (*CHELONIA MYDAS*)

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To date, relatively little data exists on the movements of juvenile green sea turtles. In March, 2006 an emaciated green sea turtle (27.5 cm, 2.36 kg), estimated to be between 3-5 years in age, was found stranded on Melbourne Beach, Florida (28° 2' 4" N, 80° 32' 32" W) This turtle underwent six months of medical treatment for plastic ingestion and was documented to have consumed more than 70 pieces of plastic prior to arrival (Stamper, In review). In August 2006, the turtle was fitted with a shell-mounted satellite transmitter (Telonics A-118) and released just offshore in Vero Beach, FL. Since that time, we have been monitoring its movements along the Florida coast. The east coast of FL has been documented to have excellent feeding grounds for young turtles and our observations indicate that this turtle has remained within 80-150 km from the release site. We did observe this individual to travel to the waters surrounding Grand Bahama Island, approximately 195 km off the Florida coast. This sea turtle has also made frequent movements in and out of the Intracoastal Waterway that runs along Florida's Atlantic coast. A number of these movements into the Intracoastal Waterway directly preceded heavy storms in the Florida area, including tropical storm Ernesto on August 30, 2006. Here we present an overview of the movements of a juvenile green sea turtle, as well as review our methodology of satellite transmitter modification and attachment that may have afforded such long-term data collection.

GPS TRACKING FOR FINE-SCALE CONSERVATION MANAGEMENT: SEA TURTLE MOVEMENT PATTERNS IN A MARINE PROTECTED AREA

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Worldwide, coastal regions are subject to anthropogenic pressure, in the form of fisheries, coastal development and tourism. Therefore the ability to track wildlife at high resolution within a nature reserve may be important in formulating rational, adaptive and dynamic management decisions for endangered species and related conservation policies. It is important to obtain information about where, when and why endangered species, such as sea turtles, use these areas, in order to implement rational and effective protective legislation and management of human activities. While conventional radio and satellite transmitters have revolutionised the ability to track wildlife movement over vast spatial and temporal scales, recently developed loggers based on the Global Positioning System (GPS) allow wildlife to be studied with unparalleled accuracy. Laganas Bay, on the island of Zakynthos in Greece, is the largest loggerhead sea turtle (*Caretta caretta*) breeding area in the Mediterranean. Around 400 sea turtles migrate to Zakynthos each summer to breed, along with over 700,000 tourists. Sea turtles arrive in Laganas Bay as early as April, before nesting starts in late May, and are frequently observed close to shore. In this study we investigated the movement and habitat use of female loggerhead sea turtles in Laganas Bay during the breeding and inter-nesting period. Using recently developed, low-powered, TrackTagTM GPS loggers, we tracked three female turtles for a total of 73 days in May and June 2006. A total of 3,753 GPS locations were obtained, with an average of 51 fixes per day per turtle (min: 40, max: 65). We also monitored the diving behaviour of these three turtles and three other females using time-depth recorders (TDR). The information obtained from our GPS loggers indicated that all three turtles spent most of their time in shallow water (<4 m sea bed depth) very close to the shore (<200 m), primarily ranging along an 18.5 km section of coastline. These observations were corroborated by TDR data acquired from all six turtles and frequent first-hand sightings of turtles close to shore during the breeding period. Prior to the formation of the National Marine Park of Zakynthos (NMPZ), nesting beach locations and relative nesting densities were used to delineate the degree of protection offered by marine protection zones in Laganas Bay. The movement and depth data collected in our study both suggest that existing legislation to safeguard sea turtles within this protected region may not include the most critical habitats for female loggerhead sea turtles during the breeding period. In fact, the NMPZ Management Agency has already taken action to introduce stricter regulation of the nearshore area through forming an 'ecotourism zone' to improve the regulation of turtle-watching activities. Our study demonstrated the feasibility of using GPS tracking to investigate fine-scale movements of a marine vertebrate, illustrating the value of GPS tracking for wildlife conservation management. We thank the Symposium Travel Fund and donors for assistance.

INTERACTIONS BETWEEN PLATFORM TERMINAL TRANSMITTERS AND TURTLE EXCLUDER DEVICES

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A pilot study was conducted in June 2006 to characterize damage to or loss of platform terminal transmitters (PTTs) attached to juvenile sea turtles encountering turtle excluder devices (TEDs). Eight 34-month-old, captive-reared loggerheads (*Caretta caretta*), half of which were outfitted with dummy PTTs, were sent through a trawl equipped with a bottom-opening Super-Shooter (BOSS) TED at a 50-degree angle. No apparent damage was sustained by the PTTs; however, preliminary findings suggest the potential for interactions between "backpack" style PTTs and TED bars that might impede a turtle exclusion from the TED. A subsequent study was undertaken in June 2007 using twenty 34-month-old, captive-reared loggerheads that averaged 47.0 cm straight carapace length and 14.13 kg. Half of these had been outfitted with dummy Sirtrack KiwiSat 202 PTTs (8x4x2 cm) in February 2007 as part of an attachment trial, while the remaining 10 served as "untagged" controls. Four PTTs were attached using PowerFast epoxy and SonicWeld putty, whereas a PowerFast/neoprene mount was used on the other six. As in 2006, the study was conducted from the shrimp trawler R/V *Caretta* near Panama City, Florida, and it adhered to the NOAA standard small turtle TED test protocol. Each loggerhead was allowed up to 5 minutes to escape through a BOSS TED at a 50-degree angle. One control turtle failed to exit the TED within 5 minutes and was recorded as a "capture", whereas the remaining controls and all PTT-outfitted turtles were excluded. None of the dummy transmitters sustained obvious damage, and all were removed from the turtles after the study. Excluding the "captured" turtle, controls exited the TED in an average of 63 seconds (SD=31 seconds), as compared to 107 seconds (SD=101 seconds) for experimental counterparts. The difference between average escape times was not statistically significant ($t=-1.318$, $p=0.215$) but there was a significant difference between the variances of the two groups (Levene's $F=7.551$, $p=0.014$). Orientation of PTT-outfitted turtles to the TED appears to explain some variance, as evidenced by the delayed escapes of two that encountered the TED carapace-first. In both cases, the PTT wedged between the TED bars, and only after periods of swimming upwards (away from the TED opening) was each turtle able to turn and free itself. Of the remaining experimental turtles, six hit the TED plastron-first and the other two hit almost "head-on". In contrast, eight controls encountered the TED carapace-first, and the other two hit plastron-first. Results mirrored those observed in 2006 and indicate that attachment of PTTs to smaller turtles may slow or, in worst cases, inhibit their exit from TEDs, particularly bottom-opening configurations. To minimize

the potential for PTT-TED interactions that impact a satellite-tagged turtle exclusion, we recommend placement of adhesive around the transmitter to cover a larger surface area and decrease the slope between the PTT and carapace. Acknowledgements: The Harvesting Systems Branch, NOAA Pascagoula enabled the trials and videography. Research was conducted under FWC Permit TP #015, and awards from the TAMUG Mooney graduate student travel fund, TAMUG Marine Biology Department, and ISTS facilitated its presentation.

KEMP'S RIDLEY MIGRATORY PATHS AND FORAGING AREAS IN THE NORTHWESTERN GULF OF MEXICO*

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The northwestern Gulf of Mexico is considered developmental habitat for the critically-endangered Kemp's ridley sea turtle, *Lepidochelys kempii*, and of growing importance to adult females as evidenced by annual nesting increases on the Texas coast since 1995. Although beach monitoring is crucial to estimating nesting population size and activity, in-water data are essential for evaluating management strategies and understanding population dynamics. In fact, the Kemp's Ridley Recovery Plan lists examining "seasonal use of nearshore habitat by juveniles/subadults" and determining "migratory paths and foraging areas" as necessary components of a strategy to achieve the recovery of this species, but such data are currently sparse. Fifteen immature Kemp's ridleys averaging 36.3 cm (SD=4.7 cm) straight carapace length (SCL) and seven adult females averaging 63.8 cm SCL (SD=2.0 cm) were outfitted with platform terminal transmitters and released off the upper Texas coast during 2004-2007. These were comprised of: 12 recreational hook-and-line captures, 2 dredge relocation trawl captures, 2 rehabilitated strandings, and 6 nesters. Immature ridleys were tracked 11-106 d (mean=46 d, SD=24 d, N=15), as compared to 20-277 d (mean=108 d, SD=88 d, N=7) for adult conspecifics. Coastal waters of the northwestern Gulf were utilized by immature ridleys as foraging areas in all years, with movements concentrated near tidal passes and fishing piers in 2004-2006 and near tidal passes and within bay systems in 2007. Females tracked during their inter-nesting intervals exhibited fidelity to the Galveston area and, upon entering the post-nesting stage, moved eastward along the continental shelf to foraging areas offshore of central Louisiana. All life stages remained on the shelf while tracked, with immature individuals preferring waters less than 20 m deep and adults inhabiting depths less than 30 m. Mortality was the probable cause of transmission cessation for at least one immature ridley, whereas one post-nesting female stranded dead 20 days after transmitter deployment. This telemetry suggests that waters along the upper Texas and Louisiana coastlines are seasonally important migration corridors and foraging areas for both immature and adult female Kemp's ridleys; however, existing regulations afford sea turtles more protection along the lower and middle Texas coast than on the upper coast. Projected population increases will likely lead to increased use of the northwestern Gulf by Kemp's ridleys and, in turn, more frequent encounters with human activities such as commercial and recreational fishing and channel dredging. The extent of these interactions and any need for mitigation measures or additional regulations in coastal waters should be examined and considered by managers to facilitate the continued recovery of this and other Gulf sea turtle species. Acknowledgements: The USACE and Coastwise Consulting facilitated access to trawl captures, whereas the NOAA Sea Turtle Facility provided access to all other tracked ridleys. Telemetry was funded by the SeaWorld Busch Gardens Conservation Fund, Schlumberger-Houston and SEED, Texas General Land Office, and TAMUG Marine Biology Department. This research was conducted under USFWS Permit TE676379-4 and NOAA Fisheries Permit #1526, and awards from the TAMUG Mooney graduate student travel fund, TAMUG Marine Biology Department, and ISTS facilitated its presentation.

FOUR YEARS AND FORTY-SIX TURTLES: TRACKING THE MOVEMENTS AND BEHAVIORS OF LEATHERBACK SEA TURTLES IN THE EASTERN PACIFIC*

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We describe the distribution and movements of 46 female leatherback turtles satellite-tagged during 2004-2007 at Playa Grande, Costa Rica, throughout the eastern tropical and South Pacific. The tagging data (21 January 2004 - 5 July 2007) encompassed a total of 12,095 tracking days, with a mean track duration of 263 d, a distance of 8,070 km, and a travel speed of 2.4 km/h. A total of 65,536 dive profiles were obtained, with a mean dive duration of 18.2 min and a mean maximum depth of 37 m. Mean proportion of time spent diving was 68%. The region used by the turtles over the tracking period spans the eastern tropical and South Pacific between latitudes 12°N and 40°S, and between longitude 130°W and the coast of Central and South America. During the inter-nesting period, turtle movements suggest that relatively small expansions of the existing marine park boundaries could significantly enhance turtle protection. Following inter-nesting, the turtles migrate southward through an open-ocean corridor spanning from Costa Rica past the Galápagos Islands, and then engage in a broad-scale dispersal south of 10°S. The 95% utilization distribution level indicated that the turtles occupy an inter-nesting area of ~1.2 million km^2, and a post-nesting home range of ~13.2 million km^2. Upon completion of the inter-nesting activity, the turtles embark on a southwest migration (~200° heading) towards the Galápagos Islands, along a well-defined corridor. The tag-derived data revealed the existence of high-use habitats including an inter-nesting area, a persistent migratory corridor, and a dispersal area in the eastern South Pacific. This information will play an important role in potential zoning and management activities of coastal and pelagic habitats for leatherbacks and for other marine species.

DIVE BEHAVIOR OF INTERNESTING LOGGERHEAD TURTLES (*CARETTA CARETTA*) AND GREEN TURTLES (*CHELONIA MYDAS*) AND RISKS OF BOAT IMPACT

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New advantages in science and technology, such as time depth recorders, have allowed researches to study the dive behavior of sea turtles in their natural habitat. Previous studies of dive behavior of internesting turtles have provided significant evidence on how to protect nesting turtles from human interactions. We examined the dive behavior of internesting loggerhead and green turtles and the risk of boat impact at Casey Key, Florida during the 2007 nesting season. The Florida Sea Turtle Stranding Network makes it clear that new management plans may need to be implemented because of the increasing trend of boat impacts. Relative boat draft, water temperature, and daily activity of nesting female loggerhead and green turtles were documented with the use of time depth recorders

(TDRs). The objective of the TDR study was to assess the correlation between surface intervals and daily activities and evaluate whether there are periods of increased surface activity that might infer greater risks of boat strikes. Protective measures, such as spatial and temporal boat restrictions, are reviewed in this report.

OFFSHORE MOVEMENT OF LOGGERHEAD SEA TURTLE HATCHLINGS FROM THE KAMODA COAST, JAPAN

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Hatchlings of loggerhead turtle are considered to achieve offshore migration from their natal beach using visual information, wave direction and the magnetic field as navigation cues. But the information about routes taken by hatchlings in the field is still lacking. Therefore we carried out a tracking study in the field and a laboratory experiment to examine the swimming behavior and directional preference of loggerhead turtle hatchlings. Newly emerged hatchlings were caught on Kamoda Beach, Japan and their orientation and movement patterns were observed in a circular tank under no light conditions after motivated by the LED that imitated light in the offshore direction (80°). This experiment was carried out following Lohmann (1991). Hatchlings tended to swim eastward on average (mean 115°, $r = 0.51$, $N = 12$, $P < 0.05$, Rayleigh test). Time series observations of movements of hatchlings showed that they mainly circled along the walls of the tank, while total durations of oriented swimming exhibited by each hatchling ranged from 0.0 to 70.8%. This indicated that hatchlings tended to maintain their swimming direction that was imprinted by the initial light condition, although the intensity to the specific direction was not very high. Field tracking was carried out during September of 2003 and 2004 at Kamoda Beach. Because this beach is opened to the east-northeast, a direction to which hatchlings can not reach the Pacific Ocean by a straight course, hatchlings were expected to use some other complicated course related to the specific local geography. Fourteen hatchlings released from Kamoda Beach were tracked for one hour using radio tags or chemical luminescent tags. Three hatchlings were tracked for more than 17 hours. All fourteen hatchlings initially kept swimming towards the east-northeast direction from the releasing point (500 m off the shoreline) and they gradually changed their orientation to the south. The three hatchlings that were successfully tracked for more than 17 hours moved towards the southwest after passing the tip of the Kamoda Cape located to the south of the releasing point, and then reached the open ocean. The average swimming speed of these three was 1.19 km/h. These courses taken by the long-tracked specimens coincided with drift routes of GPS tracked buoys during the movements of the turtles. These results suggest that visual cues are effective only for about one hour after entering the sea, and after that the swimming course of hatchlings would depend mostly on the surface currents off Kamoda Beach. These currents flow towards the Kuroshio Current that is considered to be the main migration pathway of hatchlings of Japanese loggerhead to their growth habitat. This suggests that the passive transport by currents is one of the important phases for the dispersal of loggerhead hatchlings in this area. Acknowledgements: We would like to thank the ISTS, Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service, David and Lucille Packard Foundation, and the Sandler Family Foundation, Carlos Peralta Quintero and Robert N. Allen Jr.

THE NUMERICAL HATCHLING ORIENTATION VALUE INDEX

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On urban sea turtle nesting beaches light pollution disrupts hatchling sea turtles' natural sea finding abilities and is a major cause of hatchling disorientation and mortality. The severity of hatchling disorientation events ranges widely within Broward County, FL, USA. The Hatchling Orientation Index (HOI), as described by Dr. Blair Witherington, assesses to what extent hatchlings disorientate or deviate from their direct path to the sea. As described in his 1996 presentation, we measured the angular deviations and the deviation of the mode of hatchling tracks from the most direct bearing to the ocean and developed a numerical Hatchling Orientation Value (HOV). The numerical HOV is based on the premise that the severity of a disorientation event will increase exponentially as the hatchlings deviates from the most direct path to the sea. The values of this index are the summations of components based on the left and right angular range deviations as well as the modal deviation of hatchling tracks to the sea. The values of the numerical HOV range from 1 to 10 for a modal deviation of 0 to 90 degrees. Index values increase from 10 to 120 when the modal direction was greater then 90 degrees of deviation from the ocean direction. Values ranging from about 4 to 20 corresponded with the Witherington classification of 'moderate' disorientation and values from 20 to 120 corresponded with a classification of 'severe' disorientation. The index was used to assess the severity of hatchling disorientation in Broward County, Florida. HOV sample nests were assigned prior to the start of nesting season as defined by the Florida Fish and Wildlife Conservation Commission Sea Turtle Conservation Guidelines. Preliminary data from the 2006 and 2007 nesting season indicate a slight decrease in the severity of hatchling disorientation events in problem lighting zones within the county. This data suggests that local enforcement of existing lighting ordinances has contributed to decreased disorientations events.

THE FRENZY AND POSTFRENZY ACTIVITY OF THE FLATBACK SEA TURTLE (*NATATOR DEPRESSUS*) IN COMPARISON WITH OTHER SPECIES*

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Flatback hatchlings are unique among cheloniids in that they are larger than other 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 early in-water behavior (swimming frenzy and postfrenzy) of this species in the lab under natural light-dark cycles. The activity of each hatchling was measured while they were tethered via a lycra harness to an interfaced 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. Activity and inactivity were recorded 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, but differed from that of hawksbills. The flatbacks swam vigorously during first night and first daylight period. Flatback postfrenzy is characterized by exceptionally high levels of activity: swimming most of day AND most of night. Postfrenzy behavior patterns developed slowly as the turtles shifted behavior so activity was predominately diurnal with lower levels of nocturnal activity. Like *D. coriacea*,

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, arguably 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.

POSTNESTING MIGRATIONS OF ADULT LOGGERHEADS IN THE MEDITERRANEAN

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Spatially explicit conservation measures such as the creation of marine reserves seem a promising tool for the conservation of adult marine turtles, which have been shown to occupy distinct foraging and wintering areas with large-scale movements generally restricted to reproductive migrations. The Mediterranean is an area of especially high fishery pressure, which is likely to negatively impact the already rather small regional turtle populations. The current information on spatial behaviour of adult Mediterranean loggerheads (*Caretta caretta*) is, however, insufficient for setting spatially explicit conservation priorities at sea. At-sea recovery of individuals flipper-tagged on nesting beaches and information on bycatch rates indicate the Adriatic Sea and the Gulf of Gabès region in North Africa host significant aggregations of adult loggerhead turtles, but information from these sources is potentially biased. The collection of less biased information on at-sea locations of adults, collected by means of satellite tracking, although subject to sample size constraints, is mandated, but is only available for the Cyprus nesting aggregation. We therefore set out to investigate the post-nesting dispersal of loggerhead turtles from the single most important regional nesting aggregation (accounting for ca. 25% of nesting), the Bay of Laganas on Zakynthos Island (Greece), using satellite tracking. We fitted satellite transmitters to a total of 18 females; three in 2004, four in 2005 and 11 in 2007. A clear pattern emerges of two distinct foraging regions for adult females of the Zakynthos rookery: the North African shelf (n=8) and the Adriatic Sea (n=7). Additionally, two females travelled to Amvrakikos Bay (Greece); and one turtle undertook pelagic foraging in the Ionian Sea. Tracking results are in close agreement with more traditional methods. These two main foraging regions are by far the largest discrete areas of continental shelf in the Mediterranean and regions of exceptionally high primary productivity, characterised by high fishing effort. Thermal conditions however differ dramatically between the north Adriatic Sea and the north African coast with the former being characterised by winter water temperatures of well below the presumed activity threshold for the species. We suspect that this difference in winter water temperature results in variation in overwintering behaviour between turtles frequenting the two regions. Deployment in 2007 of transmitters which render basic information on dive times will help elucidate wintering behaviour. Additionally, we plan to test the use of stable isotope analysis to unravel the migratory behaviour of untracked turtles. Integrated together, we hope to be able to offer direct management advice regarding hotspots for adult loggerheads in the region. Acknowledgements: The presenting author would like to thank the Swiss National Science Foundation, the Sea Turtle Symposium as well as the following organisations and individuals for funding to attend the conference: Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, the Sandler Family Foundation, Carlos Peralta Quintero and Robert N. Allen, Jr. Satellite tracking was mainly funded by the MAVA Foundation for the Protection of Nature. Additional funds came from the Karl Mayer Foundation, the Ocean Science and Research Foundation, and the Basler Stifung fuer biologische Forschung. JZ is funded by the Swiss National Science Foundation.

Biology Speed Session

STATE-SPACE MODELING OF LEATHERBACK TURTLE MOVEMENTS AND HABITAT ASSOCIATIONS IN THE EASTERN PACIFIC OCEAN*

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Leatherback turtles are the largest species of marine turtle and conduct long pan-oceanic migrations between their nesting and foraging grounds. They are currently critically endangered, with particular declines in the eastern Pacific population. In 2004-2007, satellite transmitters were attached to 46 female turtles nesting at Playa Grande, Costa Rica to further investigate their distribution and movements to improve conservation measures. However, satellite location data suffer from having non-Gaussian estimation errors and being recorded irregularly in time. Estimation errors are generally larger for marine animals that spend little time at the surface and particularly in the tropics, biofouling may occur resulting in periods of several weeks or months with no locations. State space models (SSM) provide a valuable tool for modeling movement data by simultaneously accounting for measurement error and variability in the movement dynamics. These were refined to improve performance with large amounts of missing data. A switching SSM was applied to the satellite tracks of the turtles, which also provided an estimate of the behavioral mode, transiting or foraging, at each location. This enabled the internesting period to be objectively defined based on a shift from the foraging to transiting mode. The movement parameters for each mode were examined and exhibited less distinct shifts than for leatherback turtles in the Atlantic, suggesting that foraging areas are less predictable in the Pacific, where searching may occur over larger areas. Comparison with environmental factors indicates an influence of oceanography on their movements that has important conservation implications.

FORAGING BEHAVIOUR OF A JUVENILE LOGGERHEAD TURTLE: HOW LITTLE TIME IT HAS TO FEED TO KEEP GOING*

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The shallow eutrophic waters off the Domitian Littoral, Southwest Italy, attract many juvenile loggerhead turtles but are also heavily used by bottom trawlers. We intended to investigate the time allocation to different underwater activities in foraging loggerheads with the ultimate aim to establish detailed time-activity budgets for these diving reptiles and make recommendations for the regulation of trawling times and depths. In a first attempt to approach this goal we equipped a juvenile loggerhead turtle with a particular data logger (IMASEN) that recorded, in addition to depth and water temperature, also beak movements at 10 Hz intervals. The turtle was caught accidentally with a net by a fishermen while he observed it feeding close to the shore, where it was released again after instrument attachment. Since recapture of animals foraging in this area is highly unlikely we developed a pop-up system with a slightly buoyant housing that contained the data logger and which was released from the turtle after three days, when a corrosive link dissolved in seawater. The IMASEN was recovered after two weeks with 50 h worth of diving and beak movement data. The first feeding was recorded 3.5 h after release and median feeding depth was 9.6 m. The turtle spent 9.3% of the entire time at the surface and 70.8 % in the upper 4 m layer. 125 dives exceeded this depth and feeding occurred only during these deeper dives. In total, the turtle allocated 8.2% of its time to deep, non-foraging dives and 11.3% to foraging dives. Duration of feeding dives was significantly longer than duration of non-feeding dives (4.36 min vs 2.5 min, W=5738.5, $p<0.001$), which was due to increased bottom times (i.e. time spent at the maximum dive depth) during feeding. Feeding related beak movements occurred only during the bottom phase of a dive, suggesting benthic feeding. Based on a previous evaluation study of this method on captive animals we could distinguish food types by the different signals recorded during ingestion. Beak movement patterns showed clearly that the turtle was feeding on both mobile prey that had to be hunted, such as crabs, and sessile organisms. Although it was not possible to identify the prey species the beak movements resembled feeding on small hard-shelled prey like bivalves and larger prey with high consistency such as sea cucumbers. The turtle fed predominantly during daylight with peak times between 0400 and 0800 h and 1600 and 2000 h. This is the first application of the IMASEN on a foraging juvenile turtle and we were able to obtain valuable information on the activity of the turtle in addition to the usual depth utilisation patterns. It became clear that the turtle had to invest only a small part of its time to foraging, thus supplying enough energy to sustain all other activities. Beak movements were also recorded during buccal oscillations and breathing and hence, there is potential for detailed analysis of time allocation during both single dive cycles and longer activity periods. This study was supported by a grant to G.C.H. from the Natural Environment Research Council, UK, and S.H. received a Symposium Travel Grant, with donations from Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, US Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, the Sandler Family Foundation, Carlos Peralta Quintero and Robert N. Allen, Jr., to present this work at the STS 2008.

POPULATION STATUS, BIOMASS, ENERGY CONVERSIONS AND GLOBAL INTAKE: LESSONS FROM CAPTIVE RAISED LEATHERBACKS*

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The Pacific population of leatherbacks has drastically declined in the last quarter of a century. Nesting females have plummeted from > 90,000 in the early 1980s to < 3,000 currently (Spotila *et al*. 2000 Nature). By-catch from net fisheries (gill, pound and drift net) as well as long-lines has been viewed as the major culprit in the decline. Here we give estimates on population status and total biomass of the Pacific population based on growth data from captive leatherbacks. As well, we estimate the total intake of jellyfish by the Pacific population based on energy conversions by captive leatherbacks fed formulated diets of known energy content. Our measures of growth coupled with published mortality rates in the wild and an assumed sex ratio of 1:1, show that in any given year there are 225,000 leatherbacks (hatchlings to sub-adults) poised to become sexually mature adults. The largest part of the total biomass is made up of 2-3 year old juveniles, approximately 30,000 turtles, which eat nearly 150,000 tons of jellyfish each year. The total Pacific population consumes 750,000 tons of jellyfish annually. These data allow insight into the resources required to sustain the Pacific population as well as understanding the dynamics involved in resource acquisition and subsequent re-allocation to functions such as growth and reproduction. Food resource hotspots can be mapped out and necessary management plans for those areas implemented. A moratorium on by-catch could result in the recovery of the species within seven years as our growth data shows that seven years is the earliest timeframe in which leatherbacks can reach sexual maturity. We thank the Conservation and Fisheries Department, Ministry of Natural Resources BVI as well as NSERC Canada.

HUSBANDRY AND RESEARCH TRAINING WITH CAPTIVE SEA TURTLES TO ADVANCE THE UNDERSTANDING OF WILD POPULATIONS*

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Four captive sea turtles (three *Caretta caretta* and one *Chelonia mydas*) at Mote Marine Laboratory and Aquarium provided a unique opportunity for researchers to implement both husbandry and behavioral research training programs. Research conducted on captive animals can then be applied to wild populations to help advance the understanding of sea turtle biology and behavior. Initially, the turtles were trained to participate in husbandry behaviors so that medical care could be provided without restraint. Procedures including measurements, weights and blood draws are now done through the animals' voluntary participation utilizing only positive reinforcement techniques. The trained behaviors allow the turtles to remain in the water during most medical evaluations. This eliminates the need to catch and restrain the turtles for routine veterinary treatments, reducing the risk of injury to both turtles and personnel. The turtles remain stationed at individually distinct targets while weights and measurements are taken, visual examinations are performed, and blood is drawn. Additional benefits include the potential to obtain regular samples to re-establish baseline data for general turtle health and development. This provides important information to veterinarians and other scientists involved in sea turtle rehabilitation and research. By slightly modifying the behaviors learned in husbandry training, the program has additionally developed into a

research training program. The turtles have demonstrated the ability to learn to offer various responses to different cues. For example, press paddle A when a noise cue is played or press paddle B when a light cue is presented. By carefully studying the behavioral responses to certain stimuli, researchers can measure a variety of sensory abilities including hearing, vision and tactile sensitivity. All research is conducted using non-invasive methods, using food rewards as reinforcement for correct behaviors. The first research study has been designed to determine the hearing abilities of two adult female loggerhead turtles. Using a go/no-go paradigm, the turtles press a response paddle when they detect a sound stimulus and refrain from pressing the paddle when they do not hear the sound. By attenuating the stimulus until the turtle no longer detects it, a range of hearing can be determined, effectively creating a behavioral audiogram. This information is crucial for advancing our understanding of the basic biology of the species and advancing techniques for conservation. By developing a true range of hearing for adult loggerhead turtles, we will have a better understanding of how these turtles may be affected by anthropogenic noise in their environment. These captive animals provide an invaluable opportunity to study behaviors and abilities that are very difficult, if not impossible, to study in the wild and apply the findings to the conservation of wild populations.

ON THE IMPORTANCE OF SEA TURTLE POPULATION SEX RATIOS*

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The observation that certain non-marine turtle lineages have lost the temperature based mechanism of sex determination (TSD), strongly suggests that TSD in sea turtles has adaptive value. Our research groups are working independently and jointly to improve our understanding of evolutionary aspects of TSD by developing a long term data base on sea turtle sex ratios with an emphasis on juvenile populations (foraging aggregations). We suggest that analyses of these foraging ground derived data sets represent the distilled results of many years of far more variable annual beach sex ratio production and that they are ecologically relevant for each population's long term viability. The sex determination techniques used include necropsies of stranded animals, laparoscopy and circulating testosterone evaluation. Each technique is accurate when properly applied. In conjunction with SEATURTLE.ORG we propose an open access interactive web-based interface where researchers can study and contribute sex ratio data for all sea turtle populations. The goals are: 1. Develop a worldwide standardized and annotated data base on Sex Ratios of Sea Turtles to cover all age-classes and a minimum of 50 years of nesting beach production for each species. 2. Develop useful and predictive models for the impacts of global warming on marine turtle reproduction. 3. Test hypotheses on the evolutionary significance of Temperature Dependent Sex Determination. 4. Develop improved conservation strategies relative to global warming issues to protect animals with environmentally based sex determination. 5. Compare sea turtle species as to their relative susceptibility to impacts of global warming. More than 50 reports of sea turtle sex ratios are published, with an even greater amount of unpublished data. Our preliminary analyses and published reports show female biased sex ratios in most of the world with 1:1 ratios uncommon and only two known male dominated populations (Australian loggerheads and East Pacific Greens). With the possible exception of a study in the report by Meylan *et al.*, no clear patterns of sex ratio change can be suggested at this time. Immature loggerheads from the southeastern U.S. show a female biased sex ratio of nearly

2:1 but do not appear to be showing an increasing proportion of females as would be predicted over the long term with the influence of global warming. Tracking these types of studies on a decadal scale may reveal the anticipated changes.

DOWN & OUT: MOVEMENTS, DIVE DEPTH & DURATION OF OLIVE RIDLEYS IN OFFSHORE FORAGING HABITAT IN THE EASTERN TROPICAL PACIFIC*

Lindsey Peavey, Jeffrey A. Seminoff, Robert L. Pitman, Tomo Eguchi, and Lisa Ballance

National Marine Fisheries Service, Southwest Fisheries Science Center

In 2006, we deployed Satellite Depth Recording transmitters on three olive ridley sea turtles in the eastern tropical Pacific; these included an adult male (SCL 66.5cm), an adult female (62.8cm), and a sub-adult (53.5cm). Deployment dates and locations were: 20 September, 10°23 N, 87°41 W; 9 October, 14°48 N, 94°34 W, and 5 November, 14°29 N, 97°34 W (190, 175, and 150km offshore, respectively); the tags transmitted 202, 156 and 166 days, respectively. Movements were qualitatively analyzed with respect to oceanographic data obtained from satellites by overlaying data using STAT. Results show that surface chlorophyll; sea surface temperature, bottom topography and currents play important roles in determining horizontal movements and dive depth and duration. Tracking turtles in their pelagic habitat, alternatively from nesting beaches, provides insight into habitat selection and the environmental parameters that affect their movements and foraging. Considering the reported recovery of olive ridleys in the ETP, they are a perfect focus species for turtle research. Findings from olive ridley studies can be applied to other critically endangered turtle species and contribute to the development of turtle conservation strategies.

HAWAIIAN GREEN TURTLES DIVE TO RECORD DEPTHS DURING OCEANIC MIGRATIONS*

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The diving behavior of one adult female and two adult male green turtles was recorded during their roundtrip breeding migration from Laniakea, Oahu, to French Frigate Shoals in the Northwestern Hawaiian Islands. Diving behavior was also captured during the return trip to their foraging grounds. All three turtles exhibited a biphasic diving behavior. During the daylight hours, diving depth was shallow (1-4 meters) and duration was short (1-18 minutes). It is assumed that the turtles were moving deliberately toward their destination during this time. Between 19:00-19:30 hours daily, the turtles began a diving pattern consisting of deep dives with a mean maximum dive depth of 35-55 meters and a mean duration between 35 and 44 minutes. The nocturnal deep diving pattern ended and the shallow diurnal diving began between 06:00 and 07:00 each day. The adult female made two dives in excess of 135 meters and one of the males made several dives in excess of 100 meters. These are the deepest dives ever recorded for a naturally diving green turtle. It took an average of 36 days for the turtles to make the trip to French Frigate Shoals and an average of 30 days to make the return trip. The deep nocturnal diving was unexpected and this behavior is in need of further investigation.

FINE SCALE MITOCHONDRIAL DNA POPULATION STRUCTURE IN LOGGERHEAD TURTLES (*CARETTA CARETTA*) NESTING ON FLORIDA'S ATLANTIC COAST: THE CLINAL SHIFT REVISITED*

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Fine scale genetic structure within loggerhead turtles nesting in the southeastern United States remains unresolved. The most recent evaluation recommended the subdivision of the southeastern United States nesting aggregation into 4 management units based on mitochondrial DNA haplotype frequencies: a northern subpopulation, including beaches from northeast Florida to Virginia; a south Florida subpopulation, encompassing southwest Florida and the central and southern Atlantic Florida coast; the Dry Tortugas; and the Florida panhandle. Adjacent beaches were generally not significantly different, and the inference was that the haplotype frequencies exhibited a classic clinal shift along both coasts of the Florida peninsula. However, sample sizes were small on some beaches and some high-density nesting beaches were not represented. To address how the haplotype frequencies change from beach to beach and to improve sample representation, we collected skin biopsies from nesting females and tissue from dead hatchlings from post emergence nest inventories on several Atlantic coast beaches during the 2006 nesting season. A portion of the mitochondrial control region was amplified using primers TCR-5 and TCR-6. These sequences were aligned and assigned haplotypes based on nomenclature on the Archie Carr Center for Sea Turtle Research website. Haplotype frequencies and management unit groupings were evaluated using pairwise tests and analysis of molecular variance (AMOVA). Turtles nesting on Ormond, Daytona, and New Smyrna beaches (n=37) exhibited significantly different haplotype frequencies from those nesting within the adjacent Volusia County portion of Canaveral National Seashore. Canaveral National Seashore (n=58) and Archie Carr National Wildlife Refuge (n=102), separated by approximately 100 km, shared nearly identical haplotype frequencies in the 2006 sample. Both were significantly different from Juno Beach (n=49) and sampled beaches in Broward and Miami-Dade counties (n=68), suggesting a demographic break occurs somewhere between Melbourne and Juno Beach. Our preliminary results suggest that haplotype frequency transitions may occur abruptly over short stretches of apparently suitable nesting habitat. Conversely, preliminary data also suggest haplotype frequencies may be consistent over long stretches of beach without exhibiting a clinal change. The data tentatively support the division of the Atlantic portion of the previously defined south Florida subpopulation into central and southern Atlantic subpopulations. It is possible further partitions exist, but more robust inferences about the integrity and boundaries of management units throughout the southeastern United States will require further sampling to increase geographic coverage and sample sizes. Based solely on the 2006 data, the boundary between the northern subpopulation and the central Florida subpopulation currently appears to occur across the northern portion of Canaveral National Seashore. However, comparison between 1998 and 2006 data on these beaches suggests that these boundaries may shift over relatively short time periods, well within a single loggerhead generation. Further research should address whether these fluctuations naturally occur on the subpopulation peripheries or whether there is an environmental catalyst driving the shift.

PHOTOPERIOD: SIGNIFICANCE AND ROLE IN SEASONAL NESTING PATTERNS*

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Many studies have investigated the relationship between photoperiod and reproduction in a variety of organisms ranging from oligochaete worms to reptiles, birds, and mammals. In sea turtles, photoperiod has also been suggested to act as a cueing system for the precise onset of reproduction. However, only the physiological basis of this mechanism has been investigated, and seasonal nesting patterns have largely been attributed to environmental factors such as air and sand temperatures at the nesting beach. In this study, we investigate the relationship between day length and the onset of nesting in sea turtles. We use green turtle data from Tortuguero as a case study and look at the relationship between changes in day length and nesting cycle of green turtles at Tortuguero. On a broader scale, we investigate the relationship between the latitudinal location of a nesting beach and the onset and length of the nesting season. Unlike other environmental variables, day length is not subjected to environmental stochasticity, and appears to play a significant role. Using the photoperiod system, turtles can perhaps more precisely synchronize reproduction. The significance of photoperiod and the advantages of relying on a photoperiodic system rather than on other environmental cues are discussed in this study.

DETERMINATION OF INTRA-SEASON CLUTCH FREQUENCY FOR LOGGERHEAD TURTLES (*CARETTA CARETTA*) IN THE GULF OF MEXICO*

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Reproductive females at rookeries are the most accessible demographic segment of sea turtle populations. Acknowledged problems inherent to sampling these populations include tag loss, incomplete capture-recapture records, variation in remigration schedules, variable female reproductive output, and unrecorded nesting events occurring outside the sampling area. In contrast, nest counts are simple to obtain and so are frequently converted to estimates of the adult female population by dividing by an estimate of female reproductive output (or clutch frequency). However, these population estimates may be seriously biased if annual clutch frequency is underestimated. To determine estimates of clutch frequency, we placed satellite tags on females at a primary nesting assemblage for loggerheads in the Gulf of Mexico. Satellite tags, flipper tags, and PIT tags were attached to nesting females at the earliest stages of the nesting season to follow movements through all internesting stages of the nesting season. The methods derived new estimates of clutch frequency and site fidelity. We employed multiple criteria to determine if a female nested, such as Argos location classes of 2 or 3 that coincided with shoreline depths of -0.5 to +0.5. The return dates would be in the expected window for an internesting interval (10-16 days) after a preceding nest. Directional vectors before and after the nest were usually directed perpendicular to shore. Females that returned are sometimes verified by nocturnal tagging staff but nests on unpatrolled regions would be overlooked. Therefore, where it was logistically feasible, egg shell samples from the excavated nest contents of a satellite tagged female were compared by genetic analysis to biopsy samples taken from the female. Preliminary results were compiled from females tracked in 2006 (n = 2) and 2007 (n = 15). The observed clutch frequency (OCF) detected by nocturnal tagging patrols averaged 1.94 nests per season (range 1-6). The OCF was substantially lower than clutch frequency verified by satellite tracking (mean = 5.23 nests, range 4-7 nests). The site fidelity among females varied substantially, from high site fidelity (6 nests within 2.4 km) to more vagrant behavior (4 nests across 109 km) that would be unobserved outside the patrol region. The unsurprising conclusions are that current estimates of

loggerhead fecundity are likely underestimated from incomplete coverage or intraseason movement away from a primary study area. The implications of these findings are relevant at several levels. For coastal zones with continuous stretches of suitable nesting habitat, turtles may be less constrained to pockets of available nesting habitat and so less simple to survey. Satellite tagging in conjunction with strategic nocturnal tagging efforts can refine population estimates based on clutch frequency.

NESTING SITE FIDELITY OF GREEN TURTLE IN THE GALAPAGOS ISLANDS*

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Long-term tagging studies of nesting females at rookeries in the Central Pacific, Western Pacific and Caribbean have shown that green turtles (*Chelonia mydas*) display a high degree of nesting beach fidelity, with only a small percentage of the females interchanging between nearby rookeries within the same nesting season. To examine this behavior in the Eastern Pacific Ocean, we studied green turtles nesting in the Galapagos Islands (Ecuador) between 2002 and 2007 at the four primary beaches: Quinta Playa and Bahía Barahona (Isabela Island), Las Salinas (Seymour Island) and Las Bachas (Santa Cruz Island). Nesting females from current season and remigrants were included in the analysis. The degree of site fidelity displayed by green turtle nesting in the beaches within each season has been examined by dividing the shoreline into reference areas of 50 m long. The vegetation coverage and position within the beach profile was recorded for each nest, and nests were marked physically and recorded with GPS. To assess whether there were differences in spatial distribution due to temporal site-selection cues, we analyzed the patterns of the nest distributions within each time frame and nest coverage conditions. Our research revealed that around 85% of females returned to the same beach to nest and 15% nested at one of the other study beaches during the same season. Within those females returning to the same beach, several showed considerable site and temporal fidelity, depositing consecutive nests within 50 m of their previous nest, revealing a preference for a specific beach microhabitat. On the whole, our results suggest that, site fidelity of green turtles in Galapagos is comparable to other sites, although slightly lower, perhaps due to the close proximity of the different nesting sites sampled. Galapagos must then be considered as one management unit. These findings will be useful tools for managing and evaluating the current zoning system used in the islands in order to improve protection and conservation of green turtle nesting habitats.

Conservation Speed Session

FIRST MEETING OF THE EASTERN TROPICAL PACIFIC SEA TURTLE NETWORK*

Didiher Chacón[1], Patricia Zarate[2], Scott Henderson[3], Jeff Seminoff[4], Sebastian Troëng[5], and + 30 other authors[6]

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The Eastern Tropical Pacific is a sea turtle hotzone. Five species including leatherbacks, loggerheads, hawksbills, green turtles, and olive ridleys occur in this area, occupying nearshore habitats of all ETP-rim nations as well as open ocean habitats throughout the region. The oceanographic conditions that make this an epicenter of sea turtle activity also promote the existence of numerous commercially targeted marine species such as sharks, tuna, and swordfish. Ongoing fisheries, both artisanal and industrial, target these species and there is increasing evidence that all five sea turtle species in the region are dramatically impacted by fishing activities, as well as a range of other human activities including direct exploitation, marine polllution and habitat conversion and degradation resulting from coastal development and tourism. Sea turtles are transboundary species, crossing national borders, management jurisdictions, and human use regimes. As a result, there is no single stakeholder entity that can combat all the problems, nor promote all the solutions. To this end there is a very clear need for a cohesive, regional sea turtle network through which many of the most problematic issues involving sea turtles can be addressed and by which the positive examples born from sea turtle conservation can be promoted. In November 2007, the First Meeting of the Eastern Tropical Pacific Sea Turtle Network was convened in Panama. This meeting brought together a multitude of stakeholders and practitioners that represent government, NGOs, research interests, nesting beach conservation programs, fisheries management organizations, and fishing industry. Participants came from a core group of Pacific-rim nations including Costa Rica, Panama, Colombia, and Ecuador. Participants discussed ways to build off of existing initiatives such as the CPPS Regional Sea Turtle Strategy and the Costa Rican Sea Turtle Network, adding to these with new information based on the most recent scientific and conservation advances. Through this inclusive approach the goal of this Network is to cultivate a cooperative synergy that will promote greater awareness to the problems and solutions in sea turtle conservation, ultimately leading to recovering sea turtle populations in the Eastern Tropical Pacific.

CONSERVATION GENETICS MEETS OIL AND GAS DEVELOPMENT IN WESTERN AUSTRALIA*

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At present there is a major push for oil and gas development off the Western Australian coast and we have been involved in providing data on the genetic structure of potentially impacted turtle populations. Some of the areas proposed for gas development include nesting beaches and foraging areas for flatback (*Natator depressus*) and green (*Chelonia mydas*) turtles. To understand the scope of potential impacts we have increased previous efforts to understand the genetic structure of both species in this region. For both species this has included the sampling of new nesting areas and increased sample sizes from previously studied areas and the sequencing of a longer fragment of mitochondrial (mt)DNA. For the flatback turtle populations we have used newer, more informative microsatellite markers and for green turtle populations we have increased sampling efforts for regional foraging populations. In this talk we discuss our involvement in the environmental impact process, compare the results obtained for flatback and green turtle populations and ask the question of whether we are caught between a rock and a hard place given the limitations of our data.

ECOSYSTEM BENEFITS OF FLAGSHIP SPECIES CONSERVATION: PIAI'S SUCCESS STORY*

Geoffrey Gearheart and Ferdiel Ballamu

Papua Sea Turtle Foundation, West Papua, Indonesia

Piai Island's green turtle rookery, in Northwest Raja Ampat, Indonesia, was discovered in 2005. Intense poaching for meat indicated urgent measures were required to protect it, along with neighboring islands of Sayang and Wayag. A step-by-step approach by local NGO PSTF (funded by Conservation International), targeting the two clans who own the islands, enabled to 1) create a strong sense of awareness that their resource was "special" but threatened, and 2) obtain their approval to protect the Islands from poachers. Discussions with community members revealed, surprisingly, that sea turtles are esteemed (stemming in part from the consumption of turtle meat in Church celebrations) if not considered charismatic. This feeling was enhanced after STAT maps were shown of the long migration routes of 5 satellite-tracked turtles from Piai. Community patrolmen on PSTF's payroll have, since December 2006, lived full time on Piai to carry out daily beach patrols and collect nesting data. The impact of the project is exceeding its initial goal of stopping all poaching: blast-fishers and shark finners, common in Raja Ampat, have not been reported in the waters surrounding Piai and Sayang since beginning 2007. The mere presence of patrolmen seems to be an effective deterrent against destructive fishers. Small reef sharks, otherwise a rare occurrence, are now spotted daily along the nesting beaches. To crown PSTF's success, the Wayag-Sayang MPA was gazetted in December 2006. With over 900 nests laid during the first 7 months of 2007, Piai is now on the map of Indonesia's major green sea turtle rookeries. PSTF's conservation formula, specific to Raja Ampat's social and cultural fabric, is now being exported to new critical sea turtle habitats in West Papua. The use of a widely acknowledged "flagship" as a focal point for conservation enables to quickly gain local stakeholders' support (an effect harder to achieve with less popular "keystones", e.g. sharks) and provides the backbone for further conservation initiatives (e.g. water patrol system, alternative livelihood programs). In this specific case, the conservation benefits supersede the species level to reach the surrounding ecosystems. This finding may be of use for future seascape-level conservation programs.

THE SEA TURTLE EGG DONATION SYSTEM OF GUATEMALA: CONSERVATION ON NON-PROTECTED BEACHES*

Scott Handy, Sarah Lucas, and Colum Muccio

ARCAS, Project Parlama, Guatemala City, Guatemala, Central America

Sea turtle conservation in Guatemala has historically relied on the use of community-based hatcheries due to weak government conservation laws actually permitting sea turtle egg collection and a legalised market. Local egg collectors on the beach are asked to voluntarily donate 12 – 20% of the eggs in each nest to the local hatchery. With ongoing studies carried out by Project Parlama, we have data to show that local factors regarding in-situ nests, like high beach nest temperatures, extreme beach erosion and natural predators, indicate the necessity for the removal of nests from the beach and the need to use hatcheries. This donation system has many flaws, but it may offer advantages in developing countries and may be a viable alternative to more strict conservation measures, by continuing to provide poor coastal communities with a sorely-needed source of income whilst removing the nests from the risk of destruction on the beach. Hatcheries also provide a focus for developing volunteer programmes and eco-tourism, thus catalysing other long-term, self-sustaining income streams. Strict conservation measures implemented in other developing countries such as the establishment of protected areas and all-out bans on egg collecting often fail, leading to the creation of paper parks, empty legislation lacking any level of community support, and importantly exacerbate rather than address poverty issues. At the ARCAS/Project Parlama site in Hawaii, the donation system is functioning at a high level due to strong relationships within the community and essential environmental education. Volunteers at the project also spend countless hours patrolling the beach finding their own nests and collecting donations from the local egg collectors. Hatchling success rate in the hatchery is around 90% and all hatchlings are released immediately. Despite the fact that egg harvesting is legalised in Guatemala, with the combined forces of the donation system and the volunteer program, the project at Parque Hawaii collected nearly 30,000 eggs in 2006, an estimated 30% of all eggs laid on the beach. Due to current Government ruling, along with local economic and environmental factors, we believe that the donation system can be seen as a viable method of sea turtle conservation on the Pacific coast of Guatemala.

COMBINING CONSERVATION RESEARCH AND EDUCATION: SEA TURTLE SURVEYS AT THE PALMYRA ATOLL NATIONAL WILDLIFE REFUGE (2005-2007)*

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To enhance the management of sea turtles and their ecosystems at the Palmyra Atoll National Wildlife Refuge, while also contributing to broader recovery objectives, we initiated a sea turtle research and conservation program in 2005. Here we present the results of six atoll-wide surveys carried out between August 2005 and June 2007 to investigate sea turtle distribution in the near-shore waters of the atoll. Sea turtles were encountered throughout the waters surrounding the atoll, but were most frequently observed on the southern flats. We consider plausible factors that could contribute to differences in distribution, including diet, shelter, tidal variation, and/or energy expenditure. We also discuss methodological limitations that could bias the interpretation of these survey data, such as the likelihood of double counting, the effects of visibility conditions and tides, and the short length of the survey periods. These surveys provide an excellent opportunity to link ongoing research and educational initiatives by drawing upon real world experiences in an informative context. Through the Network of Conservation Educators and Practitioners (NCEP) program of the AMNH, these surveys are being incorporated into a multileveled exercise.

To complete the first part of this exercise, students use real survey and fictional mark-recapture data to investigate the distribution of sea turtles along the atoll. Students will be encouraged to think critically about the benefits and limitations of these field data, and to propose methodological improvements or alternatives. In subsequent levels, they will also be encouraged to consider the historical context of sea turtles and their ecosystems at Palmyra, a virtually uninhabited Wildlife Refuge that underwent extensive habitat modification during World War II. Students will also be asked to think about the connectivity of sea turtles at Palmyra to other regional groups, and conservation implications. As with all NCEP educational materials, this exercise will be available to all teachers and students free of charge and is part of a global effort aimed at improving training in and understanding of biodiversity conservation.

RAPID ASSESSMENT OF SEA TURTLE AND MARINE MAMMAL BYCATCH IN ARTISANAL FISHERIES: CHALLENGES AND OPPORTUNITIES*

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Sea turtle and marine mammal populations worldwide are at risk to incidental mortality in marine fisheries. Management to reduce bycatch is impeded by lack of information on the spatial-temporal distribution of fishing effort, and of how many individuals from different taxa are captured in fishing fleets. Data limitation is particularly problematic for artisanal fisheries in developing countries, where even basic data for the number of fishers, types of gear used, and species impacted are unavailable. However, local knowledge can be an important source of information in such cases and has been increasingly used in resource management and assessment. Project GloBAL (Global Bycatch Assessment of Long-lived species) has developed "rapid bycatch assessment" (RBA) protocols to gather information about fishing effort and bycatch of non-target taxa in data-limited artisanal fisheries. The RBA combines boat-counts in fishing ports or villages, and questionnaires with fishermen, to obtain baseline fishing-effort and bycatch data in these fisheries. The RBA is being tested in ~10 countries in Africa, Southeast Asia, and the Caribbean. We describe the protocol, challenges and lessons we've learned to improve it, and we present results for RBAs that have been completed thus far. Our goal is to provide a template that can be readily applied to data-limited fisheries, generating much needed estimates that assist country managers to reduce bycatch while enabling sustainable fisheries.

STUDYING THE REASONS BEHIND THE DECLINE OF THE LOGGERHEAD NESTING POPULATION OF RETHYMNO, GREECE: LESSONS LEARNED FOR THE FUTURE*

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Rethymno is situated on the northern coast of Crete, hosting an important loggerhead nesting habitat, with 166 to 516 nests per season on 10.8 km of beach. ARCHELON has been running a monitoring and conservation programme in the area since 1990. Data from this period (1990-2007) indicate that despite conservation efforts, the population of Rethymno is in decline (Margaritoulis *et al.* in this volume). Studying the reasons behind this decline is important to help determine future conservation policies and may provide lessons for conservation of other nesting habitats. When it was discovered in 1989, the nesting beach of Rethymno had few natural threats that involved inundation of nests by high seas caused by the northerly summer winds predominant in the Aegean. On the other hand, Rethymno was already under pressure due to development. Tourism had rapidly developed in the area from the 70's onwards, becoming the mainstay of the local economy and leading to an expansion of hotels, bars and restaurants and houses along the beach, causing erosion. By 1989 there had already been nearly two decades of female turtles being deterred from nesting due to noise, lights from adjacent businesses and the presence of an ever-increasing number of beach furniture, and of high hatchling mortality rates due to light disorientation. The situation is further aggravated when examining turtle mortality at sea. Water sports have led to collisions between speedboats and turtles. Propeller injuries were the cause of death for 9 out of the 80 turtles reported dead in Rethymno (1990-2006). Further, interactions of fisheries with turtles, as recorded in the Mediterranean, and indicated by fishermen and stranding reports, suggest high levels of mortality due to accidental capture in fishing gear. Further, loggerhead turtles are known to be consumed in some North African countries. Although the actual mortality rate at sea is difficult to assess it does include juvenile, sub-adult and adult loggerhead turtles of both sexes and it can be assumed that a proportion involves turtles from the Rethymno population. ARCHELON's conservation efforts in Rethymno have focused on (a) active nest management (caging, shading, relocating) ensuring that each season a number of hatchlings are added to the population, (b) an intense awareness campaign to make the public embrace turtle conservation policies, (c) the implementation of a Management Plan elaborated in 1997 aiming to mitigate the existing condition and ensure that all future development will have minimal impact on the nesting site, with the support and co-operation of all stakeholders and (d) collaborative programmes with fishermen aiming to change negative attitudes towards turtles. Nevertheless, these efforts seem to have only succeeded in halting the rate of deterioration of the habitat and were unable to prevent the decline in nest numbers. While there is still hope that the last 18 year's protection will bear fruit in the upcoming years, for the survival of the Rethymno turtle population there it is imperative that protective legislation in the context of European Union's NATURA 2000 Network is applied and that regional co-operations are established. Special thanks are due to the ISTS, to Carlos Peralta Quintero and Robert N. Allen, Jr as well as Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation for financial support that made it possible for A.P. to attend the 2008 Symposium.

RESULTS OF A MARINE TURTLE SPECIALIST GROUP MEMBER SURVEY ON MOTIVATIONS, PRACTICE, AND EFFICACY OF NEST RELOCATION AS A CONSERVATION MEASURE*

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Despite its ubiquity among sea turtle researchers and conservationists worldwide, nest relocation rightfully has come under scrutiny in recent years on grounds of its potential biological consequences and its sometimes questionable conservation efficacy. As a first step toward building consensus about this issue and possibly moving toward a set of 'best-practice' guidelines, the Marine Turtle Specialist Group (MTSG) elicited the opinions of its membership in a survey about the motivations and concerns regarding nest relocation efforts for sea turtle conservation worldwide. Respondents represented 29 countries and submitted a total of 47 responses. We present the results of this survey in order to kindle further constructive discussions among the MTSG membership about appropriate implementation and execution of nest relocation in sea turtle conservation efforts around the globe.

Conservation, Management, and Policy

OPPORTUNITIES FOR SUSTAINABLE SEA TURTLE CONSERVATION IN AKASSA WETLANDS, BAYELSA STATE, NIGERIA

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Akassa wetland is located in the Niger Delta at the southern most tip of Nigeria along the Atlantic coast. It lies between 4° 21'N and 5° 59 'E and consists of three barrier Islands separated by the Nun River, the Sangana River and the Fishtown River. The wetland is highly threatened by the unsustainable and massive oil exploration in the region. Akassa sand beaches (Oginibiri beach, Okumbiri beach- turtle beach, Fishtown beach and Sangana beach) play host to migratory sea turtles and serve as nesting sites for these endangered species. Three species of sea turtles most frequently seen in Akassa are: leatherback (*Demochelys coriacea*), green (*Chelonia mydas*) and olive ridley (*Lepidochelys olivacea*). The rates of migration are higher during the breeding seasons-between September and February yearly. Despite the threat of oil spills and restlessness in the region, community support for conservation of endangered sea turtles has been strengthened through awareness campaigns and rallies conducted across the Akassa wetland by the Sea Turtle Club (a voluntary club of over 100 members). The turtle club activities have helped increase community support for sea turtle conservation and reduced killing of sea turtles by 85% in five years. The construction of a turtle observatory at the turtle beach has initiated concerted efforts to improve activities of the youth group and facilitate responsible ecotourism in the Akassa wetland. Conservation initiatives in Akassa need to be prioritized; focused capacity building on techniques for preserving and protecting turtle eggs at the nesting sites, incubation technologies, materials and best practices for turtle tagging will facilitate sustainable sea turtle conservation activities in Akassa wetlands.

SEA TURTLE CONSERVATION PROBLEMS IN ARGENTINA: BY-CATCH AND MARINE DEBRIS INGESTION

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The Regional Program for Sea Turtle Research and Conservation in Argentina (PRICTMA) was created in 2003. This regional program established a by-catch and stranding monitoring network along 3,000 km of Argentinean coastline (Buenos Aires, Rio Negro and Chubut province), building on the expertise of local sea turtle work groups. Monitoring is conducted by means of beach surveys and a collaborative effort between researchers and fishermen. Data collected since 1997 shows that juvenile green turtles (*Chelonia mydas*) have been found stranded (total reported n=46, 32.6% of these from interviews) along the coast from Gualeguaychú (33º 01'S; 58º 31'W) to Puerto Pirámides (42º 35'S; 64º 17'W). Incidental captures of *C. mydas* (total reported n=108, 18.8% of these by interviews) were concentrated in Buenos Aires province, from Quilmes (34º 43'S; 58º 15'W) to Ingeniero White (38°47'S; 62°16'W). Although, some captures (n=3) have been recorded in San Antonio Oeste (40º 45'S; 64º 56'W). Gillnets and shrimp nets were the most frequent fishing gear involved, although bottom trawl nets and pole and line were also a problem for this species. Subadult loggerhead turtles (*Caretta caretta*) have been found stranded (total reported n=48, 33.3% of these from interviews) from Buenos Aires city (34º 38'S; 58º 28'W) to San Antonio Oeste. Incidental captures of *C. caretta* (total n=38, 57.9% reported in interviews) were concentrated in Buenos Aires province, from Quilmes to Villa del Mar (50º 18'S; 72º 47'W). Gillnets were the most frequent fishing gear involved in by-catch although bottom trawl nets were also seen to interact with this species. Subadult and adult leatherback turtles (*Dermochelys coriacea*) were found stranded (total n=42, 26.2% of these by interviews) from Quilmes to Monte Hermoso (38º 59'S; 61º 18'W). Incidental captures of *D. coriacea* (total n=31, 48.4% reported in interviews) were concentrated in Buenos Aires province, from San Clemente del Tuyú (36º 22'S; 56º 44'W) to Monte Hermoso. Ingestion of marine debris has been documented for *C. mydas* from Buenos Aires city (34º 38'S; 58º 28'W) to Necochea (38°32′S; 58°45′W). Pieces of plastic, plastic bags, polystyrene, fishing lines and cables have been found in turtle's digestive tract. From December 2004 to April 2005, 37 *C. mydas* (mean = 38.31 cm, range = 33-56 cm LMC) recovered from gillnet by-catch in southern Samborombón Bay were necropsied. Ninety seven percent (n=31) of the digestive tracts analyzed had some kind of marine debris. Furthermore, 70% (n=7) of the turtles rehabilitated in rescue centers since 2000 have shed plastic debris while in captivity. To date, only one animal in rehabilitation has died due to intestinal obstruction by plastics pieces. This study presents a regional overview of the situation of sea turtles in Argentinean waters, and highlights incidental capture and marine debris ingestion as the most conspicuous conservation issues. Further exhaustive monitoring is needed to assess the mortality rate for these species due to by-catch in different types of fishing gear. Moreover, establishing the cause of death of stranded animals is pressing in order to evaluate the contribution of marine debris ingestion to sea turtle mortality.

ESTABLISHING A SEA TURTLE TAGGING AND CONSERVATION PROGRAM IN GHANA

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Earlier reports indicate that Ghana may be home to six of the world's endangered sea turtle species, but unfortunately very little is known about their current status and threats. In August 2006 we initiated the first sea turtle tagging program in Ghana with the goal of generating consistent and long-term data on the distribution of sea turtles in West Africa. During our first year of monitoring, we documented 481 leatherback nests and 103 olive ridley nests along 7 kilometers of beach near Ada Foah. We tagged 141 nesting individuals and had only four recaptures. We observed nesting females of each species in August, and this nesting continued through the end of March of the following year. The peak nesting season was from December through February for leatherbacks. Olive ridleys tended did not show any real peak in nesting activity, but was consistently nesting from August to March. The small number of recaptures during this first year may indicate the nesting females are nesting in multiple locations along the beach. Further tagging data will likely reveal the nesting patterns along the coast of Ghana. Dogs, pigs, and beach erosion are the three biggest threats to the eggs and hatchlings. Egg poaching did not occur on this stretch of beach and only a small number of adults were harvested from the nesting beach. The Adali people of this region typically do not eat sea turtles due to a traditional story that describes a sea turtle rescuing lost fishermen. Intense fishing along the coast of Ghana results in a large number of dead sea turtles each year. Fishermen, including the Adali people, sell the captured turtles to pay for the damage to their fishing nets caused by the sea turtles. Many successful conservation projects in Ghana have blended traditional beliefs with education programs and ecotourism. We believe a successful sea turtle conservation program in Ghana will require the merging of traditional beliefs, education, research, and ecotourism.

ROLE OF THE GUAYMÍ INDIGENOUS COMMUNITY IN THE CONSERVATION OF MARINE TURTLES IN CAÑA BLANCA, COSTA RICA

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Caña Blanca, Costa Rica lies approximately 7 km south of PRETOMA's sea turtle nesting beach project in Punta Banco on the southern Pacific coast of Costa Rica. In order to reach Caña Blanca and the Guaymí indigenous community, it is necessary to traverse the 7 km of beach from Punta Banco on foot or horseback, which is only possible during the low tide. The Guaymí live simply, relying on subsistence farming and hunting in the Conte-Burica Indigenous Territory, and have been known to previously collect marine turtle products (typically eggs and meat) for consumption and sale. This, however, is not an integral part of their culture and is typically done out of necessity due to lack of employment and other alternative sources of income. Little is known about the quantity of sea turtle nesting in Caña Blanca, but it is suspected to be at least equal to, if not greater than, that of Punta Banco. PRETOMA previously worked with the Guaymí from 1998-2000, but nesting numbers can only be considered a minimum due to inconsistent monitoring effort from local community patrollers. In 2007, however, the community contacted PRETOMA expressing an interest in beginning a fully-functional sea turtle monitoring and conservation project. Based on the results of a pilot project during the 2007 nesting season, PRETOMA will investigate the possibility of bringing volunteers from its Participant Program during subsequent seasons to provide additional economic incentives to the indigenous community in hopes of mitigating the poaching of sea turtles in the region. During this pilot project, PRETOMA staff worked with interested members of the community to train them in

monitoring and conservation techniques according to PRETOMA nesting beach project protocols, and supplied them with necessary equipment (field data notebooks, backpacks, flipper tags, and Spanish-language training materials). Sea turtle nesting data gathered during pilot project and recommendations for continuing conservation efforts in Caña Blanca are presented.

LOGGERHEAD NEST INCUBATION TEMPERATURES IN HATCHERY NESTS VS. IN SITU NESTS ON CAPE ISLAND, SOUTH CAROLINA

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Cape Island is the northernmost barrier island of the 64,000-acre Cape Romain National Wildlife Refuge located in Charleston County, South Carolina. Historically, Cape Island has received the highest density loggerhead sea turtle nesting in the northern sub-population geographic nesting area which extends from Amelia Island, Florida through Virginia. Management activities are carried out by the U.S. Fish and Wildlife Service and include predator management, nesting surveys, and nest protection and relocation. Since the inception of the nest protection project, hatcheries have been used for relocated nests to prevent loss from erosion or severe tidal inundation as well as predation by raccoons. The program currently uses only self-releasing hatcheries located 5 to 20 yards above the high tide line. Starting in 1997, cages made of 2 x 4 inch welded wire have also been used to protect individual nests from predation. Since 1997, the use of cages has increased and the number of nests placed in hatcheries has decreased in response to concerns of temperature alterations adversely affecting the nests. Due to the large number of nests laid on Cape Island and the significant annual loss of suitable nesting areas, hatcheries are still being used as a necessity. This study compares the temperature in the approximate center of the in situ nests to the temperature in the center of hatchery nests. MicroDAQTM LogTag temperature data loggers with a +0.1ºC resolution set to record data every half hour were used to measure nest temperatures. Data loggers were placed into every other in situ nest (n=80) during the same time period as nests were being relocated into the hatcheries (n=56). Sixty eggs, 50% of the average clutch size, were removed from the in situ nests and a data logger was placed upright in the center of the nest with the sensor facing north. The distance from the bottom of the data logger to the surface of the sand was measured in centimeters. Eggs were placed back in the nest around the egg chamber, the nest was re-covered, marked, and caged. All hatchery nests were dug out with post hole diggers to a depth of 55 cm and then bowled out to create an egg chamber. Half of the clutch was placed in the nest, a data logger was placed upright in the center of the nest with the sensor facing north, and the remaining eggs were placed around the data logger and covered. All mean incubation temperatures in the approximate center of the clutch during the middle third of incubation exceeded 29ºC and 89.7% of in situ nests and 81.5% of hatchery nests $\geq$ 30.45ºC. The incubation temperatures were significantly lower in hatchery nests than in situ nests and the mean incubation duration was significantly longer in hatchery nests than in situ nests.

MANAGEMENT OF HATCHLING MISORIENTATION ON URBAN BEACHES OF BROWARD COUNTY, FLORIDA: EFFECTS OF LIGHTING ORDINANCES AND THE LEARNING CURVE

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Prior to the 2006 nesting season, a comprehensive nest relocation program in Broward County, FL was used as a management strategy to protect sea turtle hatchlings from the disorienting effects of artificial lighting. Twenty-five years of nesting data suggest that conservation by means of nest relocation resulted in reduced nest productivity. The resultant loss in the number of hatchlings reaching the water compared to those nests left in situ prompted the Florida Fish and Wildlife Conservation Commission to alter permit conditions to exclude the use of hatcheries as a management option beginning in 2006. The designation of much larger areas considered dark enough to receive relocated nests and to leave nests in situ meant fewer nests were relocated and relocated nests were moved shorter distances. As more nests were left in situ during the 2006 and 2007 nesting seasons, the importance of light management increased throughout the County. We compared the estimated total numbers of disoriented hatchlings and the numbers of disoriented hatchlings that were unaccounted for (presumed dead) in 2006 with 2007. Since disorientation data for 2007 is only available up to September 8, 2007, the time of this writing, data after September 8 for the 2006 nesting season was not included in the following comparisons. Evaluation of 2006 disorientation reports suggested that between 14,461 and 16,897 hatchlings disoriented throughout the County. While the number of disorientation events decreased in 2007, the total number of disoriented hatchlings increased by about one percent, and ranged from 14,547 to 16,987. However, the estimated numbers of disoriented turtles reaching the water in 2007 was from 1,718 to 2,159 greater than in 2006. Concurrently, it is estimated that this resulted in a decrease in the number of missing hatchlings in 2007, between 1,632 and 2,069 compared to 2006. County wide, the incidence of disoriented hatchlings found dead on the road decreased by 68%. Reports in 2006 from the highly urbanized municipalities including the Fort Lauderdale strip, where half of the nests were caged, indicated that the number of disoriented hatchlings ranged between 1,501 and 1,621 while 2007 data show that half as many hatchlings (between 672 and 722) disoriented. Furthermore, evaluation of incidents occurring in areas of Lauderdale by the Sea in 2007 indicate that the minimum and maximum estimates of total disoriented hatchlings that reached the water increased by 755 to 910, representing increases of 65% and 54% from 2006, respectively. Therefore, minimum and maximum estimates of the number of missing, disoriented hatchlings decreased from 2006 to 2007 by 38% and 43%, respectively. Reductions in the number of lost disoriented hatchlings documented in 2007 may be attributed to the combined efforts of the enforcement of coastal lighting ordinances and the application of experience gained from the previous nesting season. With the knowledge gained from 2006, surveyors were able to avoid placement of relocated nests in areas known to have recurring lighting problems.

RESTORATION ECOLOGY OF MARINE TURTLES AT THE ARCHIE CARR NATIONAL WILDLIFE REFUGE, FLORIDA, USA: LOGGERHEAD (*CARETTA CARETTA*) AND GREEN TURTLE (*CHELONIA MYDAS*) RESPONSES TO ENGINEERED DUNES*

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The Archie Carr National Wildlife Refuge (ACNWR) is a stretch of beach located in South Brevard County, Florida, USA. Globally significant nesting for loggerheads and green turtles occurs on this 21 kilometer stretch of beach, with 9,018 loggerhead nests and 1,382 green turtle nests laid in 2006. Since its establishment in 1990, armoring (sea walls, groins, and rock revetments) has been prohibited, resulting in a "natural" beach for nesting marine turtles. In 2004 two major hurricanes made landfall just south of the refuge and eroded the natural dune face throughout much of the South Brevard coast. To resolve this issue, engineered dunes were created prior to the 2005 nesting season to stabilize the dunes. Sand from inland mines was evaluated by county and state officials, and after meeting physical attributes specifications, was used to create an artificial or engineered dune in front of properties with structures (i.e. single-family homes, condominiums, businesses). Properties without structures did not receive an engineered dune and therefore remained "natural". The 2005 nesting season ended with significantly lower nesting success rates (number of nests over the total number of crawls) in the engineered dune areas compared to the long-term average. Nesting success rates in the natural areas remained near the long-term average. The loggerhead nesting success rate fell significantly and green turtle nesting success decreased at an even greater rate in response to the 2005 beach template. However, hatching success rates (the average number of hatched eggs over the total number of eggs per clutch) were not significantly different relative to the long-term average. After the 2005 nesting season, several tropical storms damaged portions of the newly constructed dunes and prior to the 2006 nesting season, the engineered dunes were reconstructed. However, a new template was implemented to create a more gradual slope (4:1) compared to the steep slope (2-3:1) of the 2005 dunes. Loggerheads responded with a significantly higher nesting success rate in 2006. Green turtle nesting success also rose significantly, returning to a rate within the long-term range. Similar to the previous year, the 2006 hatching success rates were not significantly different relative to the long-term average. These results indicate that the slope of the engineered dunes affects the behavior of nesting females, with the more gradual slope of 2006 producing higher nesting success rates. It also appears that when suitable substrate is used to create engineered dunes, hatching success rates are not affected.
Acknowledgements: The author would like to thank the Sea Turtle Symposium for awarding me the Travel Grant and the following donors for their generosity: Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, the Sandler Family Foundation, Carlos Peralta Quintero and Robert N. Allen, Jr.

ASSESSMENT OF BEACH COMPACTION AND ASSOCIATED EFFECTS ON LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) NESTING ON NATURAL AND NOURISHED BEACHES IN NORTHWEST FLORIDA

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Beach nourishment is increasing in scope and execution as a response to coastal erosion in Florida. However, if nourished sand has different properties than natural sand, then the beach ecosystem may be altered. Regulatory agencies maintain sand specifications for nourishment projects to monitor quality of fill materials. The reproductive effort of nesting sea turtles requires a suitable incubation environment: the effects of substandard fill material may be immediate (false crawl) or sublethal (poor incubation environment). Our objective was to determine if the physical properties of sand on post-nourishment beaches differed from natural beach sand, and whether any differences observed appeared to affect nesting loggerhead (*Caretta caretta*) sea turtles. Compaction, bulk density, water content, color (chroma and value), and grain size distribution were analyzed on seven pairs of nourished beaches and natural beaches along the Florida Panhandle in summer 2006. We hypothesized that any differences in these physical properties on nourished versus natural beaches could affect loggerhead sea turtle nesting success. While compaction measurements are often the primary method of evaluating beaches post-nourishment, measuring shear resistance may provide a more complete picture of a sea turtle's perception of the beach during nest chamber excavation. In summer 2007, shear resistance measurements were taken alongside compaction readings, using a digital torque wrench attached to a magnified shear vane that was rotated over a 90 degree angle. Data on loggerhead sea turtle nesting (nesting and hatching success) on the study beaches was obtained from the Florida Marine Research Institute and examined for patterns that could be related to sand quality and nourishment status. Information from this study will be used to formulate recommendations in support of resource management practices in northwest Florida. Acknowledgements: We would like to thank the U.S. Fish and Wildlife Service and the donors and representatives of the 2008 International Sea Turtle Symposium for their financial support.

AN ANALYSIS OF UTLIZING THE LEATHERBACK'S (*DERMOCHELYS CORIACEA*) PINEAL SPOT FOR PHOTO-IDENTIFICATION

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The ability to individually identify sea turtles in the field has been the most valuable tools in advancing our understanding of these animals. Marked or identified turtles allow for the measurement of a wide variety of biological and population variables (e.g. reproductive output, longevity, and survival rates). However, traditional marking methods which utilize flipper tags are imperfect due to their short retention durations. While having substantially better retention rates, the high cost of Passive Integrated Transponder Tags and the specialized equipment necessary to detect them, prompted us to reinvestigate the feasibility of using photo-identification methods to recognize individual leatherbacks. Pioneering studies of pink spot photo-identification by McDonald and Dutton showed that the pineal spot of the leatherback is distinct enough to be used as a means of identification. These early studies also found that variation of the pink spot's appearance remains low over many years, and thus the pink spot can provide a unique identifier over the long term. However, several limitations associated with this initial study have constrained the expansion of photo-identification as a commonly accepted tool by leatherback researchers. Foremost was the limited sample size available for analysis. The research site at Sandy Point NWR, St.

Croix offers 2.4 km of beach for nesting activities, but hosts a relatively small population (220 individuals over the 1986 - 1995 time frame of the McDonald and Dutton study). With a limited choice of possible candidates it was recognized that the potential variation of pink spot form within this population was restricted. Whether the pink spot would remain a unique identifier at larger sample sizes or within larger populations was unknown. Another limitation of the McDonald and Dutton study was the lack of quantitative methods to evaluate the pink spot form. Most pink spots were characterized manually. In other words, a single investigator would visually determine whether two pink spot photos were identical. While valid for small sample sizes, and as noted by the authors, when combined with other identifying characteristics, it would be more useful if the identification of an individual pink spot could be made with quantitative characteristics. This would also allow for the automation of identification of individual turtles. This project, sought to test whether individual turtles could be recognized by their pink spot when a large sample (400) was drawn from a very large nesting population (approx. 3,000 nesting annually). It also sought to determine whether the identification could be automated using photo-identification methods that were unavailable to McDonald and Dutton and standardized data gathering techniques. Trinidad offered the ideal research location for this study as it supports more than 80% of the total leatherbacks nesting in the insular Caribbean Sea, with an estimated 6,000 turtles nesting annually (Fournillier and Eckert, 1999, Eckert, 2006). Matura Beach, in particular, was optimal because it hosts over 150 turtles per night and has an annual nesting population of about 3,000 individuals. Our presentation will summarize our findings of this study, which was conducted over the 2007 nesting season at Matura Beach.

SEA AND SEA TURTLES OF PRAIA BAIXO AND ACHADA BALEIA (SANTIAGO ISLAND - CAPE VERDE) HOUSE PRESENTATION

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The archipelago of Cape Verde is recognized as one of the most important world locations for *Caretta caretta* (Cc) nesting. However, in Santiago, the biggest and more populated island, tradition of sea turtle captures remain very embedded in the mind and behavior of the population. In May 2007 we started with a pilot initiative to contribute to the integrated management of cape-verdian sea turtles. Two littoral small villages, Praia Baixo and Achada Baleia (São Domingos county), with its black sandy beaches, were selected to study basic reproduction of Cc, as well as several issues of human interactions with sea turtles. Meanwhile, contributions to governmental authorities, mainly in the domain of basic and secondary education, were ensured, as we found a very insufficient general knowledge about the Cc importance, ecology, risk of extinction, and potential for eco-tourism and new employment opportunities. During 2008, the initiative is being hardly reinforced. The Casa do Mar e das Tartarugas Marinhas de Praia Baixo e Achada Baleia (Sea and Sea Turtles of Praia Baixo and Achada Baleia House), an environmental education center, will spring up in April, after the restoration of an old basic school building. The beaches of Praia Baixo and Achada Baleia will be converted on Live Labs, supporting different levels of environmental education and research programs, always related to sea turtles. We will try to achieve five different goals with the Sea Turtles House and the Live Labs: i. To increase general knowledge about sea turtles importance and ecology; local population, cape-verdian population and tourists will be very welcomed. ii. To encourage positive interactions between Cc and people: “Sea turtles are friends, not food!” and “We want our sea turtle friends alive!” are the slogans for the 2008 campaigns. iii. To provide an adequate place for information and training, specially tailored to specific groups, as basic and secondary teachers, and authority agents. iv. To offer a reception desk for turtle watching, and to catalyze other modalities of active and eco-tourism related with the littoral and the sea. v. To create a field basis for sea turtle research programs. Also, the initiative will promote, around the country, several thematic workshops for basic and secondary teachers, in cooperation with cape-verdian governmental authorities. We will try to contact every environmental sciences teacher, offering detailed information and a thematic pack (a booklet, a DVD, a t-shirt and some stickers, as well as an annual free-pass to the Sea Turtle House). Consequently, we will try to optimize all the possible synergies that can arise from simultaneous local and national programs and activities, even if we face financial limitations. We hope that after two or three years of activities of this initiative, our contribution to the conservation and integrated management of sea turtles will be truly effective and successful.

WORKING TOGETHER FOR SEA COUNTRY MANAGEMENT OF THE GREAT BARRIER REEF*

Kirstin Dobbs, Chicka Turner, John Tapim, Leon Jackson, Gail Barry, and Melissa Sweeney

Great Barrier Reef Marine Park Authority

Aboriginal and Torres Strait Islander people are the Traditional Owners of the Great Barrier Reef region. For over 60,000 years, their traditional connections have been part of a unique living maritime culture, and today their traditional customs and spiritual lore continue to be practiced in their use of sea country and natural resources. Sea country refers to areas of sea that Aboriginal and/or Torres Strait Islander groups are traditionally affiliated with. Thousands of years before Captain Cook struck a reef near Cooktown, Aboriginal and Torres Strait Islanders used the reef, islands and adjacent mainland to fish, hunt and gather. Social and cultural practices associated with the Great Barrier Reef demonstrate long-standing, complex and intertwining connections with people and sea country. The Great Barrier Reef Marine Park Authority and Traditional Owner groups along the Great Barrier Reef are working together to establish cooperative arrangements for sea country management. Traditional Use of Marine Resource Agreements (TUMRAs) are being developed by Traditional Owner groups to describe formal management arrangements for a range of traditional use of marine resources activities within their sea country. Traditional use of marine resources is the undertaking of activities as part of Aboriginal and Torres Strait Islander people's customs or traditions, for the purposes of satisfying personal, domestic or communal needs and may include: fishing, collecting (for example, shellfish), hunting, and looking after cultural and heritage sites. Many Aboriginal and Torres Strait Islanders undertake traditional use of marine resources activities to educate younger generations about traditional and cultural rules, protocols and for activities in sea country; practice their 'living maritime culture'; and provide traditional food for families. TUMRAs describe how Traditional Owner groups work with government to manage traditional use activities in sea country. A TUMRA may describe for example, how Traditional Owner groups wish to manage or place limits on their take of turtle and dugong; their role in compliance; and in monitoring the condition of plants, and animals, and human activities in the Great Barrier Reef Marine Park. The TUMRA implementation plan may describe ways to educate the public about traditional connections to sea country, and to educate other Traditional Owner groups about the conditions of their TUMRA and management arrangements for sea country. A case study of sustainable harvest of marine turtles will be used to highlight this cooperative management approach within the Great Barrier Reef.

SEA TURTLE CONSERVATION AND COMMUNITY MANAGEMENT IN BENIN

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The Republic of Benin is a coastal country of West Africa. It is bordered in the south by the Gulf of Guinea. Its width is of 125 km in the south and 350 km in north. The Republic of Benin extends on 750 km from the south to the north. Its surface is 114,763 sq. km. It is located between longitudes 0°40’E and 3°50’E and the latitudes 6°10’N and 12°30’N. The population was estimated in 1995 at 6.5 million inhabitants with a density of 45.9 inhabitants per sq. km. The rate of increase in the population was 3.2% in 1994. The Republic of Benin is located in a zone where a balance between the influence of the wet mode of monsoon and the dry harmattan is carried out. Four species of sea turtles are known on the Benin Republic Atlantic coast. In order of their importance, we have *Lepidochelys olivacea* (Olive ridley) and *Dermochelys coriacea* (Leatherback) whose nesting were confirmed; *Chelonia mydas* (Green turtle) and *Eretmochelys imbricata* (Hawskbill) are often fished - Dossou-Bodjrenou *et al*. (1999), Formia (2000), Fretey (2001). Most of the main threats on sea turtles in the West African region were recorded in various degrees on the coast of Benin. Poaching by humans remains the most worrying. Some actions have been undertaken since 1999 following Abidjan Memorandum of understanding concerning conservation measures for marine turtles of the Atlantic coast of Africa. Nowadays, the development of a participative Action Plan that put an accent on the responsibility of local communities and the support to generating income alternative activities was very determinant. The communities are still waiting and the sea turtles continue to be killed in some part of the beach. The new strategy is to enforce the regulations with the collaboration of local authorities to give more chance to sea turtles and other migratory species. With the support of GEF/UNDP, The Netherlands Committee of IUCN, The European Union of Aquarium Curators and New York Aquarium, Nature Tropicale has just started the implementation of a new project of conservation of sea turtles in Benin. The originality of this project is to strengthen the capacity of all the stakeholders concerned by sea turtle conservation in order to get their cooperation to implement the MoU on sea turtles in Africa. These stakeholders are local communities, administrative authorities; traditional chiefs, Eco-guards and members of the Gold Coast Sea Turtles Conservation Network (GoSTCON). They have to commit themselves in sea turtles conservation action.

ACTIVITIES 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 decline 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. The island of Roatan is one area of the country that especially facilitates initial opportunities for research, as well as engaging local communities and visitors in awareness of sea turtles in the waters of the Bay Islands. For this reason, we have initiated a series of local research and outreach efforts under the Protective Turtle Ecology Center for Training, Outreach and Research, Inc. (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 Programa de Manejo Ambiental de las Islas de La 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, 58 turtles have been monitored for health and growth. 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. Loma Linda University graduate student, Melissa Berube is currently tracking six juvenile hawksbills fitted with radio transmitters. The 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 Honduras, a long-term nesting beach monitoring program, long-term female tagging, 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 from an area where sea turtle research and conservation have not previously been national or international priorities.

DIGITIZING WATS: A UNIQUE BASELINE FOR CURRENT CONSERVATION EFFORTS IN THE WESTERN ATLANTIC REGION

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With the stated objective of serving "as a starting point for the identification of critical areas where it will be necessary to concentrate all efforts in the future", the first Western Atlantic Turtle Symposium convened in Costa Rica (17-22 July 1983) and the second Western Atlantic Turtle Symposium followed in Puerto Rico four years later (12-16 October 1987). WATS I featured National Reports from 43 political jurisdictions; 36 presented at WATS II. A quarter-century has passed, and the national reports, databases, survey results, invited presentations, panel discussions, and recommendations of these historic meetings have been largely lost to science and to a new generation of managers and conservationists. WIDECAST, in partnership with the U.S. National Marine Fisheries Service, has undertaken to digitize these historical databases as they relate to international trade, bycatch, sea turtle landings, exploitation attributed to foreign fishers, threats operative at that time, survey and population estimate data, aerial habitat assessments, and the location of active nesting beaches and foraging grounds. Moreover, the project will infuse new value to these datasets by using modern GIS tools to visually display nesting beaches, foraging grounds, species present, landings, and other notations convertible to a geo-referenced format. The project fills an important gap in Caribbean record-keeping, and ensures that data collected 25 years ago – associated with surveys of habitats, retail markets, and fishers – is placed into the public record in a way that will maximize its usefulness and help to ensure that whatever value these data might have in setting the "guidelines for future actions" is not lost forever. On the 25th Anniversary (1983 - 2008) of WATS I, we would like the opportunity to share with ISTS members progress made on this project, which we hope will inform current discussions of historical sea turtle status and trend, as well as lend new impetus to the protection of critical habitat.

EVALUATION IN SITU NESTS OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) IN PLAYA CEUTA, ELOTA, SINALOA, MEXICO, LIKE EFFECT OF THE HURRICANE "LANE"

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47 nests of olive ridley sea turtles (*Lepidochelys olivacea*) were analyzed "in situ" after they were deposited few days after hurricane "Lane" impacted directly on Ceuta Beach on September 16th, 2006. Nests were discovered and thanks to that, hatching success and natural predation (mortality rate) was estimated. I carried out an analysis of most of the nests, data obtained were: average number of eggs per nests (84.79). Hatchling success (88.32%), which represented 3,436 hatchling of 3,985 incubated eggs. Nevertheless, a certain number of hatchlings were depredated by animals like coyotes (*Cannis latrans*) that appeared in 20 nests, the ghost crab (*Ocypode occidentalis*), whose caves were found in 18 nests, great blue heron (*Ardea herodias h.*) in 2 and the raccoon (*Procyon loctor*) in one nest. Undeveloped eggs were not more than 436 and the embryos found were clasified in stages: 165 in stage 0 (35.55%), 202 in stage I (43.35%), 4 in stage II (0.92%) and 94 in stage III (20.18%). Average depth of nests was of 56.54 cm, varying between 32 and 95 cm.

EVALUATION OF LOGGERHEAD NESTING BEACH TEMPERATURES THROUGHOUT THE SOUTHEASTERN UNITED STATES

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One of the world's largest populations of loggerhead sea turtles nests in the southeastern United States. The loggerhead possesses temperature-dependent sex determination which has significant implication for the ecology and conservation of this turtle. The current study represents a comprehensive and simultaneous comparison of nesting beach temperatures throughout the range of major loggerhead nesting beaches in the southeastern U.S. As an example of the beaches examined in this multi-year study, during the 2007 nesting season, 26 nesting beaches were examined, ranging from South Carolina to Alabama, including 23 nesting beaches in Florida. The study also included both renourished and natural beaches, as well as controlled experiments examining the thermal effects of different sand types from renourished beaches. Beach temperatures were monitored with Hobo data loggers buried at mid-nest depth (40 cm) in areas of each beach where the majority of nesting occurred. In general, beach temperatures during the nesting seasons could vary depending on a variety of factors. Temperature variation was examined relative to beach location, sand type, weather, and beach topography. The results indicate that some beaches may be consistently warmer or cooler than others. The results also provide insight on the factors that contribute to the thermal characteristics of each beach. This information will facilitate the identification of nesting beaches which may be of particular management interest due to their thermal characteristics and sex ratio production. This study is sponsored by the Florida Sea Turtle License Plate Grants Program.

SEE TURTLE BEST PRACTICES: A PRACTICAL GUIDE TO CONSERVATION TOURISM

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Conservation tourism is a complex, multi-faceted endeavor whose integral nature is based upon a mix of social, economic, biological and conservation factors. To assure maximum benefits for all stakeholders involved, the goal

of conservation tourism goes beyond simple educational benefits to participating tourists and minimizing the tourism "footprint". Conservation tourism promotes conservation, reduces visitor impacts and provides for beneficially active socio-economic involvement of the local populations (Ceballos-Lascurin 1996). Often guidelines or standards are not considered in the implementation of conservation tourism projects, and this creates substantial room for subsequent environmental degradation and local socio-economic downfalls (Godfrey and Drif 2001). For example, increased crowds in sensitive areas may lead to population changes in animals as seen in the Humboldt penguin and Allen Cays rock iguana populations; garbage problems caused by over-visitation may diminish the natural integrity of the project site as seen in Tortuguero, Costa Rica; and local stakeholders may lose resources and suffer unemployment as seen in Ghana's Kakum National Park (Jaffe 2006). To address these issues, SEE Turtle, a pilot sea turtle conservation tourism project spearheaded by Ocean Conservancy, has developed a comprehensive list of best practices for general and sea turtle specific conservation tourism. These best practice guidelines will aid outfitters, tour guides and tourists in pursuing a sustainable practice of conservation tourism by minimizing sea turtle disturbances in natural habitats, preserving the integrity of each ecotourism site, assuring maximum education of the visitors, and enabling local participation and subsequent socio-economic improvements in the local community.

BASELINES, SLIDES, CLOCKS, AND THE ORIGINAL STATE OF MARINE TURTLES*

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There are powerful attractions for saving endangered animals, especially when they are charismatic flagship species like marine turtles. Yet, if conservation is not guided by clear and defensible objectives, the plans and actions may be driven by emotional reactions with little scientific justification, or even marketing ploys. One of the most important issues to be resolved is the goal of a conservation project: a clear end result must be articulated in realistic terms. Routinely such goals are framed as the recovery of populations to some desired level, and the concept of "baseline" is regularly used as a means to estimate population levels that occurred before undesired anthropogenic impacts caused population declines. Pauly's thesis of the "sliding baseline syndrome" clearly illustrates this approach, with the desired population level occurring before the "slide" to present, degenerated conditions. Implicit – and fundamental – to this paradigm are the assumptions not only that former baselines represent meaningful goals for conservation, but also that they were stable. Yet, this last assumption ignores the fact that both environments and populations are dynamic and in constant change. Hence, the selection of a baseline value depends on an arbitrary decision: how far back in time to digress in search of the "primary baseline," or in other words: when to start the clock. In the case of marine turtles, there are equally defensible arguments for selecting different baselines, for example, those which predate: human occupation of an area, or the arrival of a certain ethnic group, or the start of European colonization, or the industrial revolution. Independent of whichever baseline is selected, it is no less arbitrary than any other. As many archaeologists have explained: there is no original state of nature. Moreover, in the case of animals with complex life cycles like marine turtles, certain conditions (e.g., pre-European contact) may occur in certain parts of the geographic range, while different conditions (e.g., post-European contact) may occur in other parts of the range – all for the same individual animals. In the same token, with the late-maturing, long-lived characteristics of these reptiles, an individual can encounter certain conditions during one part of its life cycle, and very different conditions during a later stage. These life history features complicate the characterization of descriptive conditions that prevail during certain baseline conditions. Hence, constantly changing environments and complex life histories complicate the objective selection of benchmark baselines as conservation goals. Because of this, and other issues, despite claims of scientific objectivity, biological conservation is a socio-political activity; the incentives and goals can never be entirely separated from emotional and commercial motivations.

RENATURA: MARINE TURTLES CONSERVATION PROGRAM IN CONGO*

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Since 2000, the Renatura association has developed a marine turtle conservation program in the Republic of Congo (Congo-Brazzaville). Congolese beaches appear to be an important nesting site for both leatherback turtles (*Dermochelys coriacea*) and olive ridley turtles (*Lepidochelys olivacea*). Three other species are present along the Congolese shore: *Chelonia mydas*, *Eretmochelys imbricata* and *Caretta caretta*. The Renatura project now involves eighteen Congolese salaries and is built around three axes of action: 1) daily surveys on three nesting sites, ten kilometer-long each and weekly monitored of all the coast of Congo; 2) a program aimed to release marine turtles accidentally caught in traditional fishing gear; 3) awareness campaigns in schools, market places, and fishermen villages. The daily surveys consists in three patrols a day: two at night in order to observe marine turtles nesting. Each turtle is tagged (Monel tag) and measured, laying eggs are counted; a third patrol early in the morning to note down the new nests layed during the night, the nest destroyed by human or animal, and hatchlings. The daily patrols have permitted to drastically reduce the rate of turtles killed during nesting and to model the shape of the nesting season. Thanks to this model, an estimate of the number of nests layed on the entire Congolose coast monitored by Renatura association can be given; to collect data during four successive nesting seasons, on the same sites with the same methods and thus draft some global trends on the numbers of leatherback and olive ridley's nesting. The "releasing" program is based on agreements with fishermen. Renatura has negotiated with local traditional authorities to obtain those marine turtles accidentally caught in fishing nets to release them later. When a turtle is captured, the Renatura agents are phoned by fishermen to attest the release. In exchange, the Renatura association takes on the cost of the wire to fix the net frequently damaged by the turtle. The sawing work is done by fishermen themselves. This action takes into account the traditional structure of the Congolese society since the negotiations were led by the local traditional chiefs. Thanks to this agreement, more than 2,500 captures have led to a release, representing about 1,500 individuals saved from nets (since an individual is sometimes caught more than once). The data of the "Releasing" program have permitted to demonstrate the presence of a growing/grazing area used mostly by juvenile green turtles. Releasing data can also be used in a catch-recatch model to evaluate the number of marine turtles evolving along the Congolese coast. This approach gives an estimate of 2,500 juvenile green turtles in the Congolese shore water. Biometric criteria to appreciate the maturity of individuals have been established thanks to biometric data collected both on the releasing program and the daily surveys. As for the awareness campaign, several information campaigns take place throughout the year for inhabitants of Congo.

IS NEST RELOCATION WORTH PURSUING IN NORTH CAROLINA?

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Sea turtle nests that are at risk during incubation can be relocated to safer areas, to increase hatching success. Individual-based modeling exercises predict that modest increases in hatchling production may translate into population growth (e.g. Mazaris *et al*. 2005, 2006). Recent field-based studies have reported increases in nesting populations due in part to nest relocation activities (Dutton *et al*. 2005; Marcovaldi & Chaloupka 2007). However, there remains the question of whether nest relocation itself always results in higher hatching success. We investigated this question on Bogue Banks in North Carolina, a barrier island where loggerheads nest each summer.

We compared overall hatching rates for six years when local sea turtle volunteers relocated sea turtle nests vs. hatching rates for six years subsequently when no nests were relocated. Overall, hatching success per year varied, although the mean hatching success for each six year period was not significantly different. This suggests that nest relocation on this island may not be affecting population increase or decrease. However, there is evidence that some relocation sites are warmer, and thus relocation could lead to changes of hatchling sex ratios.

HAS THE TIME COME FOR A U.S. SEA TURTLE PROTECTION ACT?

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Sea turtle populations worldwide have plummeted over the last century due to human activities like egg harvesting, unselective fishing, and habitat destruction. All six sea turtle species found in United States waters have been listed on the Endangered Species Act as either threatened or endangered for nearly 30 years. This and several other laws should provide protection for sea turtles in U.S. waters. Nevertheless, many sea turtle populations continue to decline and none have recovered. Inadequate implementation and enforcement of existing laws has resulted in the failure to protect sea turtles. Sea turtles pose a unique conservation challenge, as enumeration of their populations is complicated, they reach sexual maturity at a late age, and they are highly migratory, crossing multiple regulatory jurisdictions and facing threats in each one. Existing legislation that should protect sea turtles will be examined, along with how, through implementation, it fails to accomplish the goal of sea turtle protection. New legislation that addresses the challenges specific to sea turtles is necessary if the species are to recover. Effective sea turtle legislation must include land and water protection zones, precautionary limits of sea turtle injury and death in commercial fisheries, and measures to ensure enforcement of those limits. Without improved management and active measures to promote their recovery these fascinating creatures that swam in the oceans at the time of the dinosaurs will disappear.

UPDATE ON THE CONSERVATION STATUS OF THE HAWKSBILL TURTLE IN THE YUCATAN PENINSULA (MEXICO)

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As in other regions, abundance of hawksbills in the Yucatan Peninsula (Mexico) prior to commercial exploitation is uncertain with scarce and anecdotic evidence in historical chronicles. They were considered abundant with tens or hundreds of thousands of individuals apparently present. During commercial exploitation beginning in the late 40s and into the 70s, official records indicate takes of 1,000/yr for the entire Peninsula, and between 100-300 breeding females per season and high levels of the traditional egg harvest in Campeche. The collapse in the populations by the early 70s had caused dramatic collapses provoking measures to end legal harvest, followed by extensive conservation programs on nesting beaches from 1977 onwards. Signs of incipient recovery were observable in the 90s, reaching about 5,600 registered nests for the entire Peninsula in 1999, making the population the single largest in the Atlantic basin and one of the three largest world wide. However, in spite of continuation of the beach protection measures with a better than 90% habitat coverage, the population exhibited a continued and steep decline

beginning in 2000. By 2004 the abundance levels fell to below 35% of the 99 maxima, recovered slightly in 2005-2006, but have continued of fall in 2007. None of the remaining major rookeries in the Wider Caribbean have shown any signs of declines. This and the satellite tracking of post-nesting hawksbills which demonstrate that breeders remain within Mexican territorial waters suggest strongly that the most probable impacts for this decline must be within Mexican habitats, most probably within marine habitats which have remained under studied and under protected. The critical situation has prompted attention and urgent action by Mexican authorities locally and by the Interamerican Convention for the Conservation and Protection of Marine Turtles (IAC) in order to identify causes and information gaps. At the national level a multidisciplinary technical meeting will be held in November, 2007 with the intention of compiling all available information and evaluate possible causes for the population decline, which will include the effects of incidental and clandestine take, from climate variations, pollution, natural phenomena such as hurricanes on nesting beaches. The conclusions from this workshop will be included as the major element for this presentation.

MIS/DISORIENTATION EVENTS FROM 2006 AND 2007 NESTING SEASONS IN BROWARD COUNTY, FL USA

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Florida is a major rookery site for Atlantic loggerhead (*Carretta carretta*) and important nesting grounds for green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*)sea turtles. South Florida is becoming a highly urbanized area with increased coastal development (i.e. condominiums, businesses, and hotels). Artificial lighting from these structures repels nesting females and impairs the natural cues used by hatchlings to orient to the sea, thereby increasing mis- and- disorientation events of the sea turtles. Florida Fish & Wildlife Conservation Commission (FWC) and Broward County Environmental Protection Department attempted to address this problem by relocating nests to darker beaches. Unfortunately, this alternative enabled residents and commercial businesses to prolong compliance to established lighting ordinances. In an attempt to have the lighting ordinances enforced, FWC recently ordered that fewer nests be relocated in Broward County, FL. As a result, many hatchlings during the nesting seasons of 2006 and 2007 were adversely affected by beach lighting and suffered high mortality due to exhaustion, dehydration, and predation. Municipalities with established lighting ordinances and the level of enforcement have identified areas in need of improvement and further enforcement. The effectiveness of existing ordinances has also shown strengths and weaknesses within the legal system. In addition, areas without lighting ordinances have been identified and proposed ordinances are currently being sought. The purpose of this project was to examine mis-and-dis orientation events over the past two nesting seasons, where less nest relocation occurred, in order to ascertain any significant differences. With this information, current lighting ordinances and proposed lighting ordinances can be modified to ensure the greatest survival rate for sea turtles.

EFFECTS OF PROLONGED RETENTION OF OLIVE RIDLEY HATCHLINGS IN GUATEMALA

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Sea turtle conservation in Guatemala relies entirely on the use of hatcheries, as the egg removal rate from nesting sites is known to be as high as 99.9%. Current laws do not prohibit the consumption and market of sea turtle eggs so

there is an egg donation system in place. Eggs are donated by local egg collectors to any of the 18 to 25 hatcheries along the 260km of Pacific coast. As many of these hatcheries are run with extremely low budgets, there are minimal staff, lacking scientific knowledge and operating with relatively weak conservation practices. Consequently, the release of hatchlings is based on poor scientific knowledge and many of the projects are only releasing their hatchlings at 6am. During this long period of retention inside the hatchery, the hatchlings are running around "in frenzy". Studies with other species of sea turtles have demonstrated that the hatchlings are likely to be loosing vital energy needed for terrain and marine dispersal. At various tourist villages, hatchlings are held until the Saturday sunset "hatchling races". Each morning the hatchlings are collected in the hatchery and retained in a dry bucket or holding tank of water for up to 6 days before the weekly "big event". Based on the results of previous research with other species of sea turtles, their energy levels are likely to be depleting rapidly, even hatchling deaths have been recorded due to their prolonged retention. The Saturday races attract many tourists to gather outside the hatchery where the hatchlings are sold and raced to the finish line some 10 metres towards the shore and the winner receives a free meal at a local restaurant. The hatchlings that were not purchased for the race are released at the finish line after the race has ended. Besides the issue of energy loss, this extent of hatchling retention is likely to be dramatically affecting their dispersal through altering their imprinting process and their vital navigation skills, which they instinctively learn immediately following hatching. Due to increased tourism at several beach towns, hotels are now replicating the races as a means of attracting more tourists and are claiming to be "eco friendly" by "helping the sea turtles". This research is therefore aimed at understanding the extent of the energy and speed loss with our local population of olive ridleys. This study involves measuring the change in running speeds and weight loss of hatchlings that are held back for varying periods of time. The data can then be used as a valuable tool to educate other hatcheries and hotel owners on the extreme importance of quick hatchling release to better the hatchling's chances of survival. However, if the data is to be used to its full potential, it is essential that CONAP (the Guatemalan Environment Protection Agency) authorises this study and recognises its importance. New regulations can then be formulated, based on the data from this study, to ensure the optimum approach to conservation of the local olive ridley population.

DEVELOPING AN APPROACH FOR ADAPTATION TO CLIMATE CHANGE IN THE INSULAR CARIBBEAN: THE HAWKSBILL SEA TURTLE AS AN INDICATOR SPECIES*

Lucy A. Hawkes and Carlos Drews

Future climate change may alter atmospheric circulation, potentially changing temperatures, weather cycles, wind and ocean currents. Coastal species, such as sea turtles, that use shorelines and other coastal marine ecosystems could therefore be greatly impacted. The World Wildlife Fund, through a grant from the MacArthur Foundation is working to develop an approach for adaptation options for endangered marine turtle management to climate change. In order to develop an approach, an initiative was formed: ACT (Adaptation to Climate change in the marine Turtles), an international initiative with an open door policy, operating as a network of interested specialists. Existing information about the hawksbill turtle (*Eretmochelys imbricata*) in the Caribbean was synthesised and major information gaps highlighted. Recommendations for future research were set out. A strategy to fill information gaps to aid in the design of adaptation measures was set out to include: selection of nest sites and adaptive capacity to change nesting locations; the genetic structure of hawksbill populations that will be impacted by climate change; hawksbill turtle sex ratios and their adaptability to altered temperature regimes; climate change as a driver of depensation effects; hawksbill foraging sites and the plasticity of hawksbill foraging strategies; coastal planning for climate change; communications and outreach; and finally to provide a link for marine turtle ecologists to climate science.

MARINE TURTLES: A VEHICLE TO UNDERSTAND AND ADAPT TO THE IMPACTS OF CLIMATE CHANGE IN MARINE AND COASTAL ECOSYSTEMS

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Data from the International Panel on Climate Change's fourth report now confirms with very high confidence that the rate of warming of our modern climate is unprecedented - global average air and sea temperatures have risen along with sea level and is very likely due to atmospheric increases in anthropogenic gases. Data describing biological systems, from polar terrestrial to tropical marine environments, demonstrate a coherent pattern of phenological and spatial change in accord with patterns of climate change. Marine turtles provide an excellent indicator and "umbrella" species with which to both investigate these effects and address them through adaptation. Marine turtles not only migrate between temperate and tropical zones, they also depend on habitats ranging from the coastal terrestrial to the oceanic marine zone. Changes in air temperature and rising sea levels could affect hatchling sex ratios and mortality, availability of nesting habitat, foraging habitats and even migratory corridors. WWF is building a regional partnership with other organizations to widely promote the two pillars of its program: ClimAware (What are the impacts of climate change to marine and coastal ecosystems?) and ClimAdapt (How can we respond with adaptation to the ongoing and upcoming changes?). We envision a network of key marine turtle nesting and feeding sites in which to monitor the impacts of climate change and the success of adaptation measures. Results from this project are to feed local, national and regional adaptation protocols and policies.

INDIGENOUS PEOPLE AND SEA TURTLE CONSERVATION IN GUYANA*

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Between the mouth of the Waini and Pomeroon rivers in the Northwestern region of Guyana, lies Shell Beach, a 140km stretch of beach and mudflats. Shell Beach is mainly known as the annual nesting ground for four species of endangered marine turtles -leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and olive ridley (*Lepidochelys olivacea*). Over the years, Shell Beach has been identified as a proposed Protected Area by the Government of Guyana with the Guyana Marine Turtle Conservation Society (GMTCS) being recognized as the Lead Agency for the management of the proposed Shell Beach Protected Area (SBPA). The wider Shell Beach area consists of several Amerindian communities who have traditionally harvested these turtles and their eggs for food and profit. In an attempt to reduce the harvesting of marine turtles at Shell Beach, in the 1960s scientists and two Amerindians combined efforts to appeal to fishermen and local residents to stop or greatly reduce sea turtle meat and egg consumption, and in some instances purchased the eggs and turtles from hunters in their effort to minimize sea turtle harvesting. Subsequently in 1988, this initial conservation effort developed into a successful pilot project; demonstrating that it is possible to bring about major conservation gains and protection of endangered species by working with user-group communities and cultures. This project carried out patrols along the beach during the breeding season and worked closely with the local Amerindian communities to prevent poaching during this period. The essence of this project, which still continues today, is the empowerment of the resident Amerindian peoples to become stewards of the resources upon which they ultimately depend. By involving communities into sea turtle conservation, it ensures that local knowledge of the species and the area are matched

with ecological knowledge, creating a project that is both scientifically sound and has regards for local uniqueness and culture. Recognising the importance of focusing on habitat management to effect species protection as well as the need to address the issue of sustainable livelihoods for local user communities, GMTCS has identified five main thematic areas for its activities, namely direct turtle conservation, education awareness, research, empowering local communities and promoting Shell Beach as a Protected Area. With the implementation of these thematic areas, to-date, there are approximately 10-12 community members directly involved in the sea turtle monitoring efforts with hundreds more participating in education awareness programmes, research and economically attractive livelihood projects such as Northwest Organics and Moruca Embroidery. Initiatives such as these allow community members to form Environmental Clubs, be hired as sea turtle wardens and employed by other agencies such as the Guyana Forestry Commission, and occupy leadership roles in their communities. This paper focuses on the history of the inter-relationship between conservation efforts at Shell Beach and the surrounding Amerindian communities, the conservation plans for Shell Beach and the principle programmes implemented and lessons learned.

SCIENTIFIC ASSESSMENT FOR ADAPTIVE MANAGEMENT OF THE NATIONAL MARINE PARK OF ZAKYNTHOS' SEA TURTLE NESTING BEACHES

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Scientific research is essential to select and evaluate management measures for the adequate conservation of wildlife. The National Marine Park of Zakynthos (NMPZ) was formed in 2000 on the foundation of precautionary protective legislations. Hence, scientific research was required to formulate a baseline from which to develop adaptive management of the region. In 2007, the NMPZ initiated a scientific programme with respect to the management of the loggerhead nesting beaches within the NMPZ area. Baseline information was collected with respect to (1) environmental parameters, (2) human-use and (3) loggerhead nesting activity. For all six nesting beaches (totaling 5.5 km in length) environmental data was collected using Trimble GPS, including (a) detailed mapping of beach-structure, (b) regular recording of surf- and storm-line (c) delineation of permanent transects at 50 m intervals across each beach, at which sand-moisture, sand-compaction, sand-content and beach-slope parameters were recorded, (d) recording sand temperature parameters (e) recording light-pollution levels. On nesting beaches with permitted visitor access (a) regular counts of beach visitor numbers were made, in addition to (b) visitor beach area use using Trimble GPS. On all nesting beaches sea turtle activity was recorded using Garmin and Trimble GPS units, in complement to the ongoing work of the NGO Archelon. During the nesting period, NMPZ research personnel recorded GPS locations of track apex, failed nesting attempts and successful nesting (including original and new locations of re-located nests). For 30% of nests the sand compaction, moisture level and elevation above sea level were recorded. During the hatching season, all nest locations were recorded using GPS units, while track orientation of 25% nests was recorded to evaluate sea-finding ability in correlation with the light-pollution assessment. For all excavated nests environmental parameters (roots, stones, rubbish, inundation) were recorded. A supplementary study, in collaboration with the Greek Ornithological Society was conducted to investigate seagull predation levels and appropriate management response. All data was transferred to GIS ArcView 3.3, on which environmental, human-use and turtle activity parameters were overlaid. The database was assessed to identify the overlap of human beach-use with turtle emergence/nesting sites. The information highlighted beach zones where further protection in the form of caging or tighter regulation on the beach visitor access/use is required. Environmental parameters of all the beaches were assessed in relation to nest sites to obtain information on sea turtle nesting patterns. Such information is important in order to identify areas where environmental parameters may be negatively impacting nesting activity and to determine the level of appropriate responsive management action. The scientific database will provide a sound baseline on which to (i) develop appropriate beach management measures, (ii) improve loggerhead nest protection management and (iii) conduct interannual assessments and predictive modeling to objectively evaluate existing and introduced management actions.

AN ASSESSMENT OF BEACHFRONT LIGHTING AT FOUR HOTELS AND THEIR EFFORTS TO PROTECT THE ENDANGERED MARINE TURTLES OF BARBADOS, WEST INDIES

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Artificial beachfront lighting is an increasing problem for sea turtle hatchlings and adult females. Barbados, the easternmost Caribbean island, exhibits particularly acute light pollution on the south and west coasts, which overlap one of the largest hawksbill sea turtle, *Eretmochelys imbricata*, rookeries in the region. A predominant source of artificial beachfront lighting is from hotels. To address the industry's impact, and following the recommendations of a 2000 national workshop titled "Sea Turtles and Beachfront Lighting: An Interactive Workshop for Industry Professionals and Policy-Makers in Barbados", four leading hotels participated in a six-month voluntary lighting assessment. The lighting assessments followed standard guidelines and a ranking system was developed to objectively evaluate each light fixture. The ranking system highlights fixtures most detrimental to sea turtle orientation, and encourages hoteliers to evaluate progress made toward sea turtle friendly lighting regimes over time. The results of the national assessment were presented to hoteliers and policy-makers, including mitigation recommendations for each light fixture and establishing a baseline for future assessments. The Final Report thanked the hotels for their participation, explained why their continued cooperation is critical to successful sea turtle reproduction, and directed them to helpful websites on how to obtain sea turtle friendly fixtures. The hotel industry bears responsibility for the effects of their properties on sea turtle nesting grounds; therefore, encouraging them to rectify beachfront light pollution is crucial to the management of sea turtle populations in the Caribbean and throughout the world. The study, and the willingness of major beachfront hotels to participate, provides a replicable model for other countries to follow.

THE IN'S AND OUT'S OF CITES: LESSONS LEARNED FROM IMPORTING AND EXPORTING SEA TURTLE TISSUE SAMPLES

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Due to the decline of sea turtle populations throughout past decades, all sea turtle species except the Australian flatback are listed as Threatened or Endangered under the Endangered Species Act of 1973 (ESA) and are listed as Vulnerable, Endangered, and Critically Endangered on the World Conservation (IUCN) Red List. These listings have resulted in federal and international laws for protection against over-exploitation and extinction. In addition to the ESA and the Red List, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a very important entity in Sea Turtle conservation. In 1975, CITES started implementing regulations of international import and export of wildlife specimens. CITES is an international agreement between governments that aims to ensure that the trade of wildlife is not detrimental to a species' survival. Countries join CITES voluntarily (known as Parties) and to date there are 172 Party Nations and over 30,000 species of plants and animals that are protected. Parties are able to regulate international trade through a system of CITES permits or documents to ensure that trade is legal, to monitor the type and volume of trade and to make certain that the trade does not threaten the survival of a species. Under these regulations all species of animals and plants are listed as Appendices I, II or III which provide different levels of protection based on how threatened or endangered each species is considered, although it is important to note that a species CITES category is not linked directly to its ESA or Red List status.

Nevertheless, all sea turtles are classified as Appendix I and therefore have the most stringent regulations in addition to other domestic laws. Appendix I species require two CITES permits, one from the importing country and one from the exporting country. It is important to note that obtaining a CITES permit alone is not sufficient for sample import and export. In addition to having a permit, the shipment of specimens must also be cleared by the country's appropriate enforcement agency to be considered legal. Since many collaborative scientific research projects extend across international borders, the exchange of sea turtle samples are extremely important to better understand the population status and distributions of sea turtles worldwide for their conservation and management. However the process of obtaining a CITES permit can be confusing, and the lack of consistency between countries has been problematic. At the NOAA-Southwest Fisheries Science Center we have many worldwide collaborators contributing samples to our tissue/DNA archive for permanent storage and for current and future research projects. With experience in importing and exporting thousands of sea turtle samples over the past few years, the CITES importation process has become clearer. This poster outlines optimal CITES procedures learned from various scenarios and our goal is to provide guidance to facilitate the import and export process for future collaborative scientific research.

STRATIFIED-RANDOM GREEN TURTLE ECOTOURISM IN NEARSHORE COASTAL ENVIRONMENTS

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We propose a conservation-oriented opportunity for humans to 'use' the endangered green turtle (*Chelonia mydas*) in a non-consumptive manner. Although the concept of a social safe-minimum standard analysis, as applied to the sustainability of ecotourism-dependent turtle watching, has focused on beach-nesting habitats, tourist activities also occur in shallow coastal habitats frequented by juvenile and adult turtles where they rest and feed on seagrass. When integrated over time, at space, such tourism activities may compromise turtle physiology in a manner that limits conservation goals for the species and hence the tourism. We identify research insights that can be used to achieve a creatively managed tourism – one that allows tourists to observe turtles in their natural coastal habitat in a manner that is commensurate with functional turtle conservation. The uncertainty surrounding the physiological impacts resulting from tourists in nearshore turtle environments demands tourism scenarios that minimize disturbance. We propose management options loosely based on whale-watching: i.e. voluntary and/or mandatory regulations based on home-range studies that identify localized temporal and spatial patterns of habitat use exhibited by turtles. We assume that if tourists frequent regular habitats at regular intervals the turtles will adapt to such disturbances via avoidance behaviour – to the detriment of the turtles and the tourists. We recommend temporally- and spatially-dynamic stratified-random-design ecotours that exclude critical regions of the local habitat and include the less-critical on a randomized rotational basis. Practical guidelines for tour operators that are founded in turtle habitat-occupancy patterns may ensure expanded life-history conservation measures and sustainable turtle-watching ecotourism.

THE ARRIBADA PHENOMENON AND PREDATOR SATIATION: EVALUATION OF NATURAL PREDATION ON A KEMP'S RIDLEY ARRIBADA

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The Kemp's ridley has historically been the most endangered sea turtle in the world and was near extinction in the mid 1980's. The majority of nesting occurs near Rancho Nuevo, Mexico. To prevent poaching and predation, nests have been relocated to protected egg corrals for the past several decades. Because of this and other conservation measures, the number of nesting females has steadily increased for over a decade. This was exemplified during the 2007 nesting season by a relatively large arribada that necessitated many hundreds of nests being left in situ. This provided an unprecedented opportunity to evaluate the effect of natural predation on unprotected nests. Several studies were conducted simultaneously. The first study compared predator abundance between areas with high nest density versus those with low nest density. This included the evaluation of predator tracks as well as direct observation using night vision equipment. Additionally, predator distribution was examined at multiple locations along a relatively long stretch of the natural nesting beach using predator track evaluation and automatic cameras. Finally, hatchling survival was evaluated during their movement from the nest to the water. The results indicate that the main nocturnal predators are coyotes, raccoons, and skunks. Additionally, ghost crabs, birds, and ants can impact nests and/or hatchlings. Predators typically frequented the area around each nest on a daily basis. However, there were a limited number of predators, and most hatchlings successfully reached the surf. The results are consistent with the hypothesis that the arribada phenomenon may enhance survival through predator satiation.

NGALPUN ADTHABAD A GOEYGAYIL BANGAL (OUR SEA, OUR FUTURE): AN EXAMINATION OF FISHERY GOVERNANCE ARRANGEMENTS FOR ZENADHAW MABAYGKA (TORRES STRAIT ISLANDERS) FROM A ZENADHAW MABAYGKA PERSPECTIVE*

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The UN Declaration on Rights of Indigenous People states that an Indigenous person has the right to participate fully at all levels of decision making in matters which affect their lives; they have the right to develop strategies for economic gains; and to own, develop, control and use their lands including waters and coastal seas. Zenadhaw Mabaygka (Torres Strait Islanders) are Indigenous (traditional) owners of the islands and seas that are located between Kie Daudai (Australia) and Migi Daudai (Papua New Guinea). Occupation of the islands and seas in Zenadh Kes (Torres Strait) by Zenadhaw Mabaygka dates back almost 3,000 years. Their traditional knowledge of their environment has evolved over the generations. Under Australian legislation the current fishery governance regime in Zenadh Kes is the Torres Strait Protected Zone Joint Authority (TSPZJA) which was established in 1984 under the Torres Strait Treaty between Migi Daudai and Kie Daudai. The TSPZJA sets out the regulations for Indigenous "traditional" non-commercial fisheries such as turtle and dugong and has a policy of maximizing opportunities for Zenadhaw Mabaygka participation in commercial fishing. For example TSPZJA require non-islanders to purchase an existing license to gain access to the Zenadh wapiw (Torres Strait fisheries). However,

Zenadhaw Mabaygka participation in the actual governance structure is in an advisory role, not a decision-making role for commercial and traditional fisheries (turtle and dugong). My research project examined the current management objectives of the TSPZJA and documented the aspirations and concerns of Zenadhaw Mabaygka with regards to the management of the Zenadh wapiw. As a Zenadhaw Mabaygka I used critical qualitative Indigenist methodology to both achieve this and identify the appropriate and practical governance rearrangements. The research presented me with some interesting situations where I, as an observer of the process, have had to question the position of Zenadhaw Mabaygka because of the strong personal attachment I have with the research environment. I was alarmed and worried to find that under current governance regime Zenadhaw Mabaygka have no direct say and virtually no power in the management of the Zenadh wapiw, and it was disheartening to discover that my mabaygal only could advise on fishery arrangements when sought. Furthermore, my research argues that the contemporary logic of the TSPZJA's commitment to protect both the way of life and the livelihood of Zenadhaw Mabaygka requires a governance regime that guarantees benefit sharing. In addition my data strongly suggest that (1) this guarantee can only be achieved through power sharing and (2) through management of fisheries that are both a way of life and livelihood of Zenadhaw Mabaygka and must involve them in all aspects. To reflect contemporary economic reality and Zenadhaw Mabaygka aspirations, the present governance regime requires a rearrangement of governance mechanisms, a re-articulation of the guiding principles and a modest amendment to the enabling rules. The rearrangements are needed to empower authentic participation in power sharing through decision-making processes that will accommodate Zenadhaw Mabaygka as key actors in the regime by acknowledging them as the principal stakeholders in the fisheries.

CHIEFS AND FISHING CLANS CONTRIBUTION TO TURTLE CONSERVATION IN THE SOUTH PACIFIC: LESSONS AND CHALLENGES FROM THE FIJI ISLANDS*

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Green turtle nesting populations in the central south Pacific including the islands of French Polynesia, Cook Islands, Tonga, American Samoa and Fiji are declining and continue to be in serious jeopardy. Estimates suggest 300-500 green turtles nest annually in these areas. Both flipper tagging and satellite tagging data suggests that these turtles migrate westward after nesting to foraging grounds with over 50% of returns coming from the Fiji Islands, apparently using the large areas of sea grass beds in Fiji. Fiji has a current moratorium on the capture of turtles but it is not enforced. There is also an exception to the moratorium for traditional use upon application to the Minister of Fisheries. As the prized turtles for traditional feasts are large fat adult green's the traditional take can have a substantial impact on the central south Pacific nesting turtle population. We estimate 1000's of turtles are captured annually in Fiji waters for sale, subsistence use and traditional purposes. In traditional Fijian society turtles were reserved for chiefs at their installment, marriages, births, deaths and chiefly meetings. The chiefs normally had a fishing clan the gonedau, who know the habitats and foraging areas for turtles and other prized fishes and obtain or even "call turtles" when required. In some cases the clans had turtles as totems or were the only ones who could eat turtles. While many traditions have broken down, the fishing clans are still called upon to supply turtles and other marine species to their chiefs. These clans, due to their extensive marine knowledge, are not only good fishers but also engage in illegal capture of turtles and other proscribed species. This paper will present examples and lessons learned from Fiji to show details of the approach of working with traditional chiefs and fishing clans to implement conservation measures. Early success has been achieved in two cases whereby nesting beaches are under traditional protection and the traditional fishers are assisting in turtle tagging programs and protecting foraging grounds. A notable failure occurred when fishers in one area under the direction of their chiefs captured about 90 turtles for the Methodist Church of Fiji's annual convention in spite of receiving permission for only nine. This has, however, mobilized public opinion and offers a challenge to us to increase awareness among the chiefs and elders to achieve effect conservation and sustainable use.

ECOLOGICAL RECOVERY OF THE DAMAGED BEACHES IN THE FRENCH WEST INDIES, A STAKE FOR MARINE TURTLES

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Marine turtles spend one percent of their life on the beaches for nesting but this act is vital for the permanence of these species. Martinique and Guadeloupe are subdivided into several nesting beaches with different aspects, size, morphology, quality of the substrate, and human beachgoing. Most of these beaches are administrated by the National Forest Agency in Martinique and by the Coastal Conservatory in Guadeloupe. The laws protect the natural beaches but a new law protects not only the marine turtles but also their natural habitats. The degradation of the nesting beaches is one of the major threats for the three main species of marine turtles in the French West Indies (hawksbill, leatherback, and green turtles) with poaching and accidental fishing nets bycatch. So, the recovery of the nesting beaches is one of the priorities for the Recovery Plan for marine turtles in the French West Indies validated by the French government in April 2006. In January 2006, the National Forest Agency of Guadeloupe, administrator of a large part of the natural beaches, with the NGO Kap Natirel, coordinator of the marine turtles network of Guadeloupe, wrote up a technical guideline in French to take marine turtles into account in the development and the recovery of the coastal forest. In act, this guideline has lead to the recovery of the beach of Cluny in Guadeloupe. In Martinique, the NGO SEPANMAR defined in 2005 the level of quality/damage of the beaches and now with the National Forest Agency, is scrutinizing beach by beach the state of each one and promoting adapted recovery actions, like plantation and control of the human beachgoing. These actions need time and financial investments supported by several actors: French Government, Local Communities (Regional and Departmental Councils), and Europe. The aim of the actions taken in the field is to find a compromise between marine turtle terrestrial habitats and the necessary attraction need for tourism, one of the main economic activities of both of the islands. Recently in Martinique and less in Guadeloupe, Hurricane Dean had completely damaged the nesting beaches destroying nests, trees, leaves, branches and depositing sand on the bottom of the beaches. The aspect of all beaches is modified and their recovery is now a reality.

MASSIVE CAPTURE OF NESTING FEMALES IS SEVERELY THREATENING THE CABOVERDIAN LOGGERHEAD POPULATION

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The loggerhead population from Cape Verde is one of the most important in the world. Turtles nest on several islands from this archipelago but around 90% are using the island of Boavista. In 2000 the estimation of annual nesting females in Boavista was around 5000 individuals. However, the capture of nesting females for human consumption is a widespread practice in the local populations that could be killing more than 25% of nesting females every year. The decline of turtle abundance in other islands is now increasing the hunting pressure on

individuals that nest on Boavista. During the 2007 nesting season we have estimated that only 3000 females have nested on the island and more than 800 have been killed in unprotected beaches. To this severe mortality we have to add the capture of females at sea. On protected beaches the number of nests remained stable during the nesting season. However, on non-protected beaches and due to the strong nesting site fidelity within the season, the number of nests drastically decreased during the second half of the nesting season. Unfortunately, some females that nest on the protected beaches will use unprotected ones during future nesting seasons. Thus, it is not possible to guarantee the survival of any female by protecting only some of the nesting beaches. Demographic models are being calculated in order to predict the population dynamics, their risk of extinction in the next decades and the conservation criteria needed to reverse the current trends.

BE THE TURTLE: MR. LEATHERBACK'S QUEST TO SAVE HIS SPECIES

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Mr. Leatherback is an adventurous world traveler. He is friendly, huggable, and photogenic. He is a parade-quality, life-sized leatherback sea turtle. In the past two years he has visited two Sea Turtle Symposiums, the pyramids of Giza in Egypt, the Space Needle in Seattle, the Roman Colloseum, and the Statue of Liberty. He has witnessed the eruption of Old Faithful, felt small beside the Golden Gate Bridge, stood knee deep in Andean grass, and even met his spiritual side with Tibetan monks. He has also raised money at fundraising events, served as emcee of the Great Turtle Race and spent a week educating children at the Gumbo Limbo Nature Center in Florida. And all of these events have been captured on film. Through his travels and his internet savvy, Mr. Leatherback has also made 5,000 friends on his MySpace.com profile, and enlisted 15,000 people around the world to sign his "plastics pledge". These friends ask Mr. Leatherback for advice on which seafood to eat, how to help save sea turtles, where they are found, and more. They also post supportive comments, spread messages to their friends, and vow to stop using plastic bags. Mr. Leatherback's aim is to educate the world about the drastic plight of the amazing leatherback sea turtle, and to inspire changes in human behavior. This presentation will focus on Mr. Leatherback's philosophy, his successes in reaching and touching people, and the challenges ahead.

FIRST MARINE TURTLE INVENTORY IN THE DEMOCRATIC REPUBLIC OF CONGO (DRC) -ATLANTIC COAST OF AFRICA -GULF OF GUINEA-: DRC IMPORTANT SITE FOR OLIVE RIDLEYS

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With a surface of 2,345.409 km² DR Congo, formerly Zaire, occupies 40 km of Atlantic coastline, which coincides with the outlet of the Congo River in the south. Not much was known on this large country, concerning nesting, or any existing exploitation of threatened species. First data on marine turtles in DRC was presented in the publication of the Convention on Migratory Species: "CMS Technical series Publication N°6: Biogeography and conservation of marines turtles of the Atlantic coast of Africa" by Dr Jacques FRETEY in 2001, which is primarily based on anecdotic knowledge. In 2002, a first survey by the Congolese Institute for the Conservation of Nature (ICCN) was executed, showing the presence of different species of marine turtles and its consumption. From September 2006 till March 2007, with financial support of WWF, a more profound inventory was done by the NGO ACODES collecting information on nesting and exploitation of the different marine turtle species on the Congolese coast. A summary of

the results of this first inventory in DRC are presented here. Of the total of 594 turtles observed, all species and age classes together, 95% were Olive ridleys and of that same total 97% (474/494, see table) were used for consumption. Marine turtles captured (by traditional fishing practices) at sea were from different age classes and both male and female, indicating the presence of a mating and foraging area (for juveniles) not far offshore. For conservation on national level, these results also permit the rectification of the Congolese hunting law 82-002 of 28 May 1982. This law protects the Loggerhead, the Hawksbill, the Green turtle and the Leatherback turtle, whereas this study shows the multiple threats the Olive Ridley turtle faces (on land and at sea), as well as the presence of the species, and no evidence on the presence of Loggerhead or Hawksbill turtles. Remarkably, less than 10 years ago the autochthonic coastal population in DRC didn't even touch these animals because of cultural restrictions. Even today the turtle still has an important symbolic value. This first inventory shows an extremely high percentage of exploitation of marine turtles, pointing out the need for action from the national government as well as from conservation organisations and the international community.

PROBLEMS FACING CONSERVATION OF SEA TURTLES IN JAPAN

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Japan was recently ranked as the country most detrimental to sea turtle conservation (Spotila 2004). However, it is doubtful whether this is based on sufficient information. In this paper, the authors would clear the misconception about Japan and will explain problems facing conservation of sea turtles in Japan. These problems include 1) coastal bycatch in small scale fishing, 2) nesting beach habitat loss caused by serious beach erosion and beach armaments, 3) some NGO's events harmful to hatchlings, which are collected and kept to be released later by tourists, 4) imprudent eco-tourism which leads to stomp pre-emergent hatchlings and 5) negative effects of vertically-segmented administrative system.

SEA TURTLE KILLING AND CONSUMPTION ON THE MEDITERRANEAN COAST OF EGYPT*

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Past surveys showed high levels of intentional killing of sea turtles for consumption in Egypt. The potential impact on Mediterranean populations of *Caretta caretta* and *Chelonia mydas*, using Egyptian coastal waters as neritic foraging grounds and migratory corridor, makes reducing this threat one of the top priorities for turtle conservation in the basin. However, despite intensive awareness campaign and the Egyptian government efforts to reinforce environmental laws and legislations to conserve marine turtle, exploitation and illegal trade are still occurring in several fishermen communities along the Mediterranean cost of Egypt. In this paper we provide rigorous assessment to: 1) mapping out of fishermen communities residing in the Mediterranean coast and the impact of their fishing practices on marine turtle population; 2) different socio-economic factors that affects fishermen's perceptions and practices related to marine turtles conservation and why they differ from one community to the other; 3) influence and power status of key formal (governmental and non governmental) and informal institutions on the governance of natural resources and the outcomes of conservation initiatives. Results show that human consumption of loggerhead (*Caretta caretta*) and green turtles (*Chelonia mydas*) is one of the long-standing threats facing the two species. Black market for illegal trade of marine turtles still exist in Alexandria governorate, a very significant percentage of fishermen are still predating on marine turtle, and poaching of eggs was witnessed in North Sinai. Awareness

programs conducted by non-governmental organizations and efforts by the state to enforce the law are facing difficulties because: 1) consumption of marine turtles is one of the key cultural features of some of the fishermen communities along the coast; 2) weakening social capital among fishermen communities as a result of urbanization and modernization, fading informal institutional set up and the role of the community leaders in resolving conflicts and setting up and enforcing fishers practices; 3) failure of the government to involve fishermen in setting up an agreed to regulatory mechanism to govern fisheries, which include measures related to conservation of endangered species. We argue that the way forward for conserving marine turtles should go beyond setting up conservation measures for the species to explore means for better instituting mechanisms that enhance accountability, transparency and inclusiveness in the decision making process of fisheries. Acknowledgements: Participation at the Symposium was possible thanks to a travel grant by the Sea Turtle Symposium and the following organizations: Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, as well as two generous individuals: Carlos Peralta Quintero and Robert N. Allen, Jr.

SEE TURTLES: PROTECTING SEA TURTLES THROUGH CONSERVATION TOURISM

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The typical ecotourism mantra has been to “leave no impact,” but SEE Turtles suggests that tourists should make an impact – a positive one – by directly aiding conservation. SEE Turtles is a pilot project of the Ocean Conservancy that connects travelers to important sea turtle sites by steering vital economic activity to deserving communities to help them understand and benefit from the value of the wildlife in their local environment. In short, the sea turtles are worth more alive than dead. SEE Turtles has chosen three important turtle regions in the Western Hemisphere to be the focus of a pilot effort to encourage tourists to invest their travel dollars where they will have the most impact. Expeditions recommended by SEE Turtles provide travelers with an opportunity to experience sea turtles in their natural habitat—in the water, around coral reefs, and on the beach. Travelers come away with a real appreciation for the beauty of sea turtles while knowing that their travel dollars have been spent in communities that truly benefit from the income. Eventually, SEE Turtles will include sites around the world. How will SEE Turtles protect turtles? a) Tourism generates alternative income to fishermen and potential poachers so they will not have to rely on activities that threaten turtles and/or provides a financial incentive to members of the community to protect turtles and support conservation efforts. b) Tour fees and donations increase resources for local conservation efforts. c) Best practice guidelines provided by SEE Turtles will limit tourism’s negative impacts on turtles while fostering positive impacts at SEE Turtles sites and beyond. d) Seeing turtles inspires continued involvement in conservation efforts long after the trip ends.

THE ROLE OF INDIGENOUS COMMUNITIES IN SEA TURTLE CONSERVATION EFFORTS IN THE NGÖBE – BUGLÉ COMARCA OF PANAMA*

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Sea turtles have long been of economic value to coastal residents of the Bocas del Toro region of Panama, and recently they have become an important resource for growing Ngöbe – Buglé communities. Chiriquí Beach was described by Dr Archie Carr as one of the most important nesting beaches for hawksbills (*Eretmochelys imbricata*) in the Caribbean. The historical importance of the hawksbill to the economy of people along this coast dates back centuries, when they were hunted extensively for the international tortoiseshell market. In more recent times, Chiriquí Beach was leased to 'veladors' who gained exclusive rights to all hawksbill turtles nesting in their one-mile section of beach. Such intensive hunting pressure presumably contributed to the significant decline in hawksbill nesting recorded during aerial and ground surveys in the 1980's. It was the indigenous Ngöbe communities that first acknowledged that the turtles needed protection. In 1995 Rio Caña residents took the first steps towards protecting hawksbills nesting on Chiriquí Beach by forming a community group, the Association for the Protection of the Ngöbe-Buglé Natural Resources (APRORENANB). Early turtle conservation efforts were rudimentary, hunting of turtles was only permitted every other year; but this initial effort revealed a community awareness of the responsibility to protect their vulnerable natural resources. Short periods of research at Chiriquí Beach from 1999 to 2002 confirmed the decline in hawksbill nesting activity, and provided preliminary information about the threats they faced. Discussions began in 2002 among a consortium of interested organizations, national authorities, local conservation groups and the region's indigenous communities, to assess interest in establishing a long-term hawksbill conservation program in the area. The objective was to promote an increase in the small residual hawksbill population nesting in the region. Research activities began in 2003, with the support of the indigenous communities. Their approval was formally confirmed with the signing in 2006 of a Memorandum of Understanding between the Ñö Kribo Regional Congress of the Ngöbe-Buglé Comarca, Caribbean Conservation Corporation and the National Environmental Authority of Panama. Since the project's inception nearly all personnel involved in the monitoring aspects have been members of the Ngöbe communities of Rio Caña and Rio Chiriquí, which border Chiriquí Beach. The project currently employs 19 people; 10 beach monitors, 6 cooks, a boat captain, a local field assistant, and a watchman. An important objective of the project has been to raise awareness in neighboring indigenous communities of the plight of sea turtles through environmental education activities. Efforts have also been made to promote turtle conservation within other autonomous indigenous regions in Panama. The project can boast many successes; the illegal take of hawksbill females and eggs has been essentially eliminated on Chiriquí Beach, monitoring effort has increased, there is evidence of greater awareness of turtle conservation within the region, and a change in attitude has occurred towards nature conservation in general by local residents. Much remains to be done, but the involvement of the local communities from the outset of the project has been pivotal to its success.

DEFINING 'CONSERVATION PHOTOGRAPHY': CASE STUDIES USING SEA TURTLE IMAGERY

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Several descriptions of the term 'conservation photography' have been published (Gulick 2005; Mittermeier 2005; Ward, Jr. 2004), however the term currently eludes a clear definition. 'Conservation photography' is born out of purpose and may showcase the vanishing beauty of our planet and its disappearing spirit, or 'conservation photography' may be described as the result of photographic talent combined with environmental understanding and conservation commitment (Mittermeier 2005). Alternately, a 'conservation photographer' may be identified if their imagery has a direct influence on the establishment of protected areas (Ward, Jr. 2004). Despite a clear understanding, early and present day practitioners of this genre of photography have made convincing efforts to identify the value and purpose of 'conservation photography' (Cahn & Ketchum 1981; Quammen 2001). Is a picture really worth a thousand words? Can an image or series of images elucidate a conservation issue and prompt people to take action? Do photo editors and conservationists chose imagery to represent these issues without considering what the cognitive sciences have taught us? I investigate these questions and purpose a definition of 'conservation photography' that will clearly identify the practice and more effectively allow the term to be communicated, while examining two case studies utilizing sea turtle imagery. Preliminary findings in a study of rapid visual stimulation suggest participants remember images existing within pre-determined categories using a variety of 'identifiers' including colors, content, composition and esthetics. These findings were tested in environments with audio omitted and primary and recency effects controlled. In a second study, a quantitative assessment of the frequency of sea turtle images viewed from the 'seaturtle.org' picture library, suggests 'content' is a favorable characteristic for the choice of an image rather than other image 'identifiers'. References: Cahn, R and Ketchum, R.G. American Photographers and The National Parks. National Park Foundation. 1981. Gulick, A. Connecting People and Wildness through Images. World Wilderness Congress. 2005 Mittermeier, C. Conservation Photography: Art, Ethics, and Action. International Journal of Wilderness. (April 2005). pg. 8-13. Quammen, D. Megatransect II. National Geographic Magazine (March 2001). pg. 2-37. Ward, Jr. Finding Nature's Frame. Watershed. (Fall 2004). pg. 35-45.

SEA TURTLES AND THE NETWORK FOR OAXACAN COASTAL WETLANDS: AN EXAMPLE OF A TRUE COMMUNITY-BASED CONSERVATION PROGRAM

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The Network for Oaxacan Coastal Wetlands (Red de Humedales de la Costa de Oaxaca) is a regional organization that gathers 22 community groups that work in favor of the conservation of natural resources under a scheme of community-based conservation. It was a result of a set of workshops on wetlands restoration promoted by Lagunas de Chacahua National Park in 2001, 2002 and 2004. After 2003 several communities decided to form committees which integrated several conservation activities. Over the years the groups exchanged experiences and gradually consolidated to integrate formal cooperatives. In 2004, the group got legal status as a Union of Cooperative Societies. Throughout its history, the conservation of sea turtles was a major focus for the group. The Sea Turtle Conservation Program (PROTUMAR) is operated by the Network as part of its strategic line of wildlife management and conservation. It supports the conservation of the three species of sea turtles that nest in Oaxaca: the olive ridley, the leatherback turtle and the Pacific green turtle. PROTUMAR comprises the direct participation of five community groups located in five important nesting beaches of the coast of Oaxaca. In total, it has 50 individuals from the communities of La Ventanilla, El Tomatal, Los Naranjos, Cerro Hermoso and La Tuza. Each of these communities runs a turtle camp that carry out night patrols, egg relocation to hatcheries, surveillance and release of hatchlings during the nesting season from August to April. PROTUMAR receives technical advisory from Kutzari AC as part of its Technical Advisors Council.

SHELL BEACH: A PILOT PROJECT FOR PROTECTED AREAS IN GUYANA

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Shell Beach, situated at the mouth of the Waini River, is a 90-mile stretch of beach along the North-Western part of Guyana. It serves as a nesting ground for leatherback (*Dermochelys coriacea*), olive ridley (*Lepidochelys olivacea*), green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) sea turtles, as well as habitat for scarlet ibises, dolphins, manatees, tapirs and monkeys. The uniqueness of Shell Beach is derived from it being a massive stretch of ecologically intact, undeveloped tropical coast with vast mangrove ecosystems. Shell Beach was identified as one of five priority sites in the National Biodiversity Action Plan (1999) as part of a National Protected Area System. Out of these five sites, it is one of two to have been identified as pilot projects in establishing the process for creating Protected Areas. As a result of the numerous studies conducted in the area, it has been established that Shell Beach has the required ecological, social and cultural considerations necessary for being a priority site for a Protected Area. A rapid biological assessment was conducted at the area in 2005. The Guyana Marine Turtle Conservation Society (GMTCS) is the first Non-Governmental Organization established for the protection and conservation of marine turtles. It was founded in April 14, 2000, with a vision to promote the establishment of a proposed protected area, and is a member of the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). The EPA has identified the GMTCS as the lead organization for the Shell Beach Protected Area Process. It is also involved in the sustainable management of a stretch of Crabwood Forest and the Development of North West Organic Products. Delineation Project: The EPA/GFA is currently spearheading a Delineation Project on the Shell Beach area funded by the German Development Bank (KFW). Currently, the team is conducting meetings with the residents of Shell Beach. To date, the indigenous communities have expressed their support of the delineation process and the general consensus is that Protected Areas should enable access to employment and provide benefits. Although traditional methods are still practised, opportunities to obtain secondary and tertiary education are limited. Health services are inadequate and job opportunities are generally restricted to mining and logging activities. KFW Small Grants Project: Presently, the German Development Bank is assisting local communities in and around the proposed protected area by providing grants for sustainable livelihood activities. It is anticipated that these community projects will contribute to the long-term success of the Guyana Protected Area System Project. These Projects include the construction of a Multi-purpose Building at St. John’s Community and a Guest House at Warapoka. Next Steps: It is expected that with continued support from sector agencies, Shell Beach will become a Protected Area which will ensure conservation of rare, endangered and threatened species, through habitat maintenance and management, and at the same time, protecting cultural values and creating sustainable livelihood opportunities for indigenous communities.

ARE WE SUCCEEDING? MONITORING AND EVALUATION STRATEGIES FOR MARINE TURTLE PROJECTS

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Many of the world's marine turtles populations are threatened by anthropogenic processes and each of the seven species are listed as threatened by the IUCN. Consequently, marine turtle conservation projects have gained momentum and they now exist in dozens of countries throughout the world. These projects are run, managed, and funded by a large array of institutions and often involve considerable amounts of time, money, and support. Furthermore, in order to achieve the desired conservation outcomes these project's resources often need to be delivered to programs and projects over long timeframes. Thoughtful monitoring and evaluation planning and implementation can provide invaluable information for keeping track of project (or program) progress and determining, demonstrating and sharing success/impact. Defining "success" and how to assess it are fundamental issues that often lead to project and program evaluation being placed in the "too hard basket". There are a plethora of potential indicators to choose from (biological, social and economic), and this can seem daunting. Resource limitations also mean not every aspect of a project can be subject to collection of monitoring and evaluation data. What is needed is a clear and explicit description of how the project expects to achieve its intermediate and ultimate objectives for the project. This 'theory of change' or 'program logic' can then be used as the framework on which to hang the design of a suitable monitoring and evaluation plan. The program logic can then be used to guide selection of suitable indicators that will provide information on the implementation, outputs, and outcomes of the project. In this presentation we apply "program logic" to a medium scale turtle and dugong conservation project in Torres Strait, Australia, as an example of how a relatively simple, but hopefully powerful, project monitoring and evaluation plan can be developed.

USING GPS AND GIS TO ADDRESS LIGHT POLLUTION PROBLEMS ON FLORIDA'S SEA TURTLE NESTING BEACHES

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Light pollution on Florida's beaches is endangering the lives of nesting sea turtles and their offspring. Artificial light alters vital nocturnal sea-finding behaviors and ultimately leads these remarkable creatures to their death. In Florida, the number of hatchling disorientations is on the rise due to the exponential increase in coastal development and its associated light pollution. In fact, the number of disorientations rose from 976 in 2005 to 1,521 in 2006 (FWC, 2007). Dealing with the copious amount of disorientations on a statewide level with limited staff and volunteers is a daunting task. In response, the Florida Fish and Wildlife Conservation Commission (FWC) began a pilot program during the 2007 nesting season to address the increasing number of hatchling disorientations using Global Positioning System (GPS) and ESRI's Geographic Information System (GIS). Initiated on the Southeast coast of Florida in Broward County, marine turtle permit holder volunteers began collecting GPS coordinates of the light source(s) that were disorientating hatchlings. Using FWC's hatchling disorientation report forms, the latitude and longitude coordinates of both the nests and the hazardous light source(s) were recorded in addition to other pertinent information regarding the disorientation. This data was entered into a database and exported as a shapefile to ArcGIS. The shapefile was superimposed on the most recent cadastral layer from the Broward County's property appraiser database, in order to identify subject coastal property owners responsible for the light source(s) allegedly causing the disorientation. The property owner information was extracted to an Excel spreadsheet, which automatically populated the contact field of a template violation letter. Letters were sent notifying the property owner, as well as local code enforcement officers, of the problem light source(s). Included for the officers were maps of the location of the property owners in violation in order to allow for immediate warnings to be served. Although the results of the 2007 nesting and hatching season have yet to be completed, the use of GPS and GIS technology has proven to be a valuable time saving tool in dealing with the significant amount of sea turtle disorientations. Preliminary data suggests that this new system has helped to significantly decrease nesting and hatchling disorientations.

EGG TAKE AND ARTIFICIAL INCUBATION: A CONSERVATION TOOL IN THE DOMINICAN REPUBLIC

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Egg take is the major threat to the remnant populations of sea turtles nesting in the Dominican Republic. At Jaragua National Park (JNP; Southwest DR), if no action is taken, egg take can be close to 100%. To face this problem, Dominican biologists and rangers of the Reserve started artificial nest incubation in plastic and Styrofoam boxes 35 years ago. The rangers collect the eggs and transport them into an enclosed building for incubation in a process that has not, as yet, been subject to detailed scrutiny. In 2006, the eggs were illegally taken for consumption from 68% of clutches, while rangers incubated 24% and only 8% were incubated in situ. In 2007, surveillance and enforcement of laws are curtailing illegal take of eggs and increasing the number of clutches incubated artificially. Here we compare hatching success between artificially incubated clutches and those incubated in situ for the leatherback (*Dermochelys coriacea*; n= 60; 19 in situ and 41 artificially incubated) and hawksbill (*Eretmochelys imbricata*; n= 7; 1 in situ and 6 artificially incubated) turtles in the nesting seasons of 2006 and 2007. All leatherback in situ clutches studied hatched, whilst only 78% (32) of artificially incubated clutches were successful. It is thought that failure was mainly due to suboptimal collection and/or transportation of eggs. Of the leatherback clutches we detected no statistical differences between those nests successful incubated in boxes [median (IQ range) hatching success= 59.7% (51.8-69%)] and those nests incubated in situ [56.5% (40-85.1%); Mann-Whitney test: Us= 299.2, p= 0.93]. The central tendency of these parameters is within the range of hatching success reported from other nesting rookeries around the world. Due to high level of egg take from hawksbill nests, we could not obtain enough clutches to perform statistical comparison between groups. Five of 6 clutches artificially incubated produced hatchlings (mean±SD hatching success= 67.9±27.7%; n= 5), whilst the single in situ hawksbill clutch studied had a success of 83.4%. It is important to control incubation temperatures when clutches are artificially incubated, not only to obtain maximum hatching success, but also to achieve the optimal sex ratio. Studies on incubation temperature are in progress to validate and/or inform to modify this conservation activity undertaken at JNP for many years.

RESULTS OF 21 YEARS OF PROTECTION OF THE OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA)* CAMP LA GLORIA (PLAYON DE MISMALOYA SACTUARY, JALISCO, MEXICO)

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This work shows the results of 21 years of the sea turtle protection activities at La Gloria camp. We can see important increases starting in the 90's, and the same happened in 1996 and 2000 (560, 816 and 1,163 nests, which represented 54,782, 13,582 and 112,135 eggs respectively). This same behavior has been seen in some other locations along the Mexican Pacific Coast. To date, 1,801,455 eggs have been protected, resulting in the release of 1,350,357 hatchlings. It is important to note that these increases in nest collection numbers are not only due to the moderate increase in the turtle population, but also thanks to the development of better collection facilities through the years. We now have motorcycles for the beach, gasoline, etc., as well as the participation of the following intities: Fishing Cooperatives La Cruz de Loreto (with more than 15 years participating), the Marine Secretary of México and the individuals living in the zone. The participation of the federal authorities has also been important to stop human predation, which has been a tradition for more than six decades.

FLORIDA'S BEACH RESTORATION PROGRAM: MANAGING IMPACTS TO BEACH AND NEAR SHORE HABITATS

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Erosion due to storms and shoreline retreat along Florida's marine turtle nesting beaches impacts rookeries of threatened loggerhead, endangered green, and endangered leatherback marine turtles both through reductions in sandy beach width and elevation and through compensatory measures such as beach nourishment and coastal armoring intended to reduce risk of damage from storms to upland structures. Increasing beach width and elevation through sand placement or beach nourishment alters nesting behavior by loggerhead and green marine turtles, resulting in shifts in nest site placement, increases in false crawls, or decreases in the number of nests deposited. Impacts to hatchlings include subtle alterations in the incubation environment that can affect development, hatch and emergence success and increased disorientation as nests on the elevated berm are more vulnerable to landward lights. Coastal engineers often attempt to maximize protection of shorefront real estate by maximizing the width and height of the sand fill, sometimes obliterating near shore reef or hard bottom communities that provide important habitat for juvenile green and other marine turtles. The performance of sand placed over near shore hard bottom is not well understood, and can result in unpredicted movement and spreading of sand across nearby and more distant hard bottom and reef communities. Rigorous, precise and accurate monitoring of the near and along shore habitats, while not a controlled manipulative experiment, does provide important information that managers can assess to determine impacts due to such beach restoration projects. Information on epibenthic community composition, sediment burial, substrate heterogeneity and occurrence of marine turtles has been required for several beach nourishment projects along Florida's east Atlantic Coast. Similar measurements are collected on the artificial reefs constructed to mitigate, or offset, impacts to natural hard bottom lost during the beach nourishment project. Preliminary comparisons of benthic communities and associated fauna on natural reefs before and after beach nourishment suggests that such sand placement can impact adjacent subtidal communities through direct burial and

near shore and off shore transport. Increases in chronic turbidity can also occur as waves hitting the fill berm resuspend finer sediments and particulates. These and other impacts from sand placement can result in loss of important near shore communities and shifts by more mobile components, such as larger fish, invertebrate and vertebrates species such as marine turtles, to adjacent reefs. Such shifts could result in increased inter and intraspecific competition for limiting resources or increased predation. Thus, sand fill impacts to reef communities immediately adjacent to the beach could be dispersed to communities and species farther offshore or along the beach.

PARTICIPATORY SEA TURTLE CONSERVATION STRATEGY IN THE PACIFIC COAST OF NICARAGUA

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Four species of sea turtle nest and inhabit waters of the Pacific coast of Nicaragua, being an important element of the culture, economy, and environment in the region. Several threats affect these reptiles, being the most relevant: poaching of eggs, target and incidental fisheries and coastal development. An obstacle to achieve an effective conservation of these reptiles was the lack of framework that could orientate actions in order to address this situation. Between 2005 and 2006 the environmental ministry of Nicaragua (MARENA) and Fauna & Flora International (FFI) facilitated the development of a Sea Turtle Conservation Strategy through a wide participatory process. After a fast diagnosis phase, several workshops and meetings involving key stakeholders were performed in order to achieve consensus over the main topics relevant for the conservation of the species. A vision for sea turtle conservation in the region was established as well as roles and responsibilities for each major group of stakeholders. Five principal objectives for marine turtle conservation on the Pacific coast of Nicaragua can be summarized as follows: (1) Coastal-Marine Conservation: To contribute to marine turtle population recovery, via the conservation of marine and coastal ecosystems and by significantly reducing marine turtle mortality resulting from incidental and intentional fisheries; (2) Protection of Nesting Beaches: To promote the protection of areas critical for nesting marine turtles both within and outside protected areas, via appropriate and improved management mechanisms; (3) Alternative Livelihoods: To establish the socio-economic and political conditions necessary for the promotion of scientifically-sound and sustainable alternative income-generation options based upon marine turtles and their ecosystems (eg. tourism), and thereby contribute to improved livelihoods for local communities; (4) Monitoring and Informed Natural Resource Management: To generate the scientific information required to verify the sustainability of harvesting olive ridley turtle eggs for local consumption from arribada beaches on the Pacific coast; (5) Control of Trade: To establish the legal, institutional and political conditions and mechanisms necessary to reduce and eventually eliminate the trade in marine turtles and the movement of marine turtle products and sub-products within the Pacific of Nicaragua. The Marine Turtle Conservation Strategy ("the Strategy") received official endorsement from the environmental ministry in January 2007. In this presentation we will summarize the contents of the documents as well as the lesson learned during and after the elaboration of the strategy.

THE IMPORTANCE OF SEA TURTLES IN NEW CALEDONIA – ECOLOGICAL AND CULTURAL PERSPECTIVES

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The south Pacific archipelago of New Caledonia (NC) boasts remarkable aquatic biodiversity. NC harbours important rookeries for green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles; as well as important foraging grounds for these two species and hawksbill turtles (*Eretmochelys imbricata*). Leatherbacks (*Dermochelys coriacea*) also migrate through its waters. Despite the country's importance to sea turtles, to date, little has been publicised about the conservation dilemma posed by the ecological and cultural significance of sea turtles in NC. This study sought to synthesize currently available information – mostly gray literature and personal communications – in order to bring the current status of sea turtles in NC to international attention and to widen discussion surrounding their conservation and sustainable use. Since 1989, about 4000 greens were tagged at their most important nesting site in NC: Récifs d'Entrecasteaux. With an estimated 200 nesters a year (20% of the region's population), la Roche Percée (Bourail) represents the second most important rookery for loggerheads in the South Pacific. Tagging and genetic studies have confirmed the important link between NC and Australian nesting and foraging grounds, highlighting the need for increased collaboration between the two countries. NC's northeastern waters are home to its largest concentration of foraging hawksbills, about 200 individuals. However, no nesting sites have been recorded for the species. In 2006/07 nest monitoring activities were augmented by aerial surveys of all NC beaches and fieldwork at 22 beaches; results are pending. Traditional customs and beliefs, including legends and uses of sea turtles are integral to Melanesian culture. For the indigenous Kanak, sea turtles have sacred cultural and spiritual significance. Longstanding customs traditionally restricted the consumption of turtle meat to high ranking community members at important feasts such as "la fête de l'igname", the coronation of a new tribal chief, the death of notable tribal members, and the wedding of the highest ranking chiefs. Historically, fishing rights, how animals were captured and then prepared, were all regulated by strict ritual. Population growth and the increasing influence of western culture however have partly eroded traditional values and the sacred link between Kanak culture and sea turtles. Trivialisation of cultural mores and regular consumption of turtle meat outside of customary ceremonies has increased harvest pressure on sea turtles. Greater direct take of sea turtles by Kanak as well as non-Kanak residents of NC, compounds other threats, including destruction of nesting and foraging habitats; high levels of nest depredation; poaching; and incidental take in fishing gear. Over the last 50 years, greens and loggerheads have suffered 50% and 90% declines in nester numbers respectively. The main island signed a decree in 2006 implementing a year-long ban on the harvest of turtles and eggs, except for specific scientific or customary purposes. Despite active awareness campaigns in the north, knowledge of new regulations remains low and their enforcement difficult. NGOs together with local partners are spearheading efforts to: (i) raise awareness about the importance of protecting sea turtles; and (ii) work together with local communities to integrate tribal laws and customs into an official marine management plan for the area. For her attendance at the 28th ISTS C. Wabnitz wishes to thank the Sea Turtle Symposium and charitable donations made by the following organizations: Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, as well as two generous individuals: Carlos Peralta Quintero and Robert N. Allen, Jr.

THE IMPACT OF SEA LEVEL RISE ON A MAJOR MEDITERRANEAN LOGGERHEAD SEA TURTLE NESTING SITE: ZAKYNTHOS ISLAND, GREECE

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Sea turtles are threatened by a variety of anthropogenic factors that have drastically reduced many populations worldwide. While conservation initiatives focused on these factors are now being proposed or implemented, a new threat, climate change, risks to undermine all these efforts. In order to understand how climate change can affect sea turtles in the Mediterranean region, a pilot study was conducted on Zakynthos island, Greece, the single most important nesting site in the region for the loggerhead sea turtle (*Caretta caretta*). The study considered only one of the several consequences of climate change: sea level rise (SLR). A digital elevation model of each one of the six nesting beaches on Zakynthos was created using land elevation data. The beach area, nesting area and land use was also identified from fieldwork and these, along with the digital elevation model, were entered into a geographical information system for analysis. Four scenarios of SLR in year 2100, based on recent predictions made by the Intergovernmental Panel on Climate Change (IPCC), were modelled against the elevation data in order to quantify the areas at risk from inundation. Physical beach characteristics were also identified and these were related to nesting activity, vulnerability to SLR and land use. Beaches with low elevations and low slope profiles were found to be the most vulnerable to SLR, with 13-54% of the beach area being lost to inundation following the different SLR scenarios considered (0.2-1 m). However, beach adaptation through inland regression might contrast such a reduction, but potential for this adaptation is limited by physical constraints on the back of the beaches, such as natural cliffs and artificial structures. In conclusion, the direct impact of SLR on the nesting habitat of Zakynthos can realistically affect the nest success and nesting behaviour of the turtles, ultimately impacting on the Zakynthos and hence on the Mediterranean loggerhead sea turtle population. This highlights the need of including a climate change adaptation strategy in sea turtle nesting beach management, with particular attention to artificial buildings on the back of the beaches. Given the rapid coastal development in the Mediterranean, an assessment of SLR effects on sea turtle nesting beaches is urgently needed at a regional level.

<u>Fisheries</u>

SEFSC SEA TURTLE OBSERVER TRAINING

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NOAA Fisheries Service Southeast Fisheries Science Center (SEFSC) conducts sea turtle training for permitted biologists and fishery observers. The objective is to teach researchers and observers to collect sea turtle life history data, as well as document the gear interaction at capture and subsequent handling and release. Typical training includes classroom presentations, videos, and hands on sessions. Topics covered are handling and safety,

resuscitation, species identification, morphometrics, flipper and PIT tagging, biopsy sampling, fibropapillomatosis recognition, oral cavity anatomy, mouth opening and gagging techniques, and hook and line removal. Each training is tailored to the audience, based on the permitted authorized activities and the fishery to be observed. Related references such as the SEFSC's sea turtle life history manual and form along with other presentations and videos are available on the SEFSC web site at http://www.sefsc.noaa.gov/seaturtlefisheriesobservers.jsp.

A SUMMARY REVIEW OF SEA TURTLE BYCATCH IN THE WIDER CARIBBEAN

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Fisheries bycatch has been identified as an important source of mortality for many sea turtle populations in the Western Central Atlantic. Formal assessments are scarce and are typically restricted geographically (e.g. Trinidad and Tobago; the Guianas) or by gear type (e.g. industrial or semi-industrial trawls and longlines). Our objective was to develop a region-wide assessment of sea turtle bycatch as part of a global, multi-taxa assessment sea turtle, marine mammal and seabird bycatch. Using multiple approaches (literature review, interview-based surveys, and observer data) our analysis provides a comprehensive overview of the current status of knowledge of sea turtle bycatch. The results are used to generate a preliminary model of the relationship between fishing intensity, oceanography and bycatch risk.

BYCATCH, TECHNOLOGY AND FISHERS: UNDERSTANDING THE UPTAKE OF BYCATCH REDUCTION TECHNOLOGY

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Marine turtles are captured incidentally as bycatch in many fisheries and by various gear types. One approach to reducing bycatch is through technological innovation, primarily applied to fishing gear, and the introduction of Turtle Excluder Devices in U.S. (and other) shrimp trawl fleets is one of the best known examples of this approach. In this research, we review technological innovations designed to reduce by-catch of marine turtles and other non-target species. Rather than examining the biological success of bycatch reduction technology, this research explores the process by which the technology is incorporated into or rejected by fisheries. We focus specifically on institutional factors, broadly defined to include legal frameworks; enforcement mechanisms; sources of innovation; property rights; fisher engagement in problem definition, technology design and deployment, and evaluation; affordability and cost-sharing arrangements; and local, regional and international cooperation. We argue that explicit attention to this wider institutional context in which by-catch reduction technologies are developed and deployed is critical to understanding their uptake.

PRELIMINARY DATA OF SEA TURTLES BYCATCH IN PERUVIAN ARTISANAL LONGLINE FISHERIES: DISTRIBUTION & POPULATION STRUCTURE

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The pelagic artisanal longline fishery located in Peru interacts with sea turtles and results are ingestion of baited hooks and entanglement with fishing lines. To mitigate these threats, in 2004 a program was initiated in the Eastern Pacific Region with the aim of reducing sea turtle bycatch. One of the main objectives was testing the efficacy of circular hooks during fishing trips of artisanal vessels operating in the region from ports along the coast from Peru to Mexico. In Peru these fleets target mahi-mahis and sharks. As a part of this effort, an observer program aboard fishing vessels was initiated, to collect data on the hooking rates of sea turtles and target species, gear characteristics, effort and operational modes, and species and sizes of target and bycatch species. Observers were trained to identify marine turtle species, measured carapace length and width, tail length and recorded their physical condition as well as the location of the hooks. These data were registered on biological data sheets standardized throughout the region. The program also trained observers and fishers on the best techniques to remove hooks and to release turtles. The present paper summarizes data on sea turtles size composition by species, and its distribution in the fishing area of artisanal vessels from Paita (5º 08'S) and Pucusana Port (12º5'S), between 3º S and 22º S. Preliminary results showed hooking, entanglement and sightings of *Chelonia mydas* (CCL= 42.7 cm- 110 cm), *Lepidochelys olivacea* (CCL= 41cm -75 cm), *Caretta caretta* (CCL = 33.1cm -69 cm) and to a lesser extent *Dermochelys coriacea*. Most of the loggerheads were classified as juveniles, suggesting a critical developmental area between 15 º - 17º S. Green turtles show the same patterns of fishing efforts and olive ridleys appears to be restricted to warmer northern fishing areas. Furthermore we analyze size-class composition and space-time distribution of these species inside the Peruvian longline fishing area. An important result of our work in ports and inlets is the beginning of a collaborative project between fishers and researchers to collect basic biological data of sea turtles as a way to attract awareness to sea turtle conservation. All the data collected is due to voluntary collaboration and they do not receive any gifts for reporting sightings or any fishery event that involves sea turtles. Through time we expect to engage more fishers in different initiatives to play an important role in the effort to preserve sea turtles.

INTERACTION OF THE PELAGIC LONGLINE FISHERY AND SEA TURTLES IN THE OPEN OCEAN IN THE SOUTH-ORIENTAL PACIFIC

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The situation of sea turtles in the Pacific Ocean is critical, mainly for the leatherback, *Dermochelys coriacea*. This has motivated researchers and conservationists to make an international effort to generate actions that lead to a rapid recovery of their populations. Bycatch is one of the most important causes of their dramatic decline over the last decades. Although very important work has been done on the topic of bycatch in the coastal fisheries, little is known about the bycatch of turtles in the pelagic longline fisheries in the South Eastern Pacific. During 2004 and 2005, 4 longline Uruguayan vessels operated in the Pacific Ocean between 17ºS - 34ºS and 81ºW - 101ºW. This fleet targeted mainly swordfish (*Xiphias gladius*), but also captured important quantities of blue shark (*Prionace glauca*), Moro shark (*Isurus oxyrhinchus*) and tuna (*Thunnus* spp.). Scientific observers, who were part of Uruguay's

National Observers Program of the Dirección Nacional de Recursos Acuáticos (DINARA), were aboard each vessel. Of the 887,176 fishing hooks observed, 17 *Caretta caretta*, 20 *Dermochelys coriacea*, 1 *Lepidochelys olivacea* and 7 unidentified sea turtles were incidentally caught. In 9 of the 11 trips there were interactions with turtles which represent 5.67% of the sets and in every case the turtles were released. This fleet is similar to others that are working in this area; therefore, the data collected can prove useful to interpret the impact of large pelagic longliners operating in the open ocean of the South Eastern Pacific on sea turtles.

OFFSET CIRCLE HOOKS VS "J" HOOKS: TESTS IN THE URUGUAYAN LONGLINE FISHERY*

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The use of circle hooks in pelagic longline fisheries has been proposed as a way to reduce sea turtle bycatch. Experiments were conducted in the Uruguayan pelagic longline fishery to determine whether the catch rates of targeted fish and sea turtles vary with the use of offset 18/0 circle hooks versus 9/0 "J" hooks. These experiments were conducted aboard industrial longline vessels operating in the South Western Atlantic. A total of 45,094 hooks were tested in 66 sets made from January to March, 2007, and 41 sets made between June and August of the same year. Analysis of catch data showed that 35 turtles were incidentally captured: 20 *Caretta caretta* with "J" hooks, 13 with circular hooks and 2 *Dermochelys coriacea*, one with "J" and the other with a circular hook.

ICCAT: THE INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS OR THE INTERNATIONAL COMMISSION FOR THE CAPTURE OF ATLANTIC TURTLES?

Marydele Donnelly

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The accidental capture and mortality of sea turtles in fisheries, known as bycatch, needs to be systematically addressed around the world to arrest major sea turtle declines. Bycatch of loggerheads (*Caretta caretta*) and leatherbacks (*Dermochelys coriacea*) is particularly acute in the world's expanding pelagic longline fleets which fish for tuna, swordfish and sharks. Regional fishery management organizations (RFMOs) are an excellent vehicle for promoting sea turtle bycatch reduction on a large scale, especially those RFMOs which have acknowledged the need for a more precautionary approach to the conservation of target and non-target species. Since September 2006, three RFMOs have adopted resolutions to begin to address the bycatch of sea turtles and promote the adoption of FAO's "Guidelines to Reduce Sea Turtle Mortality in Fishing Operations." Sea turtle scientists and advocates can play a valuable role in this initiative by working to ensure these resolutions are implemented and efforts to reduce bycatch continue. In the Atlantic Ocean, estimates of longline interactions with sea turtles are on the order of 150,000-200,000 loggerheads and 30,000 to 60,000 leatherbacks each year. Significantly smaller numbers of other sea turtle species also are captured in these fisheries. Longline fisheries have been identified as a major culprit in the alarming and ongoing decline of nesting populations of American loggerheads in the Western Atlantic which, until recently, were flourishing in response to decades of conservation. Fishing regulated by the International Commission for the Conservation of Atlantic Tunas (ICCAT) has the greatest impact on sea turtles of all the RFMOs managing high seas fisheries in the Atlantic and thus should be a focus of efforts by the sea turtle

conservation community to reduce bycatch. ICCAT currently has 43 members, including the European Community, United States, China, Japan, Korea, and Russia. Many ICCAT members participate in multiple RFMO agreements which ultimately may help to facilitate adoption of measures to reduce sea turtle bycatch within the relevant RFMOs. A new initiative by the five global tuna commissions to address management measures and promote a more precautionary approach to target and non-target species has promise if the Commission Secretariats and members can be convinced to act. FAO participation in reducing sea turtle bycatch is highly desirable, but as a result of constraints with financing and staff, FAO's project to develop a Code of Conduct to reduce sea turtle bycatch has stalled. Recommendations on ways the sea turtle community can help to address these issues will be discussed.

A SIMULATION APPROACH TO ASSESS POTENTIAL INTERACTIONS BETWEEN TURTLES AND FISHERIES*

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Interactions between marine turtles and fishery operations have been identified as a significant source of mortality of sea turtles. The degree of significance, however, has been difficult to quantify because of the unknown amount of unobserved interactions and non-reporting by fisheries, combined with lack of information on the abundance of turtle populations. As part of the comprehensive modeling of fishery interactions of marine turtles, we developed a simulation model to assess the interactions between marine turtles and fishing activities. We present simulation results that modeled the probability of individual turtles interacting with drift gillnets off the coast of California. The simulation uses satellite telemetry data for movements of turtles and locations of fishing gears. The simulation contained three elements: simulated fishing sets that approximated historic fishing effort in space and time, turtle movements obtained via satellite telemetry, and an interaction function where the probability of an entanglement declined with distance from the locations of simulated sets. Movements of each turtle were simulated through an area of fishing activities and the number of interactions was counted. We assumed no turtles died as a result of an interaction. Movement data for 31 turtles were available from leatherback turtles equipped with satellite transmitters in Monterey, CA, and Papua, Indonesia. Locations of fishing vessels were randomized to add stochasticity in the locations of fishing gear. The simulation was repeated 1,000 times to obtain frequency distributions of interactions for each turtle. Of 31 turtles, 25 turtles were likely to interact with fishing gear at least once. The maximum number of interactions during one simulation was 281. In the analysis, effects of the environment on neither fishing activity nor turtle movements were considered. Incorporation of oceanographic data into future simulations may allow for development of a real-time management tool to reduce future bycatch in this or other fisheries. To make the analysis applicable to the actual management decision making process, four data sources are critical; precise locations of turtles, locations and time of fishing activities, types (including size) of fishing gear, and by-catch likelihood of particular fishing gear. Without these data, results of the analysis are affected by underlying assumptions of the model. The future improvements of the model include the incorporation of environment as a driving force of fishing activities and turtle movements. With sufficient data, we think this approach can be used as a near real-time management tool for reducing the fishery-turtle interactions.

EFFECTS OF HOOK TYPE ON KINEMATIC AND BEHAVIORAL VARIABLES OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)

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Interactions between marine turtles and the longline fishing industry are a growing concern. Feeding biomechanics, foraging behavior, and diet preferences likely contribute to loggerheads' vulnerability to capture in the longline fishery. A kinematic study of 7 loggerheads (SCL 40-55 cm) was conducted to investigate how these turtles interacted with five barb-less, squid-baited longline hooks (J with 25˚offset, 16 circle no offset, 16 circle with 10˚offset, 18 circle no offset, and 18 circle with 10˚offset). Nine kinematic variables and five behavioral variables were assessed in relation to hook treatment. These data were used to test the hypothesis that loggerhead feeding behavior is modulated relative to hook type, hook size and hook offset. No difference was detected between hook treatments in all kinematic variables analyzed (P>0.05) indicating loggerhead feeding behavior may be stereotypical. Maximum gape, maximum hyoid depression, gape angle, time to maximum gape, time to maximum hyoid, gape closing time, total feeding time, open gape angle velocity and closing gape angle velocity were 6.5 + 0.9 cm, 4.3 + 0.9 cm, 48.4˚ + 7.9˚, 0.7 + 0.3 s, 0.9 +, 0.4 s, 0.1 + 0.06 s, 0.9 + 0.4 s, 611 + 182 deg/s, and -854 + -239 deg/s respectively. Mean frequency of strikes did not vary between hook treatments, or "hooked" and "non-hooked" interactions. Only 33% of all interactions resulted in "hooking" events. The proportion of "hooking" compared to "non-hooking" events was significantly different in these hook treatments (P0.05). There was a significant difference in the proportion of turtles that oriented themselves towards, straight, and away from the hook offset in the J hooks with 25˚ offset, and the 16 and 18 circle hooks with 10˚ offset (P<0.001). When interacting with J hooks with a 25˚ offset, turtles mostly oriented themselves away from the hook offset (77.2%); however, when interacting with the 16 and 18 circle hooks with 10˚ offset, most turtles oriented themselves towards the hook offset (56.9% and 50.7%). These data suggest that turtles may be able to determine the difference between a small (10˚) and large (25˚) offset, and may modulate their feeding behavior accordingly. These investigations of simulated loggerhead-longline fishery interactions provide data that may be used to develop or modify longline fishery gear that may potentially reduce loggerhead bycatch.

SEA TURTLE BYCATCH IN THE EASTERN PACIFIC: A REGIONAL REVIEW*

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Five species of sea turtles occur in the Eastern Pacific (EP). Regionally, the most threatened species are hawksbills, leatherbacks, and loggerheads. In addition to nesting beach perturbations and direct capture, incidental capture (or bycatch) in fishing activities is the principal threat to sea turtle populations in this region. In an effort to better understand the magnitude of the impact of sea turtle bycatch in the EP, we compiled available bycatch information for various species and fisheries within the region. Bycatch rates and sea turtle species taken as bycatch in the EP varied according to geographic area and fishery target species. In longline fisheries, the Chilean swordfish fishery had the lowest bycatch rate and the most frequently captured species is the leatherback, whereas in the areas off south and central Peru, bycatch rates were higher than in Chile and the species most frequently captured were

loggerheads and greens. In contrast, off of northern Peru, as well as in Ecuador and Central America, olive ridleys were the most frequently captured species and the bycatch rates are higher than the southern regions. However, the highest bycatch rates in the EP occur in Baja California Sur, Mexico, where loggerheads are captured in bottom longline sets. Despite limited information about gillnet fisheries in the region, it was apparent that gillnet and trammel net fisheries in the region captured all the species of sea turtles that occur locally. In Peru, not only leatherbacks but also greens and olive ridleys were captured in driftnets targeting sharks and rays. In contrast, the Chilean gillnet swordfish fishery and bottom-set gillnets in Baja California Sur captured almost exclusively leatherbacks and loggerheads, respectively. In Costa Rica, olive ridleys were the species most frequently captured during shrimp trawling, but greens and hawksbills are also captured. However, relatively few trawl fisheries in the region have been observed. In some countries (e.g., Ecuador), shrimp trawling has been mentioned as a possible cause for turtle strandings. To try and mitigate this problem Ecuador, Colombia, and Mexico have implemented mandatory use of Turtle Excluder Devices during shrimp trawling. Thus, while substantial bycatch research and mitigation efforts have been performed in the EP region for different gear types, substantial information gaps still exist and require further work to be addressed adequately. Conservation priorities for the EP region include the identification of the areas and seasons of highest interactions between sea turtles and fisheries, and research on bycatch reduction techniques. Mitigation measures implemented must come from coordinated work involving fishermen very early in the process, as demonstrated in the IATTC circle hook experiment that links conservationists and longline fishermen throughout the EP region. The present assessment of sea turtle bycatch in the EP is an important first step toward effectively characterizing interactions between sea turtles and fisheries in this region that will lead to development of sound conservation strategies.

EVALUATION OF TURTLE EXCLUDER DEVICES (TEDS) IN TWO MID-ATLANTIC TRAWL FISHERIES

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Sea turtle interactions are emerging as a serious concern for various trawl fisheries in the mid-Atlantic and northeastern coast of the United States. Management is currently considering introducing or expanding turtle excluder device (TED) regulations into new areas and fisheries to deal with the issue. It is vital to sound management that decision makers are aware of what impact regulations will have upon the fishery. Research was conducted in the summer of 2006 and 2007 in order to quantify the effect of TEDs on the catch efficiency of trawl gear in both the scallop and summer flounder trawl fisheries in the mid-Atlantic region. Results from the scallop trawl study indicated that overall loss in efficiency for two different net types with a TED is around 7%. The data point to a decreasing efficiency in relation to increasing catch size. The summer flounder trawl study produced an overall 35% reduction in the catch efficiency of a net incorporating a TED. These results also point to an inverse relationship between catch size and efficiency. There was no indication that the size distribution of the target catch for either of these fisheries was effected by the presence of the TED. The effects of the TED on bycatch are also considered. This work has proven significant in helping to highlight the need for fishery by fishery evaluations and developments in TED technology to meet the special conditions of each fishery. In one case, we have a TED that might be acceptable for scallop trawl fishing, with some room for improvement, if that is deemed necessary in the future. In another, we have a similar TED that has already been in regulation for some areas at certain times in the summer flounder fishery that clearly is in need of redevelopment. If TEDs are going to be considered for finfish fishery applications, certain limitations must be addressed.

CHARACTERIZATION OF THE FISHING STOCK OF SEA TURTLES IN JARDINES DEL REY (CUBA)

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Sea turtles are endangered species. Nevertheless, there are fisheries for turtles in countries like Cuba, which are considered sustainable. We characterized the legal take of sea turtles in the Jardines del Rey archipelago (Camagüey) fishery during the fishing seasons (August - April) of 2004 to 2006. We report the species-frequency distribution, size class distribution (I, 90cm, straight carapace length), sex ratio and the reproductive stage of females. Hawksbills were the most frequent species captured in the fishery (250 individuals), being almost two times more common than the other species. The species taken in the fishery depended on the month of capture (X2(df=16)=120.63, p <0.001). Hawksbills and green turtles were more frequently caught from August to October, with numbers diminishing gradually. However, the number of loggerheads captured during the fishing season was approximately the same month-to-month, but more loggerheads were captured than the other species from February until April. Females were more frequently taken in the fishery than males. The sex ratio didn't depend on the fishery month, except in loggerheads, where males were more frequently taken in September (X2(df=8)=16.46, p=0.03). In general, females didn't present branches of vitellogenic follicles. However, in hawksbill females, branches of vitellogenic follicles were more frequently seen, with significant differences in the month of September (X2(df=5)=16.08, p=0.01). The size class was dependent on the species of marine turtle (X2(df=8)=49.52, p <0.001). Green turtles tended to be larger, with class III turtles being the most common, followed by IV. In hawksbills the class III was also the most frequent, but contrary to greens, smaller individuals (class II) were the next most common. Of loggerheads, classes I and V were the most frequently captured sizes, but they were the least common size classes captured overall. A statistically significant relationship existed between the size classes of green turtles and the fishery months (X2(df=32)=93.82, p=0.001); such a relationship was also found for loggerheads (X2(df=32)=60.11, p=0.003). In August, green turtles had a wide representation of size classes (II - V), as in September and October, although in fewer numbers. Small green turtles (class I) were frequently captured in January. During each month of the fishery, class II loggerheads were captured at approximately the same frequencies. However, the individuals belonging to the classes III and IV were more frequently captured in August, while those of class V were more frequently captured in September. Consequently, we consider that hawksbills migrate through the fishing area during the period August to October, toward other areas like those of nesting, while green turtles and loggerheads can reside temporarily in these waters before migration occurs. For this reason, we recommend to extend the closure season until the first of November.

ESTIMATING BYCATCH IN UNITED STATES COMMERCIAL FISHERIES

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The Endangered Species Act, Marine Mammal Protection Act, Magnuson-Stevens Fishery Conservation and Management Act, and international agreements identify the stewardship role of the U.S. National Marine Fisheries

Service (NMFS) in leading the nation's collaborative efforts to monitor and reduce bycatch of living marine resources in U.S. fisheries. As part of its efforts to meet these responsibilities, NMFS has begun developing a National Bycatch Report (NBR) to provide a comprehensive summary of regional and national bycatch estimates in commercial fisheries for: (1) bycatch of protected species (e.g., ESA-listed sea turtles, marine mammals, sea birds, and fish) and (2) at-sea discards of fish. Version 1 of the NBR will include currently calculated bycatch estimates for U.S. commercial fisheries. Future iterations of the NBR will incorporate estimates for additional fisheries as data and estimation methods become available. Estimates will be based on information collected by observers as well as reports submitted by fishers and fish processing companies (e.g., logbooks, trip tickets). Data quality and bycatch estimation methodologies for all fisheries included in the NBR will be evaluated through a tier classification system. This system will evaluate all aspects of observer programs, industry reported data, expansion and verification data, and analytical approaches. The report will serve as a strategic document and provide a basis for determining future monitoring and management goals as well as for prioritizing funding decisions.

USE OF SATELLITE TELEMETRY TO ASSESS LOGGERHEAD TURTLE MOVEMENTS AND FISHERIES INTERACTIONS OFF PERU*

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Satellite transmitters have been used effectively in many regions to reveal information on turtle migration paths and associations with oceanographic features. However, so far there are few data on the impacts of mesoscale oceanographic features on the movements of loggerhead turtles in the southern Pacific. From 2003 to 2007 fifteen loggerhead turtles (*Caretta caretta*) fitted with satellite transmitters were deployed off the Peru coast. Ten Telonics (ST-18, ST-20) and 5 Wildlife Computers (SDR-T16, Spot 5) transmitters were used. The fiberglass cloth and polyester resin deployment technique was used for 9 deployments while epoxy “Powerfast” resin was used on the remaining 6. Satellite Tracking and Analysis Tool (STAT) was used to manage and process tracking data and environmental variables. All turtles were juveniles and were captured incidentally by artisanal longline fishing vessels from southern or central Peru. Turtles ranged in size from 40.0 to 69.6 cm CCL (mean CCL = 60.7±7.8cm). Animals were either hooked or entangled in branchlines and were released with injuries ranging from minor to severe. Ten transmitters were deployed in the austral summer (December-March), 3 in the autumn, 1 in the winter and 2 in the spring. Transmissions lasted from 0 to a maximum of 268 days (mean track = 120±77 days), with one unit still transmitting as of September 2007. Upon release, all turtles moved offshore beyond the continental shelf. All but one turtle generally remained within 1,000 km of the Peru coast suggesting that loggerhead turtles are year-round residents in these waters and that this area is an important foraging zone for loggerheads of southwest Pacific origin. Preliminary analysis also indicates that at least some of the turtles were exploiting geostrophic currents or possible oceanic fronts during their transmission period. For turtles tracked for greater than 100 days the average sea surface temperature experienced was 22.490 ºC (range=18.060 ºC to 24.690 ºC) and the average surface chlorophyll a concentration was 0.29 mg.m-3 (range=0.17 mg.m-3 to 0.50 mg.m-3). Average turtle swim speed was 0.94 km.h-1 (range=0.49 km.h-1 to 1.26 km.h-1). Our results also suggest that the turtles released in our study after following disentanglement and dehooking guidelines, appear to survive and travel for extensive periods. Satellite tracks also showed a substantial overlap of areas used by turtles with known longline fishing effort operating out of Ilo, the largest port in Southern Peru (ca. 150 longline vessels). This indicates that turtles are continually vulnerable to fishery interactions and that effective bycatch mitigation measures should be employed to minimize fishery impacts on loggerheads. Considering that the loggerheads tracked during this study spent ~44% of their time in Peruvian waters, 32% on the high seas, and 24% in Chilean waters, these efforts must be multinational in scope, and enlist all countries lining and operating in the Southeast Pacific Ocean. Acknowledgements: Conference attendance of authors Jeffrey Mangel and Joanna Alfaro Shigueto was made possible in part through a grant from The Sea Turtle Symposium, Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, U.S. Fish and Wildlife Service, David and Lucille Packard Foundation, the Sandler Family, Carlos Peralta Quintero and Robert N. Allen.

BABBLING: TURTLES, CONSERVATIONISTS, AND THE PERFECT HOOK

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Incidental capture in longline fisheries is recognized as a threat to endangered sea turtles that roam the oceans. Past studies have proposed that unless the bycatch rates are urgently reduced, sea turtle populations will continue declining and some may perhaps go extinct. Enormous efforts have been and continue to be dedicated to understand how many turtles are being captured by different longline fisheries operating around the globe, but we still have no clear figures on how many die as a result of this interaction. During the last decade, many tests have been conducted on fishing gear modifications in order to reduce the turtle bycatch rates while not decreasing the target species catch rates, mainly by comparing the use of the traditional J hooks vs. the use of circle hooks. Alarmingly, less concern has arisen about the effects that these modifications could have on other species conservation. Lots of efforts are being put to obtain adequate data that could help to determine if the use of circle hooks is indeed a positive sea turtle bycatch mitigation measure. As researchers and fishermen confront with this difficult challenge, nobody seems to be paying attention or dollars to another problem: how are we going to compare the hopefully achieved reduction in sea turtle bycatch rates with other possible effects caused to other taxa generated by the use of circle hooks?? How many endangered sharks is a juvenile loggerhead worth?? While testing circle hooks, are we really generating usable knowledge, or are we just clamping to the only available lifeboat? Should we put some effort into looking for alternative solutions??

SHARK SILHOUETTES AS A MARINE TURTLE DETERRENT: AN OBSERVATIONAL STUDY

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The decline in loggerhead (*Caretta caretta*) sea turtle populations worldwide has been linked to their incidental capture in longline and gillnet fishing gear. Preventive measures such as gear modifications, timing of set, and fisheries' closures have already been put in place to reduce incidental captures. Additional efforts are needed to further reduce the numbers of loggerheads caught by the fisheries. Previous studies show that sea turtles treat sharks as a threat and are most vulnerable to shark attack at the water's surface (Heithaus 2002). The purpose of this study was to determine if free-swimming juvenile and subadult loggerhead and green turtles (*Chelonia mydas*), in the St. Lucie Power Plant intake canal in Florida would avoid areas containing a shark-shaped decoy. If so, then similar decoys attached to fishing gear might reduce interactions between turtles and longline baits. The study divided the canal spatially into zones and measured how closely turtles surfaced to the shark-shaped decoy or a control ellipse of the same surface area that was placed in specific zones. Both shapes were then compared with surfacing frequencies when a decoy was not present. We found that the shark-shaped decoy varied in its effect depending upon where it was placed in the canal. We attribute this result to the behavior of the decoys. Our decoys were designed to be suspended mid-water, but in some current conditions, they dove to the bottom. Lowering the silhouette in the water column increased its effectiveness in repelling turtles from those zones. This result may be due to the turtles spending larger amounts of time swimming along the bottom of the canal foraging or preferring areas with slower currents. Other studies (Higgins 2006), done in still water, indicate that turtles only respond to shark shapes that are close-by (≤1.0 meter). The swift currents in the canal and the turtles' ability to dive versus surfacing elsewhere may also have led us to underreport the turtles' response to the silhouettes. Further laboratory and field research is required before the feasibility of shark silhouettes as a deterrent to turtles on longlines, gillnets, or other gear can be conclusively determined. Acknowledgements: Funding for the project was provided through a Pacific Island Fisheries contract with JW. Participation was made possible by the Sea Turtle Symposium and generous donations from the following organizations and individuals: FAU University Scholars Program, Sea Turtle Symposium, Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, the Sandler Family Foundation, Carlos Peralta Quintero, Robert N. Allen, Jr., and an Anonymous Donor.

BYCATCH MITIGATION IN THE LONG-LINE FISHERIES OF THE EASTERN PACIFIC. ONE MORE YEAR OF LEARNING WITH FISHERMEN

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Fishing sector, governments and NGOs have joint efforts to reduce marine turtle by-catch in pelagic long-line fishing operations across the Eastern Pacific Ocean (EPO). Commercial fishing trips are voluntarily carrying experiments to test circle hooks of different sizes depending on the fishery, against J hooks. An experimental design is followed 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. This is probably the largest marine fisheries conservation effort ever organized in the region. A voluntary observer program is used to collect scientific information from the fishery, including data on turtle/fishing gear interactions and to understand the fishing operations. 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. This paper presents preliminary results of the experimental fishing trials for different fisheries carrying out by 196 fishing vessels in the EPO. Trials are conducted under normal commercial fishing conditions, and thus providing real life evidence that the project is successful. From the total fishing vessels, 86 fully transformed to the use of circle hooks and best fishing practices, while the remaining 110 kept fishing with experimental gear and observers. Total crew for all vessels that participated is around 440 fishermen, including 196 captains. Differences among fisheries across the region are also explained with respect to long-line rigging, duration of the fishing trip and the fishing operation. Overall difference in hooking rates of J hooks against circular hooks is presented in the fisheries targeting tunas, billfishes, sharks, and mahi-mahi. These results indicates that experimental fishing trips are providing strong evidence in favor of circular hooks as a tool to effectively reduce the by-catch of marine turtle in surface long-line fishing operations. Proportion of swallowed hooks also shows that J hooks are swallowed more frequently than circular hooks. When a turtle swallows a hook, the possibility of severe injury is very high, therefore this evidence is providing additional positive arguments to believe that circular hooks are more benign than J hooks. The base working approach to convince fishermen to fish sustainable and clean their fishing operations from marine turtle bycatch proved successful. The model shows real life evidence of the benefits of the

gear substitution. This model seems to fit perfectly fishermen's cultural and social process of adopting new fishing practices and it is backed by recognition and trust from fishers.

STUDY ON HOOK-RELATED LESIONS OF SEA TURTLES INCIDENTALLY CAPTURED BY LONG-LINE FISHERIES, AND ASSESSMENT OF HOOK-REMOVAL TECHNIQUES

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Incidental capture by long-line fisheries is a significant factor for the decline of some marine turtle populations. Studies have been carried out worldwide in order to determine the real impact of this type of fisheries on sea turtles, and different modifications on fishing gear have been tried to minimize incidental capture of sea turtles without affecting the fishing of target species. However, so far very few studies have been carried out to assess post-capture mortality of incidentally captured turtles. As part of a large international program in Central- and South American Pacific, a 15-day experiment was carried out on board an Ecuadorian long-line vessel comparing J (Nr. 4) and Circle (Nr. 13/0) hooks. An experienced sea turtle veterinarian participated in this cruise. The objectives were: 1) to assess the location of the different hooks on captured turtles and the related lesions, 2) to determine the best ways to remove those hooks minimizing the damage to the turtle, 3) to determine the most useful instruments to remove hooks, 4) to assess the lesions caused when removing hooks, 5) to relate lesions on the animals to post-release mortality and 6) to train observers on hook-removing techniques. 56 sea turtles (olive ridleys, *Lepidochelys olivacea*, and black turtles, *Chelonia mydas agasizii*) were examined during the experiment, all sub-adults or adults. For each animal the following data were recorded: species, curved carapace length, type of hook, point of hooking, depth of lodging, lesion related, removal of hook, lesion post-removal, and any additional clinical comments. Some hooks were removed by the veterinarian, in order to evaluate the different tools available and the best way to use them. The rest of the hooks were removed by the observers, always in presence of the veterinarian. Together they assessed which hooks could and could not be removed, and which removal techniques were most effective without harming the animals. Some details of anatomy of sea turtles were explained while removing hooks, as well as the best methods to handle turtles causing minimal stress. After hook removal and the appropriate treatment, the turtles were released from the fishing boat. This is the first time that a veterinarian is taken on board a fishing boat to assess the lesions related to long-line hooks and their removal. The experience has proven extremely useful for observers, fishermen and scientists, giving a more complete picture of the problem of incidental capture of sea turtles by long-line fisheries. Both observers and fishermen were extremely interested in all aspects of the study and took part whenever possible. They acquired further knowledge in the anatomy and biology of sea turtles, establishing a closer relation with these animals. Better techniques for turtle handling and hook removal were also studied with observers and fishermen, and a pack with essential instruments for hook removal of turtles was recommended, including a net for fishermen to lift turtles on board. Further similar studies are planed to relate lesions of turtles to post-release mortality, using different tools such as an endoscope and telemetry. Acknowledgements: The authors would like to thank Ocean Conservancy for their financial support in this study.

RELATIONSHIP AMONG SIZE AND REPRODUCTIVE CONDITION IN THE FISHING STOCK OF *ERETMOCHELYS IMBRICATA* IN JARDINES DEL REY, CUBA

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Although hawksbill (*Eretmochelys imbricata*) is endangered, it is still used for the consumption and craft of the shell by some coastal settlements and countries. Cuba has been one of the nations that has defended the sustainable fishery of this resource, establishing some fishing regulations as the existence of a minimum size of fishery (65 cm). We re-evaluate this adjustment analyzing the relationship among the individual's size (20, four males) and the reproductive condition (sexual and reproductive maturation), belonging to the legal fishing stock of Nuevitas (province of Camagüey), during the periods of post closed season (August - December) of 2005 and 2006. First, the individuals were classified by the fishermen according to the sexual class (male, female and uncertain) and the reproductive state (mature or immature), keeping in mind the size of the odd appendix and the phenotype of the gonads. Together, these data with each individual's measurement (SCL, straight carapace length), were recorded into the fishery-sheet. The samples of gonads were fixed in Bouin's solution to characterize the gametogenesis. A part of each sample was included in paraffin and the other one frozen to be serially sectioned and histochemically stained. As we didn't find available information about folliculogenesis, we describe ten stages of follicular development similar to those described for other reptiles: five previtellogenic and the same quantity of vitellogenic. The morphology of the previtellogenic follicles is similar to the present pattern in crocodilians, with a monostratified granulosa. The vitellogenesis is characterized by the progressive accumulation of abundant polysaccharides and proteins in yolk platelets, and in smaller quantity lipids added among the platelets. These platelets don't group like it happens in the alligators. Once the maturation states were classified, the primary data were corroborated (sexual class and maturation state). Determination of the male sex and the minimum size of fishery did not correspond. The fishermen identified females instead of males (SCL(N=3)=72.5±5.8 cm) without development of the odd appendix ("tail"). Although the females exceeded the minimum size of fishery, 35% were sexual immature (SCL(N=7)=67.4±7.9 cm), with prevalence of the previtellogenic stage IV. Although, the rest were sexual mature (SCL(N=9)=71.8±6.8 cm), they didn't present vitellogenic follicles beyond the stage VI neither corpora albicantia. Consequently, most of them were virgin. Size didn't allow to differentiate the sexual immature females of the mature ones (t(gl=14)= -1.22; p = .24). All the males showed spermatogenic activity, being 75% sexually mature without development of secondary characters. However, the spermatozoa were absent in these and in the remaining one (SCL=75.0 cm), the relative quantity of spermatozoa didn't cover the lumen of the seminiferous tubules. Therefore, in spite of being sexually mature individuals, none were reproductively mature. These results indicate that in the fishing stock there was prevalence of reproductive immature and virgin individuals although they had sizes above 65 cm. Consequently, we recommend that the minimum size of fishery should be reconsidered.

UNTANGLING THE TANGLED: KNOWLEDGE, ATTITUDES AND PERCEPTIONS OF FISHERMEN TO THE RESCUE AND THE DISENTANGLEMENT OF SEA TURTLES IN KALPITIYA, SRI LANKA*

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Turtle bycatch causes several thousand individuals of various sea turtle species to die every year. While turtle bycatch mitigation strategies are well established for trawl fisheries, fewer efforts are in place when dealing with floating gillnet fisheries. This is a project first developed to proactively disentangle sea turtles while simultaneously gauging the knowledge, attitudes and perceptions of fishing communities of Kalpitya in Sri Lanka. Based on an interview-based questionnaire survey of 319 fishermen, we found significant differences in fishermen’s attitudes towards sea turtles, with 39% (n=124) saying turtles are important to conserve while 32% (n=102) were indifferent and another 16% (n=51) did not think that they need to be saved. However, 97% (n=309) of the individuals believed that turtles predominantly lived on fish while 60% (n=188) of them were convinced that turtles were detrimental to their fishing catch. From a conservation standpoint, it was important to note that the fishermen of Kalpitiya did not hunt turtles. A considerable number of them believed that turtles were endangered (67%, n=214) and supported sea turtle habitat protection (81%, n=257). They also agreed that nets and fishing lines were a threat to turtle survival (82%, n=262). Finally, a significant number of individuals were interested in helping with sea turtle and habitat protection (98%, n=310). Our research showed although fishermen had some knowledge about turtles and their habitats, there was a need for long-term conservation awareness focusing on education and training of fishing communities in marine conservation. To this end, a combination of awareness and community development programs initiated for fishing communities resulted in enlisting their support and/or their participation in sea turtle disentanglement. The sea turtle disentanglement component focused on rescuing turtles caught accidentally in fishing nets off the western coast of Sri Lanka during the ‘flying fish’ season from November 2006 to May 2007. Forty-six turtles were rescued during the six-month period with olive ridleys (*Lepidochelys olivacea*) accounting for a large proportion (96%, n=44). In addition, a green (*Chelonia mydas*) and a hawksbill turtle (*Eretmochelys imbricata*) were also rescued. After collecting morphometric data, all the rescued sea turtles were released safely back into the sea after double-tagging them on both flippers. While 54% (n=25) of the olive ridleys were adults, 52% (n=24) were males. Some rescued turtles were injured (7%, n=3) due to entanglement while others suffered shell damage (17%, n=8). Some sea turtle species get killed when caught accidentally in fishing nets when not foraging for fish. But active foraging for fish was causing entanglement of carnivorous olive ridleys. Sea turtle rescue and disentanglement can be a useful proactive strategy to help save adult populations in feeding and breeding areas. But assessing fishermen's attitudes and developing strategies to enlist their support and/or participation is vital to untangling the tangled turtles in floating gillnet fisheries.

WORKING WITH ECUADORIAN FISHING COMMUNITY TO REDUCE INCIDENTAL MORTALITY OF SEA TURTLES IN ARTISANAL LONG-LINE FISHERIES -PROGRESS DURING 3 YEARS (2004 - 2007)*

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A participatory program started in Ecuador in the second quarter of 2004, to mitigate incidental mortality of sea turtles in artisanal long-line mahi-mahi and tuna fisheries. The program brought together people sharing two goals: 1) nobody wants sea turtles to become extinct and (2) nobody wants fishers to be put out of work. Local artisanal fishers and their families have been a main component of the program to find viable mitigation measures in the fisheries. The response of the fisheries community, the fisheries agencies from the region, International organizations, and governmental and non-governmental organizations resulted in the development of a multi-year regional program, extending from Peru to Mexico. The implementation strategy of the program consists of four main components; workshops with fishers and their families, tests of circle hooks, data collection based on on-board observer program, and distribution of instruments to release incidentally caught turtles. Workshops have been organized to introduce the problem and possible resolutions, and to facilitate participation of fishers in the program. The hook tests have been carried out following an experimental design (replacing half of the J-type hooks in a line by circle hooks of adequate type/size for each fishery) in commercial long-line fishing boats under normal fishing conditions. Observers on board monitored the tests and corrected necessary data to verify the effectiveness of the circle hooks in the reduction of incidental mortality of turtles and in the catch rate of target species. The program staff distributed various types of instruments (ex. De-hookers, dip-net) to the fishers, and trained them to handle and release incidentally caught turtles by appropriate procedures. The program has expanded its activities considerably, in particular during the last two years. To August 2007, 86 workshops with over 3000 participants have been organized with long-line fishers and their families. The number of fishers who accepted circle hooks for tuna long-line has been increased favorably. Hook exchange has been done in 168 fishing boats, of which 110 boats have replaced all of the J-type hooks in a line by circle hooks. The observer program has grown very rapidly, and the number of observer trips has gone past 400, with over 400,000 hooks observed. Additionally, some experimental works were also conducted with collaboration of local fishers. The results of fishing experiments with J-style and circle hooks with wire appendage showed very clearly the advantage of wired hooks in reduction of turtle hookings. Modified float-lines with nylon monofilament and full-monofilament long-line showed great promise as a technique to reduce sea turtle entanglements.

REDUCING BYCATCH OF LOGGERHEAD TURTLES IN THE SOUTHWEST MEDITERRANEAN VIA COLLABORATIVE RESEARCH WITH FISHERMEN

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Bycatch in surface longlining is currently considered one of the main threats worldwide for the loggerhead turtle (*Caretta caretta*). One of the main hotspots of this problem is the southwest Mediterranean where the Spanish longlining fleet, targeting swordfish and albacore tuna, catches between 20,000 and 30,000 turtles annually. A series of mitigation measures were identified by a 2006 EC LIFE Nature project that involved monitoring the fisheries and research focused on habitat use of loggerhead turtles on the fishing grounds. These measures as well as the development of other technological measures for the management of this bycatch problem were included in a Spanish Mediterranean Loggerhead Turtle Conservation Plan which was presented to the Spanish and European DGs for Biodiversity. We present the results of experimental longlining to test the use of mackerel bait instead of squid in the swordfish fishery, and the use of 12/0 circle hooks and deeper setting of hooks in the albacore tuna fishery. In order to test these mitigation measures, experiments were carried out onboard commercial longlining vessels operating in their natural fishing grounds. The experimental gears were normal traditional longlines split into equal segments of test and control. Bait, hook and depth were tested separately. In the mackerel testing conducted in August of 2005, two observers were recording data. For the circle hook and depth experiments a veterinarian observer was added to the team to analyze the severity of hooking in detail. In a total of 30 experimental sets, 104 loggerhead turtles were caught. Results show a significant reduction in bycatch rate when changing squid bait for mackerel and also with deeper sets. In addition to a significant reduction in the bycatch rate when using 12/0 circle hooks, severity of hooking appeared to be reduced, with mostly foul hookings and superficial hooking. Results show that these technical measures also reduce bycatch of other species including undersized bluefin tuna, a species of special concern at present in the ICATT region. Finally, involving fishermen in bycatch mitigation experiments facilitated an understanding and acceptance of future regulations.

BYCATCH OF MARINE TURTLES IN THE LONGLINE FLEET OF MANZANILLO, MEXICO

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This document presents the specific composition, relative abundance, distribution and sizes of marine turtles in the longline bycatch during the operations of a shark fleet through 2003-2007. The characteristics of this fleet, based in Manzanillo, Colima (western coast of Mexico), and the environmental scenario during this time are also shown. Information was collected by an observer on board and the environment was described from sea surface temperature imagery and meteorological records of NOAA satellites. This fleet operated in a strip located between 50 and 200 nm in front of Mexico’s central western coast. It is composed by small boats (10.5-14 m), mainlines and gangions are ≈27.5 km and ≈7 m long respectively; the fishing trip is 6 or 7 days long. Fishermen have been changing to circular hooks and they have adopted protection measures. The distribution of the fleet changed throughout the year depending on the weather, during the summer it moves closer to the coast (50 nm) and the rest of the year further into the ocean. Most of the turtles were adult *Lepidochelys olivacea* (olive ridley); however, during 2003-2004 also captured were young and sub-adult specimens of *Chelonia mydas* (black turtle) and one individual of *Dermochelys*

coriacea (leatherback turtle). The female: male ratio of the olive ridley turtle varied between 5.5:1 and 2.7:1. The black turtles were caught beyond 50 nm. The variations in the specific composition are possibly related to their reproductive cycles and the environmental conditions, as suggested by the comparison of the relative abundance with the nesting trend reported.

UNDERSTANDING ENTANGLEMENT THROUGH DISENTANGLEMENT: A PRELIMINARY CHARACTERIZATION OF SEA TURTLE BYCATCH IN SOUTHERN NEW ENGLAND, USA

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Since 2005, a formal network of disentanglement responders, The Massachusetts Sea Turtle Disentanglement Network (MASTDN), has gathered information on sea turtle entanglements in the state waters surrounding Massachusetts, USA. Turtles in this region are poorly understood due to their cryptic nature, and disentanglement affords a unique opportunity to study these animals and bycatch. Here we report on specific characteristics of the entanglement problem, including the species involved, location, the configuration of entanglements, and fisheries type. MASTDN confirmed 38 cases of live and dead entangled turtles over three summer seasons. Nearly all (92%) of the cases involved the U.S. federally endangered leatherback (1 loggerhead was confirmed). Most of these leatherbacks (32) had multiple wraps of rope from buoyed markers involving both the fore flippers and neck. One turtle was solely entangled around a fore flipper and the pygal bone. In two instances, turtles were wrapped only by the neck. These data suggest that first contact with gear likely occurs at the fore flippers. All well-documented live animals (10) were found with obvious signs of trauma from these wraps, an additional eight were found dead (in all cases the carcasses could not be recovered for necropsy). Documented wounds include both superficial (9) and deep lacerating (1) abrasions at wrapped body areas and the carapace; at least two instances of vomiting were also observed. All entanglement reports fell between June and September, with a distinct peak in mid-August. Most reports came from within 5 km of shore and may have to do with an unknown combination of fisheries/turtle habitat preference and boating traffic (the predominant source of entanglement sightings). Most entanglements involved gear from fixed pot fisheries and rarely mooring lines and fish weirs, suggesting that gear set with roped buoy markers is a priority risk. MASTDN found no cases of entanglements involving submerged rope between pots or nets, possibly indicating a lower risk or a lower rate of detection. In a few instances turtles were found entangled in multiple gear sets or had moved substantially between entanglement sightings, suggesting that these animals are powerful enough to relocate gear, at least locally. Furthermore, during Network searches for entangled turtles, many animals dove away from the approaching response vessel, suggesting that initial detection of entangled turtles is difficult, most likely resulting in an under representation of entanglement. No reports of turtles caught in hauled fisheries or hook fisheries were reported to MASTDN during this time period, but this may be an artifact of outreach program design rather than a representation of actual bycatch risk. These observations suggest that the proliferation of fixed fishing gear should be monitored regionally for sea turtle bycatch and that mitigation should target a significant reduction of rope, and therefore risk, in turtle habitat.

PHYSIOLOGICAL STATUS AND POST-RELEASE MORTALITY OF SEA TURTLES RELEASED FROM GILLNETS IN THE CAPE FEAR RIVER, NORTH CAROLINA

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Fisheries impacts on sea turtle populations are thought to be substantial, which is why bycatch reduction is a hotly debated subject amongst conservationists and fisheries managers. Commercial gillnet fisheries in the lower Cape Fear River, North Carolina frequently capture juvenile sea turtles incidentally. Although most are released alive from gillnets, there are no existing data on the physiological impacts of entanglement and the ultimate fate of sea turtles following release. We investigated blood biochemistry and monitored post-release movements of sea turtles that were captured in gillnets in the Cape Fear River. Satellite and VHF transmitters were deployed on sea turtles that had been entangled in gillnets for periods ranging from 30 – 240 minutes to monitor post-release behavior and survivability. The majority of location data obtained from sea turtles in coastal (inshore) areas are typically of low quality (location classes A and B), due to surfacing behavior in this habitat (Godley *et al*., 2003; McClellan, pers. comm.). Turtles that are severely stressed from enforced submergence or intense struggling may spend more time at the surface repaying an oxygen debt, which could result in frequent and strong satellite transmissions of high quality (location classes 3, 2 and 1). We monitored transmissions from turtles for several weeks following release, and calculated the percentage of transmissions of each location class for each turtle. A large percentage of high quality location data is indicative of a greater amount of time spent at surface, and extended recovery from a stress event. Prolonged, high quality transmissions from a location on land suggest that a stranding has occurred, and we attempted to locate and recover carcasses when this transmission pattern was detected. In addition to monitoring post-release movements, we analyzed blood samples to assess the physiological status of the turtle at the time of release. Blood samples were analyzed for ions (Na+, K+, Mg2+ and Ca2+), lactate, corticosterone, enzymes (lactate dehydrogenase and creatine kinase), and expression of heat shock protein mRNA. These measurements provide insight as to the degree of stress experienced by the turtle while entangled in the net, and physiological adjustments made to counter the stress event. Analysis of co-variance (ANCOVA) was used to compare biochemistry values of sea turtles with low percentages of high quality satellite transmissions, high percentages of high quality satellite transmissions, and turtles for whom mortality was confirmed by location of a carcass. Co-factors in the analysis included time spent in net, body size, temperature, and species. Results from this study can provide insight on post-release mortality of sea turtles captured in gillnets, which may be used by fisheries managers to regulate the gillnet fisheries in North Carolina to reduce the impacts on juvenile sea turtle populations. Acknowledgements: We would like to thank the North Carolina Sea Grant for providing project funding, Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, Sandler Family Foundation, Carlos Peralta Quintero and Robert N. Allen, Jr. for providing travel funding, and the Sea Turtle Symposium for allowing us to present our work.

BIOCHEMICAL INDICATORS OF POST-RELEASE MORTALITY FOR SEA TURTLES CAPTURED IN GILLNETS

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Bycatch of sea turtles in commercial fishing gear has been identified as a significant source of mortality contributing to population declines. In addition to the deaths that occur while sea turtles are entangled in fishing gear, there may be delayed mortality of sea turtles released alive from fishing gear. Severe disruption of physiological homeostasis and induction of the systemic stress response may result in alterations of normal diving and foraging patterns and leave sea turtles susceptible to other threats, such as predators, boat strikes, and further encounters with commercial fisheries. Several investigators have attempted to document post-release mortality of sea turtles using telemetry, although the high costs of equipment and labor limit the scope of these studies. Development of a diagnostic toolkit for predicting mortality based on the biochemical and physiological status of sea turtles at the time of capture would complement and expand upon data gathered through telemetry-based studies. The long-term effects of capture-related physiological disruption on behavior and, ultimately, survivability of sea turtles could be substantial, but to date there has been little effort to integrate physiological data into estimates of mortality. Once validated against telemetry data and documented instances of post-release deaths of sea turtles, biochemical profiles obtained by taking a blood sample from sea turtles at the time of capture could yield key information regarding health status and the likelihood that sea turtles will survive after they are released. Use of biochemical profiling would be a relatively cost-effective means to refine the current mortality estimates used as the basis for important fisheries management decisions. We will present preliminary results from biochemical analyses of blood samples obtained from juvenile green and Kemp's ridley turtles captured in commercial gillnets in the lower Cape Fear River, NC during the summer and fall of 2007. Turtles were entangled in nets for periods ranging from 15 – 180 minutes. Blood samples were taken immediately upon removal from net and prior to release from boat, and satellite transmitters were deployed to monitor the turtle's movements and fate following release. Analysis of co-variance (ANCOVA) was used to test for significant differences in biochemical parameters (lactate, corticosterone, ions, enzymes) of sea turtles that survived and sea turtles that died after release. Variables such as species, date of capture, temperature, sex, body size, and gear soak time were tested as co-variates in the analysis. We will explore the feasibility of using logistic regression analyses to investigate relationships between biochemical parameters and the fate of the sea turtle. Biochemical parameters that show significant differences between sea turtles that live and sea turtles that die following release may be used alone or in combination as independent variables and the fate of the sea turtle (0 = dead, 1 = alive) may be used as the dependent variable in a logistic regression model. Predictive power of the model may be assessed by comparing model predictions with the actual fate of turtles and by the R2 value of each regression.

EXEMPTED LONGLINE AND DRIFT-GILLNET FISHING PERMITS (EFPS) IN U.S. PACIFIC: LEGITIMATE EXPERIMENT OR LOOPHOLE TO INCREASE FISHING EFFORT IN PROTECTED LEATHERBACK CONSERVATION ZONE?

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In 2006 and 2007, Pacific Fisheries Management Council endorsed an exempted fishing permit (EFP) for drift gillnets for swordfish inside the Leatherback Conservation Zone (LCZ), a three-month time area closure off the coast of California and Oregon. In 2007, a proposal was submitted to begin a new longline fishery inside California's EEZ, which would have also allowed fishing inside the LCZ. Both proposals were eventually defeated after an outcry from scientists, conservation organizations and in the case of the longline fishery, a rejection by the California Coastal Commission. Unfortunately, the Council and NMFS have already indicated they plan to try again in 2008 to get permission for these fisheries, and environmentalists are preparing to once again oppose these proposals. EFPs are usually reserved for testing experimental fishing activities, but we argue, neither of these proposals rose to the level of hypotheses testing, but instead were an excuse to allow increased effort for fisheries that have been restricted due to their take of leatherbacks and other protected marine species. To strengthen protections for leatherbacks, three environmental organizations have petitioned for critical habitat designation in the foraging zone of the Pacific leatherback off the U.S. Pacific coast.

UPDATE ON MODIFIED FISHING GEAR TO REDUCE BYCATCH OF SEA TURTLES IN LONGLINE GLOBAL FISHERIES

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I will present an update on our efforts to identify tools to effectively reduce the incidental capture of sea turtles in longline fisheries. The report will summarize experimental field trials comparing modified fishing gear to traditional methods in numerous fisheries worldwide where incidental capture of sea turtles is high enough to allow for statistically robust comparative results. At present, we encourage regional fisheries management organizations to adopt the following measures as means to reduce both sea turtle-fisheries interaction rates as well as injuries caused by fishing gear, thereby increasing survivorship of turtles after their release: 1) Replacing J hooks and tuna hooks with circle hooks reduces the deep ingestion of hooks by sea turtle species that tend to bite baited hooks (e.g. hard shell sea turtles); 2) In fisheries with bycatch of large (45-65 cm carapace length) loggerhead turtles (*Caretta caretta*) or leatherback turtles (*Dermochelys coriacea*), using large sizes of circle hooks (i.e., wider than 4.9 cm minimum width, e.g. size “18/0”) can substantially reduce the bycatch of both species. It appears that larger hook size reduces capture rates of turtles that bite baited hooks (hard shell turtles), and that circle hook shape helps prevent turtles that seldom bite (e.g. leatherbacks) from being snagged and subsequently entangled; 3) In fisheries with bycatch of smaller turtles, using smaller sizes (e.g. size “16/0”) of circle hooks can reduce capture rates of sea turtles when the circle hooks replace other hook styles with smaller widths. Circle hooks tend to be much wider than other hook styles with similar length and gape; 4) Another way to successfully reduce capture rates of sea turtles while continuing to use a relatively small hook is to increase the effective width of the hook by adding a wire appendage; 5) Using fish for bait instead if squid can reduce bycatch of both leatherback and hard shell sea turtles. Use of fish bait is especially valuable in offsetting the potential loss of swordfish from use of circle hooks. With regards to maintaining a viable fishery, these recent field trials comparing J and circle hooks in shallow set swordfish fisheries in Italy, Brazil, and Uruguay, have shown viable CPUE for target species using circle hooks plus fish bait. And trials in deep set tuna fisheries in the United States and Indonesia have also shown viable CPUE for target species.

BYCATCH BY NUMBERS: CAN OCEANOGRAPHIC CONDITIONS HELP PREDICT FISHERIES BYCATCH?

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While many factors have contributed to the decline of worldwide sea turtle populations, longline fishing, in particular, has received significant attention in the past decade. As a result, there has been an increase in the amount and accuracy of bycatch data available. However, there are still areas where data is lacking. The aim of this study is to determine if certain underlying oceanographic conditions contribute to increased bycatch or if bycatch is ocean basin specific. Bycatch data from the Atlantic-based and the Hawaii-based longline tuna and swordfish fisheries was examined in areas of similar oceanographic composition. Changes in fishing pressure and gear types, as a result of policy decisions, was taken into account, as well as the differing impacts longline fishing has on each species. If bycatch rates and composition are similar between the two study regions, then this will provide insight into what bycatch will be like in other comparable regions where bycatch data is not available. If any obvious differences appear, it will be possible to do further analysis to explain the variation. This work was made possible through the generous support of Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management

Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service- Marine Turtle Conservation Fund, David and Lucille Packard Foundation, the Sandler Family Foundation, Carlos Peralta Quintero, Robert N. Allen, Jr and the Doris Duke Charitable Foundation.

DEVELOPING STRATEGIES TO REDUCE SEA TURTLE BYCATCH: USING LIGHTSTICKS AND SHARK SHAPES

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Factors that attract sea turtles and target fish species to fishing gear likely include numerous sensory cues. Recent physiology and behavior studies indicate that sea turtles have especially acute visual function and that visual cues most likely play important roles in whether sea turtles interact with fishing gear. Based on these findings, we suggest that modifying the visual environment associated with fisheries can effectively reduce turtles' interaction with fishing gear. Field experiments in Baja California, Mexico were conducted to determine whether lightsticks and shark shapes had an effect on sea turtle catch rates in modified gillnets used by sea turtle monitoring programs. Preliminary trials suggest that the presence of activated lightsticks on the nets reduce the number of turtles caught. One potential reason for this decline in turtle catch is likely a result of the increased visibility of the nets from lightstick illumination. This finding suggests that lightsticks used in a gillnet setting could reduce sea turtle interactions. Whether lightsticks on gillnets have an effect on targeted fish is not yet known. In addition, experimental data with a shark shaped "scarecrow" suggest that the presence of shark shapes near turtle monitoring nets decreases the number of turtles caught. Shark shapes could potentially be used to deter turtles from entering areas of concern. Additionally, behavioral and physiological experiments indicate that turtles can see UV light while certain pelagic fish such as some billfish and mahi mahi cannot. Transparent UV-absorbing plastics could then be used to make shark shaped silhouettes visible to sea turtles, but not to targeted pelagic fish such as mahi mahi.

ANALYSIS OF THE ARTISANAL LONGLINE FISHING GEAR AT ZAPARA ISLAND: A THREAT FOR SUBADULT LOGGERHEAD SEA TURTLES?

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Longlines are one of the kinds of fisheries widely known to interact with several sea turtle species and impact their populations on a global scale. The longlines have been reported all along the coast from the Gulf of Venezuela. However, the interaction with sea turtles has been more intense in the south region. Zapara island (10°58'58"N - 71°33'45"W), at the southern region, has approximately 250 fishermen, from which about the 70% use longlines. This fishery is often set at depths between 8 and 15 m, with hooks number 4 and a distance to the coast between 2,000 and 14,000 m. Five species of sea turtle have been reported for the Gulf of Venezuela: green, hawksbill, loggerhead, olive ridley and leatherback. The loggerhead is the most frequent turtle in Zapara island. Because of their carnivorous eating habits and food resources in this zone, these are the ones that interact the most with this type

of fishing activity, which uses fish and squid as bait. Between 2005 and 2007 interviews and surveys were carried out by the Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV) on fishermen and inhabitants of Zapara Island. Collected data permitted us to identify the sea turtle species impacted by longlines in the study area. It is evident that the relationships between the baits, the hook depth, salinity and substrate are the main factors which increase the interactions between loggerhead turtles and superficial longline fisheries developed at the southern region of the Gulf of Venezuela. Longline fisheries affected 96% of loggerhead juveniles and subadults (n=20). This was the highest interaction value for any sea turtle development stage in the study area. Loggerhead mortality caused by longline fisheries was from 70 to 150 individuals per year (2 to 3 turtles per fishery gear). Due to this, it is necessary to implement viable fishery methods that allow fisherman and loggerhead sea turtles to coexist and to mitigate the incidental capture, such as the employment of circular hooks, ideal depths standardization for a non-interactive fishery with sea turtles, especially loggerheads that use these feeding grounds. Also, the development of studies that involve the implementation of new and different baits to avoid by-catch of sea tutles by these fishing arts.

SEA TURTLE STRANDINGS AND MORTALITY IN THE GALAPAGOS ARCHIPELAGO: CAUSES AND THREATS

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In the waters of Galapagos, two species of marine turtles are most commonly observed: the green turtle, *Chelonia mydas*, and the hawksbill, *Eretmochelys imbricata*. The more oceanic species, such as leatherback, *Dermochelys coriacea*, and olive ridley, *Lepidochelys olivacea*, are rarer. *C. mydas* is the only species that nests in the Galapagos and is abundant throughout the year, while *E. imbricata* seems to be restricted to some periods of the year to the central part of the Archipelago but is most commonly observed during the whole year in the warmer waters around Darwin and Wolf Islands. Mortality of marine turtles is linked to both natural causes and those associated to human activities. Information on sea turtle mortality along the coast of Galapagos has not been documented on a regular basis prior to 2002. Here we provide data on sea turtle stranding and mortality observed from 2002 to 2007, give possible causes of death and detail threats facing turtles within the Galapagos Marine Reserve (GMR). Data was collected by field teams during nesting seasons and during field trips at foraging areas and also provided by local guides, tourists and the general public. Sea turtles were identified using IUCN/SSC Marine Turtle Specialist Group identification keys, their curved carapace length (CCL) and curved carapace width (CCW) were measured, and sex was determined. Around 50 green turtles and 2 hawksbills were recorded dead in the Archipelago. Dozens were found stranded alive at various beach sites, and helped to return to the sea. Injuries caused by boat propellers and shark bites were common in foraging and nesting habitat. These injuries included limbless turtles (missing at least 1 flipper) or those with partially cut flippers as well as hooks (J type) embedded in soft parts. A massive infestation by a burrowing barnacle and the atrophy of rear flippers were registered in foraging areas and nesting beaches, respectively. The number of stranded turtles increased in 2006/7 season with the first records of headless and limbless individuals. Some mortality and injuries must be due to natural causes, while others being the result of human activities (fisheries and tourism). These findings will be useful to guide the decision making process in regard to regulations and management activities implemented in the GMR.

Foraging and Developmental Areas

GREEN TURTLE FORAGING ECOLOGY IN MORETON BAY, AUSTRALIA AS OBSERVED USING THE CRITTERCAM

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Traditional techniques for studying green turtle foraging ecology, such as the analysis of food availability and ingested dietary material, have suggested that green turtles are able to forage selectively and differentiate between potential food sources. The mechanism by which this choice is made is not well understood. In this study, we aimed to assess the benefits of using an animal borne imaging device, the Crittercam, to observe green turtle foraging behaviour in Moreton Bay, Australia. Eight large (CCL > 88cm) green turtles captured whilst foraging on seagrass flats were fitted with the Crittercam, and up to four hours of continuous footage was obtained for each turtle. The released turtles demonstrated an immediate ‘flee’ response swimming to deeper water. During the four hours post-release, turtles swam almost continuously and rarely stopped to feed on seagrass, suggesting that longer deployment times, with an initial acclimation phase, are required to more fully understand questions pertaining to feeding ecology. Green turtles in this study were commonly observed to feed on gelatinous material from the water column, a nutritional source that has previously been overlooked in this population, but described in other green turtle populations using the Crittercam. As previous dietary studies in this population had only assessed crop content during necropsy and in lavage samples, easily broken down material, such as jellyfish, had not been identified. The results of this study indicate that Crittercam technology can provide insight into turtle diet selection and suggests that turtles in Moreton Bay may have a more flexible diet than previously described, indicating they could switch to alternate prey items when seagrass quality or quantity is compromised.

SEASONAL AGGREGATION OF SEA TURTLES IN CAPE LOOKOUT BIGHT, NORTH CAROLINA, USA

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The inshore waters of North Carolina provide foraging habitat for large numbers of sea turtles, with loggerheads predominating, and turtles have long been known to be prevalent in the waters behind Cape Lookout called ‘the Bight’. The number of turtles encountered in this area was first quantified during a survey spanning 1992-1993, where turtles were observed during spring, summer, and fall, with sighting numbers reaching a peak mean of 2.20 per 20 minute vigil during the summer (Rittmaster *et al*., 1994). However, later data suggest that this peak occurs earlier, during May (K. Rittmaster, pers. comm.). Although many hypotheses have been proposed to explain the large numbers of sea turtles in the Bight during this time of year, including 1) reproductive aggregation; 2) use of the Bight as a hibernaculum; and 3) aggregation around a geographic restriction (the Bight and adjacent Barden’s Inlet) as turtles migrate into inshore waters, to date none of these explanations have been investigated in any detail. As a result, we set out to survey Cape Lookout Bight during late April and May of 2007 to assess the aggregation, attempt to capture turtles, and to begin characterizing the population inhabiting this area. During two visual survey

days, observers on a single vessel recorded 28 and 43 sightings per hour, many of which appeared to be loggerheads. The majority of these turtles had large quantities of mud covering the carapace and/or head, which could be the result of emergence after dormancy but may also indicate benthic foraging. On those same two days we attempted to capture turtles using a 1 m diameter breakaway hoop net; however surfacing intervals were typically very short (1-3 s) and we were not successful. On two additional days we deployed a 100 m long, 10-in stretch mesh monofilament entanglement net and captured six loggerheads (CPUE = 0.60 turtles/h). The turtles ranged from 63.6 to 80.6 cm SCL-tip with a mean of 72 cm, which was significantly larger than that of turtles inhabiting Core and Pamlico Sounds May through December, 1998 to 2007 (n = 754; p<0.005, Mann-Whitney test). The length of the 80.6 cm individual's tail suggested that it was an immature male and we outfitted this turtle with a Wildlife Computers SPOT-5 tag to track its movements. After its release, the turtle traveled northward through the sounds, left inshore waters, and then continued north to a location approximately 30 km east of Virginia Beach, Virginia (around 34.74680 N and -75.48467 W) where it has remained throughout the summer months. This site is quite near the summer ranges occupied by several other male loggerheads satellite tagged in Cape Canaveral, Florida (M. Arendt, SCDNR, unpublished data), suggesting that the area may be an important foraging location. The satellite tag continues to transmit, allowing for the possibility of following the turtle on its fall migration and to determine its overwintering area.

FEEDING OF JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) IN SOUTHERN BRAZIL

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The coast of Rio Grande do Sul State is an important developmental and feeding ground for green turtles (*Chelonia mydas*), a globally threatened species. Understanding its diet is of vital importance to maintain a sustainable population. The aim of this study was to determine the diet of green turtles in southern Brazil. The analysis of gut content was carried out with individuals that had either stranded or were caught in artisanal fisheries. This study was carried out along 335 km of beach between Lagoa do Peixe (31°20'S; 51°05'W) and Arroio Chuí (33°45'S; 53°22'W). Each animal was measured (curved carapace length - CCL) and the entire digestive tract was removed. Samples were washed, sorted in a sieve and preserved in formaline 4%. Food items were identified to the lowest taxonomic level, and their importance in the diet presented as frequency of occurrence (%FO) and index of relative importance (IRI = (%FW + %V) x %FO). Data on anthropogenic debris are shown as present/absence. A total of 32 digestive tracts were analyzed from juveniles, with CCL ranging from 31.5 to 56 cm (mean=40.3 ±6.0 cm). Anthropogenic debris was found in 100% of the samples. Most frequent items were macroalgae, mollusk shells, plants and insects, present in respectively 93.5%, 75.0%, 59.3% and 53.1% of samples. Items with highest %IRI were macroalgae (33.5), cnidarians (19.5), mollusk shells (19) and plants (18.5). Animal tissue accounted for 54.1% in weight, plants 40.3% and substrate (stones, sand, soil) 5.4%. Currently, 36 taxa were identified. Macroalgae found were Ulva lactuca, U. flexuosa, U. clathrata (Clorophyceae), Giffordia sp., Sargassum sp. (Pheophyceae), Porphyra sp., Polisiphonia subtilissima, Pterocladia capillacea, Jania rubens and Gelidium sp. (Rodophyceae). Identified mollusks were Diacria rampali and Cavolinia uncinata and unidentified gastropods, bivalves and cephalopods. Scyphozoa and Hidrozoa also were found. Among vegetable matter, Spartina ciliata and Andropogon arenarius were found. Identified insects were Odonata, Hymenoptera, Lepidoptera and Coleoptera. Crustaceans present were Brachyura and Lepas sp. The diet of green turtles in southern Brazil could be considered omnivorous and generalist, in contrast to the diet of adult green turtles reported in the literature. The specimens analyzed did not show a strictly herbivorous diet, probably because they are in a transition stage between the carnivorous diets of their first pelagic years and the predominantly herbivorous diets of adults.

CHARACTERIZATION OF SEA TURTLES IN THE COASTAL WATERS OF CARIBBEAN NICARAGUA*

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As part of a larger sea turtle conservation program, the Wildlife Conservation Society has been conducting an in-water capture-mark-recapture study in the coastal waters of Caribbean Nicaragua since 1999. Green, hawksbill and loggerhead turtles frequent these waters, using the area as feeding and developmental habitat, as well as a migratory route for some. Results from this in-water study thus far provide a better understanding of population characteristics and needs, and help guide conservation actions. Results on size, sex, movements and tag recoveries will be presented, as well as principal threats to sea turtles in the area and the status of conservation efforts on this vast feeding ground.

FIRST ANALYSIS OF STOMACH CONTENT TO IDENTIFY THE DIET OF FORAGING GREEN SEA TURTLES IN THE GULF OF VENEZUELA

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The Gulf of Venezuela (GV) is considered to be one of the most important feeding areas for sea turtles in Venezuela. Five sea turtles species are reported, but the green sea turtle (*Chelonia mydas*) is the most frequent. Its feeding habits and diet have not received much attention in Venezuela. Therefore, we analyzed stomach contents from 3 green turtles captured by artisanal fisheries in the GV, a subadult (LCC 72; ACC 63) from Tapuri and two juveniles (LCC 27.5; ACC 23.5 and LCC 23; ACC 20) from Porshoure and Zapara, respectively. Stomachs were dissected and contents were preserved in a 4% formalin/seawater solution. Food items were identified to the lowest possible taxonomic level based using a dissecting microscope and taxonomic keys. The entire sample volume and the relative volume of each diet group were estimated by water displacement in a graduated cylinder. For the subadult, *Thalassia testudinum* (99.4%) and *Syringodium filiforme* (0.19%) and unidentified plant material (0.39%) were the most abundant components. For the juvenile from Porshoure, the stomach contained *Phaseolus vulgaris* (83.49%), *Phaseolus* sp. (9.02%), *T. testudinum* (5.41%), *S. filiforme* (2%), *Dictyopteris delicatula* (0.30%) and unidentified plant material (0.15%). The stomach of the juvenile from Zapara contained *Dictyota* sp. (53.3%), and animal remains, such as bivalves (16.6%), unidentified material (16.6%), *Crassostrea* sp. (3.3%), *Olivella petiolita* (1.6%), *Aequipecten* sp. (1.6%), and *Corbulla contracta* (1.6%). It seems that juveniles show a higher percentage of omnivory than subadults, but our sample size is small. The higher percentage of animal remains in the green turtle from Porshoure may be due to a more opportunistic diet as the characteristics of each region affect the food available locally. More research is necessary to identify the key feeding areas of green sea turtles in the Gulf of Venezuela.

FEEDING ECOLOGY OF GREEN TURTLES, *CHELONIA MYDAS*, IN THE GALAPAGOS ISLANDS*

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The Galapagos Islands have been recognized as one of the most important nesting areas for green turtles in the eastern Pacific Ocean but it is also a place where thousands of green turtles gather to feed. Here we describe the dietary components of 65 green turtles captured from February to August 2006 at three foraging sites, including Punta Nuñez (Santa Cruz Island), Caleta Derek (Isabela Island) and Bahía Elizabeth (Isabela Island). We used esophageal lavage to collect samples from turtles, ranging in size from 40 cm to 108.5 cm (mean CCL = 66.23 cm). A calculation of mean volume for each food type (%V) was determined. Recovered dietary components included the algae *Ulva, Polysiphonia, Codium, Callophylis, Gelidium, Dictyota, Caulerpa, Hypnea, Bostrychia, Halymenia* as well as mangrove, *Rizophora mangle* (%V of herbivorous foods = 91%) and invertebrates such as Cnidarians (%V of invertebrates = 8%). The %V of consumed food varied among study sites. *Ulva* was the most abundant algae in samples from Bahía Elizabeth and Caleta Derek, while *Dictyota* and *Caulerpa* were the most abundant in samples from Punta Nuñez. Additionally we found seasonal variation, with *Ulva* being the most abundant during the cold season (August) while *Bostrychia*, *Gelidium*, and red mangrove, *Rizophora mangle*, were the most abundant during the warm season (February). We present the first report of jellyfish as a diet item of green turtles in the Galapagos. Overall, six females tagged while nesting in the Galapagos were also recorded feeding, thus confirming the presence of a local, non-migratory stock of green turtles in the Galapagos Islands. These data indicate that foraging grounds must be categorized in local management plan as protected areas under the Galapagos Marine Reserve Zonation Scheme.

HABITAT AND POPULATION ASSESSMENT OF CARIBBEAN GREEN TURTLE AGGREGATIONS INHABITING THE CULEBRA ARCHIPELAGO'S COASTAL WATERS*

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Whereas green turtles are less abundant than hawksbill turtles in the waters surrounding Puerto Rico, an important juvenile green turtle aggregation exists on the Culebra Archipelago, where foraging ground studies have been conducted since 1987. We present results of recent work on green turtle ecology and population dynamics, at two high densities habitats, Bahia Manglar and Culebrita. Turtles captured on these foraging grounds ranged in size from 26.0 to 81.0 cm SCL n-t (mean = 53.3 cm, SD =11.71, n=553). Long distance tag recoveries have been received from Brazil, Nicaragua, Colombia, Venezuela, and Dominican Republic. A total of 185 green turtles have been recaptured in our study area since 2001, with time intervals between captures of up to 7.3 years. At Bahia Manglar, turtles grow at a mean rate of 6.13 cm/yr (SD= 1.8; n= 74 intervals), wheras at Culebrita, growth is slower at a mean of 4.13 cm/yr (SD= 1.49, n= 89 intervals). Culebra green turtles appear to grow much faster than green turtles in

other areas of the western Atlantic. Molecular studies indicate that the Culebra green turtles originate from from several rookeries in the Greater Caribbean. Sonic telemetry was conducted to determine habitat use and feeding pattern at Manglar, with four turtles providing data. These animals displayed a marked pattern of daily activity, with each turtle actively feeding for a limited portion of the day. The benthic habitats of our two main study sites were compared and characterized. The bays differ in the oceanographic regime as well as in the human uses of the bays and in the adjacent terrestrial areas. A habitat characterization and map distribution of the benthic habitats of the two bays is presented. Fibropapillomas are present in a substantial proportion of turtles at Puerto Manglar. To establish the relationship between water pollution and tumor incidence, we analyzed the concentration of fecal bacteria following EPA protocol in both habitats. Also, DNA-based markers were used to identify the presence of human fecal contamination; and finally 15N isotopic values of macro algae to determine level of waste water impact. The results of the three methods suggested some level of contamination at the Manglar study site and in a lesser scale at Culebrita. The importance of these green turtle aggregations for Puerto Rico and therefore for the whole Caribbean and Eastern Atlantic is evident. Current threats of human development in these feeding grounds are increasing and urgent management measures need to be taken.

GREEN TURTLE DIET IN CORISCO BAY (GABON, EQUATORIAL GUINEA)

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Corisco Bay occupies an area of approximately 1,570 square kilometers. It is dotted with small islands and sandbanks, and is bisected by the national border between Equatorial Guinea to the north, and Gabon to the south. It is a highly productive ecosystem composed of areas of sandy and rocky bottoms, including corals, sponges, seagrass and algal beds. This work represents a preliminary survey of green turtle (*Chelonia mydas*) diet in the area. Since 2003 we have been collecting samples from the digestive tract of individuals captured by the local population for sale and personal consumption. Algae were found to be the main diet component of the surveyed turtles (n=7). Even though a great number of seaweeds were found in the region, only seven species were considered to be the main components of the diet of the green turtles. The food items included two species of red algae (*Digenea simplex*, *Chondracanthus* sp.), two of green algae (*Chaetomorpha* sp., *Caulerpa taxifolia*) and three of brown algae (*Dictyota batresiana*, *Dictyoteris delicatula*, *Spatoglossum macrodontum*). Green algae were the most frequent component of the diet; both *Chaetomorpha* sp. and *Caulerpa taxifolia* were present in 57% of the stomach samples. Sea turtles and their Corisco Bay habitat are subject to several threats, including direct capture, trawling (leading to bycatch and seabed damage) and pollution. It is essential to continue diet composition and botanical studies, in order to further strengthen the arguments in favour of legal protection of this habitat, one of the most critical green turtle foraging and developmental areas along the Atlantic coast of Africa.

INFLUENCE OF THE FEEDING FACTOR ON HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN GUADELOUPEAN ARCHIPELAGO

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The hawksbill turtle, *Eretmochelys imbricata*, is a pantropical species that is abundant on coral reefs and feeds mainly on sponges. However, their feeding habits have never been studied in Guadeloupe and the impact of this species on the reef ecosystem is poorly understood. The INAScuba Protocol, of the Sea Turtle Restoration Plan of Guadeloupe, monitors foraging Sea Turtles in Guadeloupean coastal waters. This protocol is based on the local dive centers volunteering to record all their dives and turtle sightings since 2002. This protocol has been designed in order to estimate population trends of foraging sea turtles, to be used as an indicator of the restoration of foraging populations in Guadeloupe. Over 15,000 data of sea turtle sightings have been collected. Hawksbill turtle sighting data collected between 2002 and 2006, from three different areas were analysed: the "Côte sous le Vent" (west coast of Guadeloupe), "Les Saintes" (South Islands of Guadeloupe and "Port-Louis" (North of Guadeloupe). The study on their abundance variations allowed establishing that globally on "Côte sous le Vent" and "Les Saintes", these sightings are increasing which means that these populations follow this tendency. Different models have been compared using the Akaike Information Content). The Akaike Weight was used to compare the probability of different models to best represent the data. The exponential increase model was chosen as the most representative one. The statistical analysis of this data covered 16 sites (8 on the "Côte sous le Vent" and 8 in the "Saintes") where a sponge cover study by linear transect has been realized. At each site, three replicate 60 meters transects were sampled to visually identify the sponge species over 5 cm, count and measure them. Measurements were used to estimate the volume index. The intercept distance between the measuring tape and the sponge was recorded to estimate the sponge cover percentage. Hawksbill turtle abundance, the sponge cover percentage, the volume index and the number of sponge species were compared using MANOVA and ANOVA. The results indicate that Hawksbills influence the sponges' volume index on the sites where they are abundant. When the hawksbills are in a great number in a location, their predation on sponges seems to induce a decrease of their biomass. Thus, hawksbill turtles seem to play an important role to maintain reef biodiversity and aid in their conservation through predation on sponges. Their conservation may well be fundamental for coral reef health.

A JUVENILE HAWKSBILL AGGREGATION: LESSONS LEARNED FROM A 10 YEAR OLD MONITORING PROJECT IN THE DOMINICAN REPUBLIC

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Since 1996 we have been monitoring an aggregation of juvenile hawksbills using aquatic survey techniques at seven sites in Jaragua National Park, southwestern Dominican Republic (DR). This study expands and updates previously presented information on this aggregation which is very likely the most important one for the DR. As of July 2007, 1029 captures have been performed on 850 individual hawksbills. Turtle size has remained skewed toward small juveniles throughout the period (mean = 30.6cm straight carapace length, SD =6.7, range 18.1-69.1, n = 1025), and an increasing relative abundance has been detected at most sites. Recapture interval ranged from 23-2148 days (n =131) and mean distance from first to last recapture was on average 655 days (SD =1375). While the majority of recaptures showed high site fidelity (displacement less than 1km), two long-distance recaptures of our tagged

animals (Honduras and Colombia) suggest a more complex picture of residency. Mean annual growth rate was 4.8cm (SD = 1.7) but showed significant differences among study sites. Mark-recapture techniques were used to estimate population sizes under different model assumptions. Juvenile green turtles also occur regularly at most of the sites but at lower sighting frequencies (only 48 captures and 3 recaptures). Involvement of the same local field assistants and international sponsors has been crucial to the continuation and ease of implementation of monitoring activities. Recently, a greater involvement of youths from nearby towns has helped foster the projects' local acceptance and support.

IDENTIFYING MARINE ALGAE ASSOCIATED WITH SEAGRASS BEDS ON FORAGING HABITATS OF GREEN SEA TURTLES IN THE GULF OF VENEZUELA

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The Gulf of Venezuela, located in the northwest part of the country, is an important feeding area for four species of sea turtles, the green turtle (*Chelonia mydas*) being most abundant. This species has predominantly herbivorous feeding habits, reason why its frequency of appearance has been tied with the presence of seagrasses. It has been reported that the nutritional preferences of this species are related to the availability of food, reason for which it includes in its diet diverse species of marine algae which are abundant and diverse in the Gulf of Venezuela. The objective of this study was to identify and evaluate in a preliminary way the algal diversity associated to these seagrasses. We sampled the areas of Castilletes and Porshoure over a period of four months, vegetal samples were collected from shallow waters to depths of 15 m. These are common areas for capture of green sea turtles where the seagrasses (*Thalassia testudinum* and *Siryngodium filiforme*) are found. The collected samples were preserved and stored in formalin 4% for their identification with the use of a steremicroscope and an optical microscope. Between both localities we found 30 taxa of marine algae, grouped in 7 orders, 9 families, 15 genres, 19 identified species and 9 nonidentified species. A great part of the species and identified genres have been reported by several authors in stomach contents of *Chelonia mydas*, reason for which they potentially represent the diet of this species. This type of study constitutes a key tool to analyze the nutritional ecology of the species, and to understand therefore the relationship between the characteristics of its habitat and its foraging habits. It is important to give continuity to this type of investigations in order to go deeper into the knowledge obtained on the nutritional habits of this species in the Gulf of Venezuela.

THE SECOND POST-CONSTRUCTION ASSESSMENT OF JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) ON THE NEARSHORE REEFS OF BROWARD COUNTY

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There has been a long-lived struggle to document and protect populations of endangered green turtles along the shores of Southeast Florida. Most conservation efforts have been focused towards nesting females and hatchling success upon the beaches, however, little has been done to investigate ‘in-water’ juvenile (3-5 yr old; <65 cm SCL) green turtle populations that are also critical to the species as a whole. Coastal Planning & Engineering, Inc. (CPE) has been selected by Broward County to establish the first geographic information system (GIS) database of juvenile green sea turtle populations along the County’s nearshore developmental reef tracts. In response to the Broward County Shore Protection Project, a second post-construction record of juvenile green turtle population density along the nearshore reefs was completed. The 'Shark Fishing' surveying technique, a safe, effective, turtle-friendly approach for estimating turtle populations over nearshore hardbottom habitats was used. The data obtained during the late spring/early summer surveys is timed to record observations and density estimates during that period of the year when juvenile marine turtles establish strict home ranges. This hypothesis is supported by the similarity in the number of turtles observed during both the 2007 northward (43 observed turtles) and southward (37 observed turtles) directed efforts. Within the Broward County Shore Protection Project area of Segment III, turtles had no significant change in population abundance two years after beach construction (ANOVA; df = 7, P = 0.02). An average of one turtle was seen either swimming along the bottom, resting on the bottom, or at the surface approximately every 1.2 km. The Segment II control site also found no significant change in turtle abundance after completion of the Segment III Shore Protection Project (ANOVA; df = 7, P = 0.02). An average of one turtle was observed either swimming along the bottom, resting on the bottom, or at the surface approximately every 0.45 km. For the past five years, juvenile green turtle estimates have been recorded within the nearshore waters of Broward County. These waters have been shown to be a critical habitat for the development of immature green turtles, and the monitoring of their population estimates allows County officials to better regulate for the protection of this endangered species (Wershoven and Wershoven, 1988). Following beach restoration projects, the possibility of compromising nearshore hardbottom substrates through sediment coverage still remains. An archive of in-water survey records can be used to see if these effects cause either temporary fluctuations or long-term variation in the population dynamic.

CHANGES IN SEX RATIOS OF GREEN TURTLES (*CHELONIA MYDAS*) AT A MID-OCEAN DEVELOPMENTAL FORAGING SITE (1990 – 2007)*

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The seagrass beds of the Bermuda Platform support a large feeding aggregation of *Chelonia mydas* that originates from at least five different nesting beaches in the Caribbean Sea and Atlantic Ocean. These green turtles have been the focus of study of the Bermuda Turtle Project since 1968. Turtles are caught in a 625 m entrapment net at a series of regularly sampled grass beds. Captures to date indicate that there are few if any mature *C. mydas* on the Bermuda Platform and thus this aggregation represents a developmental site for immature green turtles (22.3 - 81.0 SCL min, mean = 47.37 ± 12.49 cm). Our data suggest that these turtles recruit to Bermuda at sizes of approximately 25 - 30 cm and depart Bermuda for more southerly foraging grounds at sizes of approximately 65-75 cm. In the interim they reside on the Bermuda Platform for some 10-15 years and perhaps longer. Thus, sex ratio data from this site represent an averaging of trends in sex ratio over time and space. Since 1990, the sex ratio of a large sample of green turtles from this site has been estimated annually via laparoscopy (n = 132), radioimmunoassay or a combination of these methods. Gender has been determined for about 2,500 green turtle captures (1,700 individuals) between 1990 and 2007. This data set allows testing of hypotheses regarding the effect of global climate change on sea turtle sex ratios.

HABITAT CHARACTERIZATION OF GREEN SEA TURTLE (*CHELONIA MYDAS*) KEY FORAGING GROUND, AT THE NORTH AREA OF PENINSULA GUAJIRA, GULF OF VENEZUELA

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The identification and characterization of feeding habitats are recognized as research priorities for the conservation of the sea turtles on a global scale. The Gulf of Venezuela (GV) is considered to be one of the most important feeding areas on the Venezuelan coast. Four species of sea turtle have been reported for the GV: green, hawksbill, loggerhead and leatherback turtle. Of these, the green turtle is the most abundant, and is the only species where juveniles, subadults and adults are present. Preliminary studies have revealed that the major components of the green turtle diet at most life stages are present in the GV. For the omnivorous juveniles, this includes hard and soft coral reefs with several sponge species and a diversity of macro-microalgae associated with rocky substrates; for the herbivorous adults this includes marine plants such as *Thalassia testudinum* and *Siringodium filiforme*. However, nothing is known about the location and extent of these marine habitats in the GV. As a first step towards characterizing these areas, we used a Geographic Information Systems (GIS) to integrate layers of data on depth,

substrate type and vegetation cover. These data were obtained between 2005 and 2007, during a total of 28 days of sampling, in which we surveyed 43 five km-long transects parallel to the coast and randomly allocated within an area previously identified as having high levels of illegal turtle hunting (38,700 hectares). We surveyed an average of 5 points per transect, which were regularly spaced 1 km apart, yielding a total of 211 points surveyed. Within our study area, we found that substrate types were: 60% (23,220 hectares) sandy with seagrass beds, 32% (12,384 hectares) sandy-rocky with macro-micro algae, coral reefs and associated sponges, and 8% (3,096 hectares) sandy without vegetation cover. These substrate types were found at all depths within the study area (a range of 3 to 15 m). However, seagrass beds were on average present in more shallow areas, with a mean depth of 5 m. We were able to further classify these seagrass beds as: only *Thalassia* (15%), mixed *Thalassia-Siringodium* (60%), only *Siringodium* (20%) and other species (5%). Thus, the most frequent single vegetation cover type in the area with high illegal green turtle capture in the GV was *Thalassia-Siringodium*, which covered 13,932 hectares in total. Previous studies have indicated that, although the total area of feeding habitat is probably much larger in Nicaragua than in the GV, the areas affected by illegal turtle capture in the two locations are comparable in extent. The present study further revealed that within these areas of illegal capture, the total extent of seagrass beds (and thus the potential foraging habitat available) is also comparable: 23,220 hectares of seagrass beds in the GV, compared to 20,000 ha in Nicaragua. The next steps toward more in-depth comparisons between the two locations will include studies of important factors such as seagrass bed productivity and green turtle habitat use in the GV.

SUBADULT LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) ARE FEEDING IN SOUTH COAST OF THE GULF OF VENEZUELA

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The importance of feeding grounds for sea turtles has been considered an area in which conservation efforts should be focused. The Gulf of Venezuela (GV), a center of artesanal fishing, is an important foraging area for five sea turtle species: green, hawksbill, loggerhead and leatherback. However, loggerhead turtles are the most abundant in the southern zone of the GV. This frequency may be the result of the substrate that supports invertebrates and a diversity of mollusks, which are the main diet components of subadult loggerhead turtles. Field surveys carried out between 2005 to 2007 included 21 subadult loggerheads collected in the southern region of the Gulf of Venezuela. All loggerheads were individuals captured by artisanal longline fishery. Very few of these turtles were released and were comprised mainly of subadults with the exception of one adult female. This situation shows that subadult loggerheads are vulnerable to an increasing artisanal longline fishery in the southern region of the GV. However, the communities in this area have demonstrated an interest in sea turtle conservation. Therefore environmental education tools and research involving the community are key strategies to mitigate negative interactions between fisheries and sea turtles in the southern area of the GV.

TROPHIC STATUS OF GREEN TURTLES (*CHELONIA MYDAS*) IN THE EASTERN PACIFIC BASED ON STABLE ISOTOPE (d15N, d13C) ANALYSES

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The green turtle (*Chelonia mydas*) is one of the most widely distributed sea turtle species in the world, facing as many threats as there are nesting beaches. To develop appropriate conservation measures it is important to know as much as possible about the species' life history strategy, particularly relating to foraging ecology. Classical dietary analytical methods such as esophageal lavage and fecal analyses have been widely applied, but they only provide a dietary "snapshot" which is inadequate for determining long-term diet and nutrient assimilation patterns. A more efficient approach is to analyze the stable carbon and nitrogen isotopes present in the animal's tissues, since they integrate information on assimilated nutrients over time. An added advantage is that this technique is minimally invasive and the analyses are conceptually straight-forward. The objectives of this study were to establish the variability and foraging ecology of green turtles and their trophic structure in the Eastern Pacific. Epidermis and index habitat species samples were collected from 259 animals captures among 7 different shallow water foraging grounds along the coasts of USA, Mexico, Ecuador and Peru. All samples were dried and analyzed for %C, %N, d13C and d15N by mass spectrometry. A comparison of stable isotope values among years shows a great consistency of d15N ($F_{4,52}=1.18$; $P=0.33$; range 16.00 to 17.75‰) in epidermis, which suggests it is a good diagnostic tool for long-term trophic status of green turtles. Stable isotopic composition of epidermis varied significantly among study sites for d15N ($F_{6,258}=94.25$; $P<0.001$; range 9.75 to 16.99‰) and d13C ($F_{6,258}=25.54$; $P<0.001$; range -16.77 to -12.29‰). Isotopic values for index algae and seagrass species at these foraging grounds varied significantly among sites for d15N ($F_{3,82}=7.37$; $P<0.001$; range 6.12 to 13.28‰) but not for d13C ($F_{3,82}=0.22$; $P=0.94$; range -16.03 to -13.62‰), a result possible related to small sample sizes. All sites except Bahia Magdalena had a nitrogen disparity between tissues and habitat values to an extent that suggests these populations were consuming invertebrates in addition to algae and/or seagrass. Future isotope analyses and trophic studies will be pursued to determine the source of these higher nitrogen values. These findings will hopefully help in the development of conservation measures for protecting green turtles, their food sources, and entire foraging habitats.

OCEANIC AND NERITIC FORAGING STRATEGIES OF ADULT LOGGERHEAD TURTLES: A SEXUALLY DIMORPHIC FEEDING STRATEGY?

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Analyses of skin samples for stable carbon and nitrogen isotopes were used to evaluate diet and habitat use of female loggerhead turtles (n=308) prior to their arrival at nesting beaches in Florida. Samples were collected in 2003 and 2004 from turtles nesting at four locations on the east coast of Florida. We simultaneously collected samples of invertebrates on the carapaces of nesting turtles (n=60) from one of the sites, Canaveral National Seashore. Stable isotope analyses of skin indicate that prior to the breeding season, loggerheads nesting in Florida use two different foraging strategies. From 45 to 70% of females forage in oceanic waters, whereas the rest forage in benthic habitats of neritic waters. Analyses of epibionts collected from turtles sampled for stable isotopes indicate that the species and density of invertebrates present on turtles from oceanic habitats differ from those found on turtles from neritic foraging habitats. Our analyses of 13C and 15N and epibionts from nesting loggerheads led us to our next question. Do male loggerheads exhibit the same pattern? Based on stable isotope analysis of blood samples from 14 male loggerheads captured off Cape Canaveral, Florida, male loggerheads do not exhibit the bimodal pattern in foraging habitats that was found in female loggerheads. We are collecting more samples from male loggerheads to validate this apparent sexually dimorphic pattern.

A CELLULAR AUTOMATA APPROACH TO PREDATOR-PREY MODELING IN LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)

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Western Atlantic loggerhead sea turtles navigate a gauntlet of predators as they migrate directly from their natal beaches to the open ocean. Very little, however, is known about predation rates on post-hatchlings after they leave the shore. Primary sex ratios along nesting beaches of the south-eastern U.S. vary from 9:1 females to males in south Florida to 1:1 near the northern limit of the nesting range. The south Florida subpopulation makes up approximately 90% of annual loggerhead production. Therefore, the overall expected loggerhead sex ratio should be highly skewed towards females at about 6F:1M. Surprisingly, neritic juvenile populations of the south-eastern U.S., as well as juvenile populations of primary habitats along the eastern Atlantic, show a sex ratio of approximately 2F:1M. The mechanism of this occurrence remains uncharacterized. Several plausible scenarios have been proposed to explain this discrepancy including: sex-specific differential fitness and the existence of unknown subpopulation primary habitats. In this work, we present a cellular automata based model designed to simulate the predator-prey interaction during post-hatchling migration to the open ocean. To the authors' knowledge, the effort by Witherington and Salmon (1992) is the only attempt to quantify predation rates of post-hatchling migration in loggerheads. They tracked turtles for as long as two hours swimming from their natal beaches and compared predation rates during day and night. Observed predation rates were lower than those observed in other sea turtle species, emphasizing the need for further studies. Despite the lack of empirical predation estimates, stock assessment reports from the SouthEast

Data, Assessment and Review (SEDAR) process provide the public with a compilation of relative abundance information for various fish species in the form of catch per unit effort data. These data enable us to make relative estimates of individual predator species as a function of geographic location. A cellular automation is a discrete model consisting of a fixed number of cells (or locations) each represented by a single state at any given time step. There are a finite number of states and here we model female and male turtles and one or more predators as specific states. Male and female movements are not completely random, but tend towards the open ocean. Cellular automata parameterized with primary sex ratio data, show us that under conditions of increased predation, survivors completing the voyage to the oceanic juvenile stage are comprised of ratios closer to those found in neritic juvenile subpopulations. The 2F:1M sex ratio cannot be fully explained without considering the mixing of stocks and the different predation conditions associated with each. Currently, we are developing the model to explore factors that contribute to neritic juvenile sex ratios including: the effect of differential fitness, modeled as a sex specific difference in swim velocities, swim distance to the gulf stream and varying degrees of predation pressure. Initial results show that cellular automata analyses are potentially an important tool for the study of sea turtle population dynamics.

SIZE DISTRIBUTION OF GREEN SEA TURTLES (*CHELONIA MYDAS*) FEEDING IN THE GULF OF VENEZUELA

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The Gulf of Venezuela (GV) is a foraging ground for five sea turtles species: green, hawksbill, loggerhead and leatherback. Of these, the green turtle is the most abundant and is the species most impacted by artisanal fisheries. The extensive prairies of seagrass present in the study area constitutes suitable habitat for a great number of green turtles. These turtles are from some of the most important nesting colonies in the Caribbean and use this area as a feeding area and migratory corridor during the nesting seasons. To identify which green turtle life stages were present at the GV, we collected 209 carapace measurements during beach surveys between 2002 and 2007. Analyses of the following measurements were taken from all carapaces: Maximum Carapace Length and Maximum Carapace Width (MCL and MCW). These measurements show that juveniles, subadults and adults are all present in the GV. Sixty-six percent (n=137) of the turtles measured were juveniles and subadults, and 34% (n=72) were adults, mainly females. These results permitted us to confirm that the Gulf of Venezuela is a feeding ground used by green sea turtles, mainly juveniles and subadults. However, it is important to note that adult green sea turtles, mainly females are the most impacted by artisanal fisheries. Conservation programs are still necessary to mitigate the interactions between sea turtles and artisanal fisheries.

SIZE DISTRIBUTION AND REPRODUCTIVE STATUS OF LOGGERHEAD TURTLES AT BAJA CALIFORNIA SUR, MEXICO

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The waters of the Pacific coast of Baja California Sur, Mexico (BCS) represent important foraging habitat for five of the world's seven sea turtle species. Two of the five species nest and forage at BCS (Dc and Lo) the other three (Cc, Cm and Ei) migrate to BCS waters from distant nesting areas. The endangered North Pacific loggerhead population nests exclusively in Japan and juveniles undertake developmental migrations that can last several decades and span the entire Pacific. Tens of thousands of loggerheads aggregate in BCS waters, apparently to forage their way to maturity and to fuel their return migration to Japan, where they are thought to remain in the western Pacific through adulthood. Because hundreds of loggerheads are accidentally killed in small-scale fisheries along the BCS coast annually, it is essential to verify the reproductive status of the BCS foraging population to evaluate the demographic effects of this bycatch mortality. Loggerhead nesting has never been reported in the East Pacific. However, despite the conventional wisdom that upon approaching maturity juvenile loggerheads return to and remain at West Pacific nesting and foraging habitats, adult-sized—presumably reproductively mature individuals—and mating behavior have been reported from BCS waters. In this study we assessed the size distribution and reproductive status of individuals caught and stranded at BCS. From 2003-2007 we collected morphometric data on over 2300 stranded loggerhead carcasses and over 400 hand-captured individuals. In 2006 we began photographing and collecting gonads from fresh-dead, stranded carcasses. The aim of this study is to i) characterize the reproductive status of loggerheads (*Caretta caretta*) on BCS foraging habitat through analysis of their gonads, ii) evaluate the relationship between their reproductive status and size, iii) compare loggerhead size between their BCS feeding and Japanese nesting areas, and iv) evaluate the existence of a threshold carapace length and/or ontogenetic condition of gonads for loggerhead transpacific remigration.

EVALUATION OF THE FORAGING HABITS OF THE GREEN TURTLE (*CHELONIA MYDAS*) IN BAHÍA MAGDALENA, B. C. S., MÉXICO, USING STABLE ISOTOPE (d15N, d13C) ANALYSIS

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Studies related to the foraging ecology of sea turtles can help us clarify their roll as predators and their importance to marine ecosystems. This information can be used to develop conservation measures for protecting green turtles and their food sources. Until now, most studies have focused on the analysis of stomach content to describe the foraging ecology of green turtles. This method has some disadvantages, principally because it only represents a dietary "snapshot" and is inadequate for determining all the sources that have been assimilated. An alternative that has been proposed from diverse authors is the use of the stable carbon and nitrogen isotopes, since they integrate information

on assimilated nutrients over time. The objectives of this study were to establish the variability in the trophic position and principal food sources of the green turtles that feed in Bahía Magdalena. Blood plasma and epidermis samples were collected from 29 animals and 19 index habitat species at different seasons in the year. All samples were dried and analyzed for %C, %N, d15N and d13C by mass spectrometry. Stable isotopic composition did not vary significantly among tissues for d15N, but did for d13C, possibly reflecting differences in their biochemical composition. A comparison of stable isotope values along the study period shows a great consistency of d15N in both blood plasma and epidermis and d13C in epidermis, but not for d13C in blood plasma. The isotope signatures between different size classes are consistent among all tissues with the exception of d15N in blood plasma. The results suggest that this population maintains the same trophic position throughout the year, but their principal food items maybe changing in a short-term scale. The isotopic signatures of green turtles can be found within the range of potential food sources analyzed, except for brown algae and seagrass, which confirms that the principal food source consists of chlorophyta and rhodophyta species and may also include some invertebrate species.

PRELIMINARY RESULTS ON THE ECOLOGY AND CONSERVATION OF IMMATURE BLACK TURTLES, *CHELONIA MYDAS*, AT A COASTAL FORAGING AREA IN BAJA CALIFORNIA SUR, MEXICO

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Located on the Pacific coast of Baja California Sur, Mexico, San Ignacio Lagoon (SIL) is part of the El Vizcaino Biosphere Reserve. The lagoon is shallow, protected, and has extensive sea grass and algae beds that provide critical habitat and food resources for the black turtle, *Chelonia mydas*, also known as the east Pacific green turtle. SIL was once a major center for sea turtle hunting on the Baja California peninsula when the fishery was still legal. Today, despite a complete moratorium on the use of sea turtles in Mexico, the lagoon continues to be a “hot spot” for poachers who supply turtle meat to residents of northern Mexican cities and sometimes even U.S. border cities. Francisco “Gordo” Fisher, a well-known poacher who operated out of SIL, admitted to illegally collecting and selling more than 100 metric tons of black turtles during his eight years as a poacher. Since 2001, Grupo Tortuguero has been monitoring black turtles at SIL, collecting standard morphometric data, determining relative abundance, and measuring growth. In collaboration with Grupo Tortuguero and the Earthwatch expedition Tracking Baja’s Black Sea Turtles, this research will expand upon the work conducted in SIL during the past decade. Preliminary results will be presented on black turtle distribution and movements, population characteristics, and mortality estimates. From this research and analysis, we will be able to determine a framework to inform existing conservation efforts such as Ocean Conservancy’s SEE Turtles program, which includes Baja California Sur as one of its three initial conservation tourism sites. Results from this research will also help inform conservation decisions in similar foraging areas where illegal poaching and incidental bycatch are high. In addition, this study will provide critical ecological information on the black turtle, a species listed as endangered under the IUCN Red List.

STATUS OF HAWKSBILL SEA TURTLE (*ERETMOCHELYS IMBRICATA*) IN A FORAGING HABITAT IN THE GULF OF VENEZUELA

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The Gulf of Venezuela (GV) is a foraging ground for 5 sea turtle species. The second most common is the hawksbill sea turtle, especially in coral reef areas, where sponges are abundant, the principal component of their diet. Mostly, sub-adults and juveniles are found, although there are adults too. This species is greatly endangered because it is exploited for its shell without any regulation. In the GV there are a lot of trading ports were hawksbill shells are commercialized freely. Most of them are captured by artisanal fishermen who employ nets and harpoons for their capture in key feeding areas. At least 20 juveniles or sub-adults are anually poached in the northern part of the gulf. The location with most carapaces found up to date is Castilletes, followed by Porshoure. Both ports are located in the northern zone of the GV, where the hawksbill turtle is most common. In the southern part of the GV there are fewer records of carapaces found. Based on the measures of the LMC, it was estimated that the most common age group is juvenile to sub-adults (79,59%) followed by adults (24,41%). There are no records of hawksbill in an early stage. Conservation campaings must be employed in the ports around Gulf of Venezuela, to avoid or reduce to a minimun the killing of hawsbill sea turtle, taking in consideration that it is difficult to employ educational programs in these areas because Wayúu culture allows killing turtles without guilt; because they see it as a gift from God. Nevertheless because the Gulf of Venezuela has a suitable habitat for hawksbill sea turtle, it must be protected, otherwise it will continue to affect the breeding colonies where these hawksbills come from, and overall the global population.

THE "TANQUECITO" - A TECHINIQUE TO ENHANCE TURTLE CAPTURE SUCCESS DURING SNORKELING SURVEYS

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We describe the use of a simplified SCUBA system for use during snorkeling surveys for marine turtles. The "tanquecito" consists of a 13 cu ft SCUBA tank fitted to a compact harness that enables snorkelers to carry compressed air when needed to catch turtles. With practice, this method can significantly enhance the effectiveness of turtle capture efforts, especially where depths exceed 15 m (50 ft) and/or when attempting to hand-capture adult hawksbills. This method is currently used during in-water surveys at Mona Island (Puerto Rico) and Bonaire (Netherlands Antilles).

USING STABLE ISOTOPES TO INVESTIGATE SEA TURTLE ECOLOGY

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Stable isotopes have increasingly been used in ecological research to examine diet, trophic interactions, nutrient cycling, migration, and life history ecology. Stable isotopes have not been extensively utilized in sea turtle research, although they have been used in several contexts summarized in this review. These studies include 1) determining isotopic discrimination and rates of incorporation, 2) diet analysis and trophic status, 3) nutrient cycling in ocean and beach ecology, 4) predation of sea turtle nests, 5) respiratory physiology and diving behavior, and 6) information about the location of cryptic life stages. Isotope ratios of animals reflect those of their diets with some enrichment due to selectivity of the heavier isotopes in metabolic reactions. Typically, 13C and 15N can be used to identify trophic level and diet in terrestrial mammals based on standard enrichment factors. Only two studies thus far have examined the rates of incorporation of 13C and 15N in sea turtles, which is critical to interpretation of data for diet and trophic level analyses. Stable isotope analysis of tissues reflects diet over a long period, which can be an improvement over stomach content analysis in determining dietary history, as gut contents only provide a snapshot in time. Use of stable isotopes in dietary studies has revealed patterns in alternate foraging strategies of both loggerheads and green turtles as well as the trophic status of several species. Stable isotope ratios can also be used to examine nutrient flow, as ratios differ with ecosystems, but have been used on only two nesting beaches. Sea turtles typically forage in nutrient-rich marine ecosystems and nest on nutrient-poor beaches. Recently, it was determined that green turtle and loggerhead nests supplement beach soil and dune vegetation with marine-derived 15N. I plan to further study the role of green turtles as biological nutrient transporters by using stable isotope analysis to examine the spatial and temporal fluxes of nutrients from green turtle nests through the beach ecosystem at Tortuguero, Costa Rica. More specifically, I will examine how nutrient availability and incorporation varies with nest density and how the additional nutrients may affect plant productivity. This review investigates the diverse approaches for incorporating stable isotope analyses in sea turtle research and the ramifications for conservation as well as future directions for my own research involving stable isotopes to examine the nutrient flow between marine and terrestrial ecosystems.

OCEANIC-STAGE KEMP'S RIDLEYS FROM THE OPEN WATERS OF THE GULF OF MEXICO*

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Young oceanic-stage Kemp's ridleys (*Lepidochelys kempii*) are almost never observed at sea. This report describes observations of 14 *L. kempii* juveniles that were located in the open waters of the eastern Gulf of Mexico. The observations were made during August in the years 2005, 2006, and 2007, on cruises out of Sarasota, Apalachicola, and Pensacola, Florida (USA). Cruises were made with the purpose of finding epi-pelagic sea turtle habitat. This search effort targeted frontal zones revealed by geostrophic currents modeled from NOAA satellite altimetry data. All turtles were observed within floating lines of pelagic Sargassum algae 35—70 NM from shore in water depths of approximately 100—600 m. Six of the 14 *L. kempii* were captured by dip net. Captured turtle sizes ranged from 21.7 to 25.4 cm CLSL and from 1.7 to 2.7 kg. Turtles that evaded capture dove perpendicular to the water's surface or beneath dense Sargassum mats. Turtles evading capture were believed to have been approximately 25 cm CLSL. Instantaneous behavioral observations made upon first discovery (n=14) recorded seven turtles using their front flippers to part Sargassum ahead of their mouth, five turtles swimming slowly with their front flippers breaking the water's surface, and two turtles inactive with their carapace and front flippers above the water. One captured turtle

was fitted with a time/depth/temperature data logger, released at its capture site, and recovered after approximately 24 hours. This turtle's depth and temperature data profiles showed extensive time at the surface during daylight, and several nocturnal dives to a thermocline at 20 m where the turtle remained for several minutes each dive. Our observations indicate that surface waters of the eastern Gulf of Mexico provide important developmental habitat for *L. kempii* that have not yet recruited to coastal neritic habitats.

AN EVALUATION OF SINALOA'S COAST (GULF OF CALIFORNIA, MEXICO) AS DEVELOPMENTAL AND FEEDING HABITAT FOR SEA TURTLES

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Starting in 2005, we began monitoring in the lagoon system San Ignacio-Navachiste-Macapule, municipality of Guasave, México (25° 15'N and 25° 35'N and 108° 30'W and 109° 03'W). The objectives of this monitoring in

water and along the coasts were to 1) determine sea turtle species diversity; 2) determine temporal and spatial distribution of sea turtles; 3) determine basic biological parameters of turtles that will be captured (i.e. weight, length, sex); 4) identify primary threats to sea turtles due to anthropogenic impact; and 5) establish an integral program for the conservation of sea turtles with the involvement of local communities. Prospective studies began with the participation of river fishermen and student volunteers in the lagoon system and around all islands within the system. We documented 55 live and dead sea turtle strandings from three species: olive ridley, *Lepidochelys olivacea* (73%), black, *Chelonia mydas* (20%) and hawksbill, *Eretmochelys imbricata* (7%) sea turtles. Preliminary analysis of frequency distribution of straight carapace lengths (SCL) for live ridleys ranged from 10-71 cm SCL dominated by turtles falling within 61-70 cm (56%). Black turtles ranged 26-110 cm SCL dominated by turtles sizes 51-60 and 61-70 cm. Hawksbill turtles ranged 36-90 cm SCL dominated by turtles 36-50 cm SCL. The smallest turtles found were olive ridleys (12.9 cm). Prospective studies continued in 2006 in the marine zone. We captured, measured and marked five olive ridley turtles (three females, one male and a juvenile weighing 10 kg and measuring 42cm SCL). These turtles were captured by hand in the water using the "jumping" technique and a net designed by local fishermen. When it was not possible to capture turtles we documented turtles to species by sight and registered location with a GPS. We recovered a hawksbill entangled in fisheries debris (6 kg and 39cm SCL). We brought this turtle into captivity. Following a successful rehabilitation the turtle was released 60 days later. We documented seven confiscated turtles from illegal fisheries by the Marines (all adult turtles: seven black and one hawksbill). Preliminary results demonstrate the importance of these habitats for feeding and development for three of the five sea turtle species present in the Gulf of California. We have partnered with experts in the new field of conservation medicine to begin careful health evaluations of sea turtles in these ecosystems. Following interviews with fisheries communities we documented the practice of sea turtle consumption and illegal sale. Probably there is a significant impact to these threatened species due to illegal trade.

Genetics

GEOGRAPHIC DISTRIBUTION OF MTDNA SEQUENCE VARIATION AMONG MEXICAN GREEN TURTLE ROOKERIES FROM THE GULF OF MEXICO AND CARIBBEAN SEA*

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With more than 8,000 nests a year laid in over 40 nesting beaches in the Gulf of Mexico and Caribbean, the Mexican green turtle breeding assemblage is one of the largest in the Atlantic basin. As a result of direct conservation actions at national and regional scales these populations show signs of consistent increases in nest abundance (global avg. > 12% per annum 1988-2006) although trends are not identical between sub-regions within the country, nor is the same trend consistent across the Atlantic. Though sketchy for Mexico, flipper tagging and satellite telemetry also reflect behavioral differences between populations. Effective management of this highly migratory species is difficult at both national and regional levels without accurate knowledge of the number and geographic distribution of individual demographic units. To improve our understanding of the genetic structure of the Mexican populations we analyzed the geographical distribution of sequence variation in 800 bp mtDNA control region amplicons from 480 individual samples, derived from the 16 most important rookeries in Mexico spanning the species' nesting distribution in the Atlantic coast (from Tamaulipas to Quintana Roo). Our purpose was to (1) identify the individual breeding stocks (or management units, MUs) present in Mexico, (2) assess the geographic scale at which genetic discontinuities exist between MUs, and (3) use the haplotype profiles to re-evaluate the contribution by Mexican MUs to previously studied regional foraging sites (FGs). We resolved a total of 12 distinct haplotypes; six had already been reported but only in Quintana Roo (CM-A1, -A3,-A16, -A17, and –A18); four had only been reported at a foraging site (-A22, -A26, -A27 and -A28); one (-A2) had never been reported for Mexico; and one new haplotype. Genetic differentiation appeared to be correlated with geographic distance between rookeries (R2=0.32) with a general East-West decline for the proportion of the two most common haplotypes CM-A1:CM-A3. Nonetheless, exhaustive pair-wise Fst analyses indicated the presence of four genetically discrete breeding stocks (MUs) consisting of either a single or a group of continental rookeries in close proximity: Tamaulipas-Veracruz, Campeche-Yucatan, Quintana Roo, or rookeries nesting on reef beaches: Cayo Arcas- Arrecife Alacranes. Significant genetic differentiation was generally found between rookeries separated by more than 500km, with the marked exception of the insular rookeries (less than 250km). Preliminary Mixed Stock Analyses, including our new data, on three previously published datasets from regional foraging sites where Mexican haplotypes have been reported (Bahamas, Barbados and North Carolina) not only eliminate the majority of "orphaned" haplotypes but also indicate that the contribution from Mexican rookeries is much greater (2-3x that of previous results) and more complex, with levels of contribution varying for the different MUs. Having a capacity to distinguish the movement and dispersal patterns of four different MUs in Mexico with new genetic data our ability to address basic ecological and management issues has improved dramatically.

ORIGIN OF LOGGERHEAD TURTLES (*CARETTA CARETTA*) FROM THE CENTRAL MEDITERRANEAN NERITIC FORAGING GROUND

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The wide North African continental shelf in the central Mediterranean is known to be one of the few important areas in the basin for loggerhead turtles in their neritic phase. The high fishing effort in this area, especially by trawlers with consequent high number of captures and probably high mortality, is reason of concern for the conservation of marine turtles in the Mediterranean. Moreover, the basin hosts several distinct colonies considered as independent management units for conservation, an additional factor of vulnerability. In this context, it is important to assess the origin of the turtles frequenting this area. Tagging showed that this area represents a foraging ground at least for turtles from Greece. To investigate if possible other populations use this area, samples for genetic analysis were collected from 70 turtles caught by trawlers harbouring at Lampedusa Island. Sequences of the mtDNA control region were obtained and compared with those known from Mediterranean and Atlantic nesting sites. Results showed that sampled turtles are from different and distant nesting sites, such as Turkey and West Atlantic. Unfortunately, gaps still exist in the knowledge on haplotype composition and frequencies from different Mediterranean and Atlantic nesting sites, and the low degree of differentiation between some of them undermines a proper mixed stock analysis. However, preliminary results suggested that the continental shelf of the central Mediterranean represents a neritic foraging area for turtles from most of the Mediterranean nesting areas. Moreover, in contrast to previous reports, Atlantic turtles that enter the Mediterranean in the oceanic phase, appeared to use the Mediterranean continental shelf as neritic foraging grounds, where they are subject to incidental catch by trawlers.
Acknowledgements: Participation to the Symposium was possible thanks to a travel grant by the Sea Turtle Symposium and the following organizations: Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, as well as two generous individuals: Carlos Peralta Quintero and Robert N. Allen, Jr.

MICROSATELLITE DNA DIVERSITY IN GUIANAN OLIVE RIDLEYS

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The olive ridley is the most threatened sea turtle in the Guianas region (Guyana, Suriname, French Guiana). Dramatic declines of nesting activity have been reported over the last decades, and beaches of Guyana do no host nesting females anymore. Together with monitoring on sites, microsatellite nuclear DNA polymorphism was screened in order to better understand the population‘s dynamics and to help the implementation of adequate

conservation strategies in the region. Samples came from French Guiana (n=60, nesting females sampled in 2005 and 2006), Suriname, Honduras and Costa Rica (n=50 per country, piece of skin of formalin-preserved hatcheries collected in the 1980s). Despite the low success rate of DNA amplification with formalin-preserved tissue, levels of allelic and genetic diversities, heterozygosity, and gene flow could be evaluated to complement the data on population trends. Guiana's population shows high level of genetic diversity, mitigating the pessimistic suppositions that could be made of genetic erosion if nesting activity alone were taken into consideration. Unsuspectedly, two ancestral stocks were detected in the Guiana population with the molecular results, providing new insights on the dispersal of the species in the Atlantic basin.

BLACK TURTLE (*CHELONIA MYDAS*) CONSERVATION IN THE MEXICAN PACIFIC, A GENETIC PERSPECTIVE

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Nowadays, political and economic forces drive most conservation efforts to secure the persistence of endangered species. To be successful, such conservation efforts should preserve the processes of life, a task that requires the identification and protection of branches in the tree of life, the maintenance of life-support ecosystems, and the continued adaptation of organisms to changing environments. Nowadays, state-of-the-art genetic techniques and algorithms have become widely used for such purposes. Under this perspective, we review the value of available genetic information for the black turtle conservation agenda in the Mexican Pacific: i) DNA sequence comparisons have served to fullfill phylogenetic goals, pointing that black turtles nesting in the area belong to a single species that is globally comprised by various ecotypes or sub species (that are continuously revised); ii) Former analyses of neutral markers have served some ecological goals. These point towards the existence of what appears to be a large continental subpopulation that nests in Michoacán and a smaller insular one that nests in the Revillagigedos Archipelago. In addition, our study conducted at Bahia Magdalena (BM), Baja California Sur, revealed a relevant conservation problem: The area serves as a feeding and developmental ground for juvenile black turtles that are frequently poached for local consumption or illegal trade. However, it was unclear if just one or various nesting colonies in the Eastern Pacific were contributing to this black turtle aggregation and were consequently affected by high mortality rates. Thus, we analyzed mitochondrial control region haplotype sequences (n= 60 turtles) using a phylogenetically based aggregation approach, to assign each turtle sampled in BM to its most probable nesting colony. Five haplotypes were found among sampled black turtles: four of them, including one not previously described (Cm001), were found to belong to nesting colonies in mainland Mexico (Michoacán), and a fifth one appeared to belong to the Revillagigedos Archipelago. Combining this information with haplotype frequencies we estimated the contribution of different nesting colonies to the mixed stock at our study area, and we found that the contribution of individual breeding colonies was similar to other feeding grounds in the Peninsula of Baja California. Therefore, two black turtle nesting populations of quite different sizes (Revillagigedo << Michoacán) are contributing equally to a mixed stock that is being subject to incidental capture and illegal poaching, with serious conservation implications (further Bayesian population assignment analyses are needed to confirm the latter). Also we found a slight, but significant, difference in spatial structure between the feeding areas of the Gulf of California and the Pacific ($\Phi ST = 0.05489$; $P = 0.00098$). Finally, our analyses help to clarify the contribution of different breeding colonies to the feeding areas around B.C.S., and provide important information for the conservation of the black turtle in the future. However, it is evident that much more genetic research is needed to fullfill evolutionary conservation goals aimed to assess the adaptation potential of black turtles to the changing environment in the Mexican Pacific.

USE OF MICROSATELLITE MARKERS FOR MATCHING GREEN TURTLE NESTS TO FEMALES ON MOLOKAI IN THE HAWAIIAN ISLANDS

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Almost all green turtle nesting in the Hawaiian Islands occurs at French Frigate Shoals (FFS), a remote reef with several sand islets located at the midpoint of the 2,400 km linear archipelago. However, there have been sporadic nestings observed on the beaches of the main inhabited islands, including Kauai, Oahu, Maui, and Molokai. Nesting has been monitored by The Nature Conservancy community volunteers at Kawaaloa Beach. Given the low numbers of nestings, only one nester has been tagged and sampled, in 1997, and monitoring is confined to observation of nests. In the absence of tagging, it is unclear how many females nest on this beach. We developed and tested a genetic approach to inferring the number of individual nesters from genotypes determined from dead embryos and hatchlings sampled from a total of 5 nests laid on Molokai. Samples were salvaged from non-viable embryos following emergence of the nests, and were from one nest laid in 2004 and four nests laid in 2006. We used mitochondrial DNA (mtDNA) sequencing combined with nuclear DNA analysis with 15 microsatellite markers to evaluate the potential number of nesters. Results showed all nests were laid by a female with the same mtDNA haplotype as the female sampled in 1997, which interestingly is a relatively uncommon haplotype only found in 16% of the Hawaii population based on the extensive survey of FFS and the foraging populations and strandings throughout the archipelago (Dutton and Balazs unpublished data). Based on the microsatellite genotypes, we identified a hatchling from at least one nest laid in 2006 as the offspring of the nester sampled in 1997. This female's alleles were absent at one or more loci of the offspring genotypes, indicating that the other four nests were likely laid by different females, however the combined results indicate Molokai greens sampled are closely related; nests share between 25 and 50% of their alleles with the female that nested in 1997, and match with at least 11 out of the 15 markers. This suggests that the sporadic nesting observed on Molokai may have resulted from a recent founder. Further evaluation of the markers and additional sampling is underway. Our results show that these genetic tools can be applied to provide insights for population assessments where access to nesting females is difficult.

THE GENETIC STRUCTURE OF WESTERN AUSTRALIAN GREEN TURTLES (*CHELONIA MYDAS*): AN ANALYSIS OF THE GEOGRAPHIC SCALE OF GENETIC EXCHANGE*

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Recent interest in development of coastal and island habitats in Western Australia has highlighted a need to better understand the dynamics of the marine turtle populations that use these areas. Green turtles (*Chelonia mydas*) nest on both mainland and island beaches, and rely on important offshore foraging grounds throughout the region. These regions are of global importance because the Western Australian coastline supports some of the largest green turtle populations remaining in the eastern Indian Ocean. Genetic studies have provided an understanding of the genetic

structure of green turtle populations in the region, but at present there are important gaps in our knowledge. Nesting populations have been analysed using mitochondrial DNA (mtDNA) sequencing techniques from the Lacepedes Islands, North West Cape, Scott Reef and Ashmore Reef. Foraging populations have been analysed from the Cocos (Keeling) Island and Ashmore Reef; further east from Fog Bay, Field Island and the Cobourg Peninsula and further north from Aru, Indonesia. However, some important foraging populations have not been studied, and for some rookeries increased sample sizes are required to improve the robustness of the analysis. The research presented here focuses on the stock composition of feeding grounds, based on increased sampling of potential source rookeries to understand more clearly the dynamics of the populations. We have advanced on previous work by increasing the sample size of the nesting locations to 35-40, and all foraging populations to 60-70 individuals. We included new nesting populations from several offshore islands (Browse Island, Barrow Island and Maret Island), as well as two previously unstudied foraging populations at Shark Bay and Cocos (Keeling) Island. Samples were assayed for variation in mtDNA by sequencing approx 800 base pairs of the control region. This region spans the 384 bp used in previous studies, thus allowing for comparisons. The longer sequence was used with the hopes of gaining increased resolution with a longer read. This would be particularly useful in SE Asia, the Timor and Arafura Seas and east Indian Ocean, where many of the turtles have two very common mtDNA variants (C1 and C3), which make it difficult to accurately assign turtles to their origins when sampled from their feeding grounds. The new markers were used on turtles that have the C1 and C3 variants to screen for additional variation that could enhance our capacity to distinguish among nesting populations. Results are presented from the analysis of four new nesting populations and two new foraging populations, along with a re-analysis of four nesting and two foraging populations that were previously reported.

FERTILIZATION ORDER IN *CHELONIA MYDAS* BREEDING IN THE MICHOACAN COAST, MEXICO

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There are still many aspects of the sea turtle life cycle that remain obscure largely because as they are adapted to an aquatic life the only moment at which they are easy to study is when the breeding females arrive at beaches in order to nest. Genetic tools allow insight of aspects that could have implications to the understanding of the structure and function of the female reproductive tract. In this study we used the paternal assignment for each hatchling in the order in which it was laid as an indirect means to determine the fertilization order within the reproductive tract. We gathered samples from the hatchlings belonging to two nests from the *Chelonia mydas* population nesting at Colola Beach, Michoacan state, Mexico. Nuclear DNA was extracted from the tissue samples by proteinase K digestion (overnight) followed by ethanol precipitation. PCR was carried out in order to detect multiple paternity using the two microsatellite loci Ei8 and OR1, previously reported for *Eretmochelys imbricata* (hawksbill) and *Lepidochelys olivacea* (olive ridley) respectively. The order of paternal genotypes in our results show that while the two analyzed clutches were fertilized by multiple males (2 males for one clutch and 3 males for the other clutch), there was no specific fertilization order within the reproductive tract. This suggests that the sperm used for the fertilization of eggs is a mixture of the seminal fluid present inside the female. This is an alternative application of molecular techniques that allows a novel insight into one of the more obscure aspects of the anatomy and physiology of the fertilization process in sea turtles.

CONSERVATION GENETICS OF NORTH ATLANTIC LOGGERHEAD SEA TURTLES: ANALYSIS OF NUCLEAR AND MITOCHONDRIAL DNA

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Complex population structure has been described for the loggerhead sea turtle (*Caretta caretta*), revealing lower levels of population genetic structure in nuclear compared to mitochondrial DNA assays. This may result from mating during spatially overlapping breeding migrations, or male-biased dispersal as previously found for the green turtle (*Chelonia mydas*). To further investigate these multiple possibilities, we carried out a comparative analysis from twelve newly developed microsatellite loci and the mitochondrial DNA control region (~804 bp) in adult females of the Cape Verde Islands (n=158), and Georgia, USA (n=17). The Cape Verde archipelago harbours the third largest loggerhead sea turtle nesting aggregation in the world, after the populations of south Florida, USA and Masirah, Oman. Cape Verde is also the sole major confirmed nesting area for this species in the eastern Atlantic. Our results reveal levels of gene flow across different genetic markers between North Atlantic loggerhead sea turtle rookeries, providing insight into the mechanisms leading to complex population genetic structure that would provide immediate conservation applications.

THE ORIGIN OF GREEN TURTLE (*CHELONIA MYDAS*) FEEDING AGGREGATIONS ALONG THE ARGENTINE COAST

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The green turtle, *Chelonia mydas*, like other species of marine turtles, show great migratory displacements from the reproduction areas towards the feeding zones. Since 2003, the Program Regional de Investigation and Conservation of Sea Turtle of Argentina (PRICTMA), analyze the situation of these reptiles on our coasts providing evidence of their use of the habitat. In the present work we determine the genetic composition of the green sea turtle in feeding and development areas of Argentina inferring the probable natal origins in relation to the different nesting beaches from the Atlantic Ocean by means of the analysis of 490pb of the control region of the mitocondrial DNA. The sequences were edited, aligned and compared with the described haplotypes for 12 nesting sites (Naro- Maciel *et al*. 2007). Sixteen out of 31 analyzed juvenile individuals (33 - 48.8 cm curved carapace length) exhibited CM8 haplotype, 10 individuals showed the CM5, 2 individuals had CM42 whereas the CM9, CM6 and CM32 haplotypes were present in one individual. Haplotype CM42 has not been described in nesting beaches and had been detected in the feeding zones of the Bahía de Corisco (Gabon), the Gulf of Guinea (Formia 2002), and Almofala- Brazil (Naro-Maciel *et al*. 2007). This result demonstrates the necessity of more exhaustive studies in the nesting beaches with the intention of obtaining a better characterization of them. The genetic diversity was evaluated through the haplotype (0. 643 +/- 0.064) and nucleotide diversities (0.0032 +/- 0.0022) The analysis of the Mixed Stock, through a Bayesian approach, suggests that the green turtles in the feeding area of Argentina would come in greater proportion of the nesting beaches of Trinidad (33%), Island of birds (19%), Surinam (16%) and Atol das Rocas (13%). Our results suggest that different nesting colonies are contributing to the Argentine foraging areas, and, unlike previously detected in Uruguayan studies (Caraccio *et al*. 2005), Trinidad would be the nesting beaches that makes the greater

contribution. The genetic analysis of both nesting and foraging areas constitute very helpful information to determine possible migratory routes, and to implement measures of mitigations and plans of conservation, not only in the areas of reproduction, but also in the areas of development for these seriously threatened species.

GENETIC DIVERSITY OF *CARETTA CARETTA* (LINNAEUS, 1758) MARINE TURTLE IN NESTING AND INCIDENTAL CAPTURE AREAS FROM BRAZILIAN COAST USING MTDNA CONTROL REGION

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The marine turtle *Caretta caretta* (Linnaeus, 1758), known as loggerhead turtle, has been considered an endangered species by the IUCN (The World Conservation Union) and a vulnerable species by the MMA (Brazilian Environmental Ministry). In Brazil, this species has the highest number of nesting areas concentrated mainly in Espírito Santo and Bahia states. So far, little is known about their population genetic structure. This work aims to characterize the genetic structure based on the variability of the mtDNA control region. Samples from nesting areas of Rio de Janeiro (Bacia de Campos, N=64), Sergipe (Abaís, N=8; Pirambu, N=38; Ponta dos Mangues, N=5) and Rio Grande do Norte (Pipa, N=1) states plus samples of incidental capture at Rio de Janeiro (Bacia de Campos, N=2), Sergipe (Pirambu, N=1) and Ceará (Almofala, N=1) states were collected and preserved in 70% ethanol. Total genomic DNA was extracted and mtDNA fragments were amplified with LCM15382 and H599 primers. PCR products were purified, sequenced and analyzed. Three haplotypes were found: CC-A4, CC-A24 and one haplotype called CCxLO from specimens considered hybrids with an external morphology of *C. caretta* and the mtDNA of *Lepidochelys olivacea* (Eschscholtz, 1829). Since the incidence of *L. olivacea* mitochondrial genome introgression in *C. caretta* rookeries was only observed in Sergipe, which is the nesting place of the largest Brazilian population of olive ridleys, the result could be related to an overlap of reproduction and nesting periods for both species. When the *C. caretta* populations from Rio de Janeiro and Sergipe were analyzed separately, the genetic diversity ($h = 0$ and $0.2793 +/- 0.0826$) and nucleotide diversity ($\pi = 0$ and $0.000759 +/- 0.000915$) clearly distinguish them. Both nucleotide and genetic diversity values increased considerably when hybrids found in the Sergipe population were included in the analyses ($h = 0.5522 +/- 0.0548$; $\pi = 0.040116 +/- 0.020222$). Considering that the CC-A4 haplotype is exclusive of Brazil and differs from CC-A24 in only one substitution, these results support the hypothesis of a unique Brazilian nesting *C. caretta* haplotype profile. In the same way, the low nucleotide diversity suggests a common ancestry, with CC-A4 being the probable origin for Brazilian populations. CC-A1 (Pipa, RN) and CC-A17 (Almofala, CE) haplotypes, here reported for the first time for Brazil, were previously known for pelagic juveniles from Azores and Madeira (CC-A1) and Madeira (CC-A17). CC-A1 is one of the most frequent haplotypes for the North Western Atlantic nesting populations. Data from this work support the hypothesis that through transoceanic migrations, Western Atlantic rookeries are the primary source of pelagic juveniles for Eastern Atlantic habitats. Thus, the Northeastern Brazilian coast would be an access pathway for turtles born in the Caribbean region.
Acknowledgements: Financial support was granted by CAPES, SR2-UERJ, CENPES-PETROBRAS (Mamíferos e Quelônios Marinhos Project).

DEVELOPMENT AND APPLICATION OF SINGLE NUCLEOTIDE POLYMORPHISMS (SNPS) FOR POPULATION STUDIES OF *CHELONIA MYDAS*

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Chelonia mydas was used as a model to develop novel methods for discovery of nuclear SNP loci in an organism with little published genomic information. SNPs have the potential to improve data quality and genotyping efficiency of nuclear data to address questions in population and evolutionary genetics. The relatively high prevalence of SNPs in genomes compared to microsatellites creates a potential for the discovery and screening of high numbers of loci with greater genome coverage. DNA extracts from 40 green turtles sampled in Caribbean, East Pacific, Central Pacific, and Mediterranean locations were used for two methods of SNP discovery. The first approach employed amplified fragment length polymorphism (AFLP) techniques to generate random fragments of DNA. A total of 94 fragments between 60 and 340 bp in size were separated by gel electrophoresis, excised, and sequenced to design 14 sets of primers for sequence comparison amongst individuals. The second technique utilized a microsatellite enriched genomic library to screen sequences of DNA segments not containing microsatellites. Site-specific primers were designed for 16 candidate clones from the microsatellite library to produce segments ranging in size from approximately 230-500 bp. Both discovery methods resulted in the ability to amplify identical regions of DNA across a set of individuals. The resulting homologous sequences were compared across green turtles and any nucleotide difference at a single point along the linear sequences was indicative of a SNP. Approximately 8,500 bases were screened resulting in the discovery of 90 SNPs, or an average of one SNP every 95 bp. One SNP was chosen from each locus to generate a set of 13 independent SNP markers. Primers were designed and used for the optimization of 13 assays for the Amplifluor SNP real time genotyping system. The SNP discovery panel of 40 *C. mydas* samples were successfully genotyped with 11 Amplifluor primer sets to validate the assay system. Genotyping of approximately 200 individuals from eastern and central Pacific nesting regions is underway for the analysis and validation of SNP markers to identify population structure.

TEMPORARY VARIATION OF NESTING POPULATION OF *ERETMOCHELYS IMBRICATA* IN THE JARDINES DE LA REINA ARCHIPELAGO AND THEIR TEMPORARY CONTRIBUTION TO THE FISHING STOCK OF JARDINES DEL REY ARCHIPELAGO (CUBA)*

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As hawksbill turtles are considered critically endangered and are included in CITES Appendix I, all international trade of the species or its products is banned. Nevertheless, legal fisheries for the species exist within national jurisdictions of some countries such as Cuba. The nesting abundances of hawksbill populations under long-term protection programs within the Western Atlantic show a general increasing trend, with the single exception of the Yucatan Peninsula stocks. Nesting of hawksbills in Doce Leguas (Jardines de la Reina) has remained stable or with slight increases according to local censuses. Using 465bp-sequences from the mtDNA control region, we attempted

to evaluate the following hypotheses: (1) there is temporal stability in the genetic composition of the Cuban population nesting at Jardines de la Reina across the 1994, 1997 and 2004 seasons; (2) there is temporal variability in the levels of individual regional stocks contributing to the aggregations making up the Cuban fishing legal take over the same period of time, with the contribution from regional stocks increasing over time except from the Yucatán Peninsula nesting population. The haplotype profile of the rookery showed no significant temporal variation across years (C2(df=4)=5.15, p=0.26), nor was there any indication of inter-seasonal genetic differentiation (Fst=0.06, p=0.08) with a much larger within year variation (94.2%) than between years. In the 2004 sample from the harvested population the most abundant haplotype was EI-A1 followed by EI-A13, with EI-A3 appearing for the first time. Consequently, the contribution of Cuban nesting population should not affect the composition to the fishing stock in the aggregation area of Jardines del Rey. Haplotype composition of the mixed stock being extracted from was significant over time (C2 (df=32)=54.87, P=0.002) and in the most recent sampling (2004) the proportion of the most common haplotypes (EI-A1 and EI-A11) became inverted. In 2004 the most common haplotype was EI-A11, the most frequent in the Mona Island (Puerto Rico) rookery, followed by EI-A1, the most common in Cuba and other rookeries such as Barbados and Antigua. This suggests that contributions by the local nesting population have diminished over time, while that of Puerto Rico has increased. When rare haplotypes or those appearing in only a single year were removed from analysis, the inter-seasonal heterogeneity remained time (C2 (df =6)=12.64, p=0.03). With these results, both hypotheses are accepted. Considering that most of the genetic sampling takes place during the months of highest take (Aug-Oct), that the harvest is taken from sites with mixed stock aggregations, and that this has indicated the increments of the EI-A11 haplotype characteristic of the Puerto Rican nesting population, we have recommended that the closed season be extended in Cuba until November 1st (from May to November).

GENETIC STRUCTURE OF LOGGERHEAD POPULATIONS IN THE GREATER CARIBBEAN AND ATLANTIC WESTERN SHORE BASED ON MITOCHONDRIAL DNA SEQUENCES, WITH AN EMPHASIS ON ROOKERIES FROM SOUTHWESTERN CUBA

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Effective management of sea turtles depends on the understanding of the demographic interconnections among nesting populations. In Cuba, preliminary data on loggerhead (*Caretta caretta*) nesting suggests low levels of current nesting. However, since the local common term for all turtles is the vernacular name for this species, it suggests a much higher abundance of loggerheads in the past, such as is referred in chronicles from the European colonization period. Using 375 bp sequences from the 5'end of the mitochondrial DNA control region we elucidated the genetic relationships among four loggerhead rookeries in southwestern Cuba (Guanahacabibes Peninsula, San Felipe Cays, south Isla de la Juventud and Cayo Largo del Sur), and we analyzed these data within a regional context to understand the contribution of each to the genetic structure of the Greater Caribbean population. Contingency chi-square tables and Fst tests were applied to all pairwise comparisons of Cuban and previously analyzed populations for the species in the Atlantic basin. Incongruities between some of the results from these tests were resolved by testing hypotheses of genetic versus geographical association through AMOVAs. Within the Cuban rookeries, haplotypes belong to two dissimilar lineages, i.e., North and South Atlantic, and the Greater Caribbean – Mediterranean lineages. A haplotype (CC-A2), belonging to the latter, was found in highest frequencies respect to the others (CC-A1, 8, 10, 12, 14). One haplotype (CC-A12), previously reported only in foraging areas, was found to be endemic for the San Felipe rookery. As no significant differentiation was found between any pair of Cuban rookeries they were therefore considered a single demographic unit. However, when the set of Cuban

rookeries was compared to the remaining rookeries in the analyzed region, some genetic structuring was revealed. In total, seven demographic units can be discerned (PCT (df=6) = 0.37, p=0.001; PSC (df=11) = 0.05, p=0.54), with higher variation within than among populations. Five in the USA: (1) northwest Florida (Eglin Air Force Base, San Blas Cape, St Joseph's, Tyndall Beach), (2) SW Florida (Key Island, Sarasota County), (3) SE Florida (Hutchinson Island, Melbourne Beach, Port Everglades, Volusia County), (4) NE Florida to North Carolina (Amelia Island, Balhead Island, Cape Lookout, Cape Romain, Georgia, Topsail Island), and (5) Dry Tortugas, one in Quintana Roo (Mexico) (6) and the last in southwest Cuba (7). Among these, a historical genetic exchange is suggested by the results but must have been limited in time and extent. Consequently, the Cuban demographic unit appears to have exchanged very few migrants with other populations in the region. Thus appearing to constitute a separate deme of the regional metapopulation and should be managed in a regional context.

GENETIC STRUCTURE OF *DERMOCHELYS CORIACEA* FROM THE TROPICAL PACIFIC OF MEXICO, AS INFERRED FROM NUCLEAR MICROSATELLITES*

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In the last two decades, the number of leatherback nests in Mexico decreased 97%. This emphasizes the importance of conservation strategies for this species. The highest nest densities in the country occur on the beaches of three states: Michoacán, Guerrero and Oaxaca. The application of molecular markers has been a widespread and useful aid in the conservation biology of marine turtles since they allow the identification of individual populations. In this context, nuclear microsatellite variation provides a better resolution in identifying breeding stocks than any other molecular marker. The objective of this study was to assess the genetic structure of leatherback sea turtles in the Mexican Eastern Pacific on the basis of variation at nuclear microsatellite loci amplified with primers derived from the olive ridley. DNA was extracted from blood samples collected during the 1997-1998 nesting season from beaches in the states of Michoacán (Mexiquillo), Guerrero (Tierra Colorada) and Oaxaca (Cahuitán, Chacahua, and Barra de la Cruz). Fifty-three extracts were analysed by PCR in order to amplify loci OR-1, OR-2, OR-4, OR-7 and OR-8. Levels of polymorphism were determined and evaluated for applicability in genetic structure analyses. The observed variation was used to generate fixation index (Fst) and Reynolds' distance matrices, the latter being converted to cladograms. Our results showed that OR-1 was monomorphic, whereas OR-8 amplified as two polymorphic loci (OR-8/LB1 and OR-8/LB2). General polymorphism for the species was low relative to that found in other species, with a minimum of two alleles for OR-7, a maximum of seven for OR-4, and an average of 4.2 alleles per locus. Average observed heterozygosity was 0.446. Loci that were in Hardy-Weinberg equilibrium but did not present linkage disequilibrium when analysed together were OR-4, OR-7 and OR-8/LB1. In conjunction, they exhibited a total of 13 alleles. Fst distances based on these loci showed greater significant differences ($P<0.05$) in pairwise comparisons including Mexiquillo, and Barra de la Cruz or Chacahua. The last two were the most southern rookeries and the cladogram grouped them as the only members of a clade, with Mexiquillo as the most distant group. Cahuitán and Tierra Colorada appeared in the middle as distinct clades, with the latter closer to Mexiquillo. The differentiation between Barra de la Cruz and Mexiquillo was corroborated by different cladograms that included a variable number of loci, which highlights the robustness of such difference. Also, the set of compared cladograms showed a consistent correlation between genetic and geographic distances. In conclusion, Mexiquillo represents a population with genetic features that differentiate it from the southern rookeries. The distance between rookeries seems to be acting as a source of genetic differentiation in the region.

EVALUATION OF MALE BREEDING POPULATION INFERRED FROM PATERNITY ANALYSES IN THE CAPE VERDE ISLANDS

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Because of the extensive migrations of marine turtles through the ocean, many aspects of their biology have been unknown for a long time. However, much information has been recently gained from genetic studies and population monitoring of female turtles at their nesting sites. In contrast, still very little is known on the genetic diversity, population structure and dispersal patterns of the male breeding population, mainly because of the difficulty of capturing and monitoring them at sea. The aim of this study is to assess the genetic patterns of the male breeding population of the loggerhead turtle, *Caretta caretta*, using a non invasive approach and compare them to the female breeding population. This study will allow us to infer male genotypes based on a large previous data set of paternity analyses in this population, and analyse their genetic composition and patterns of variability without capturing them. In addition, we will identify the genetic composition of males with higher paternity contribution. The use of paternity programs to evaluate the reliability of father's genotypes, and the relevance of paternity analyses as non invasive methods for genetic characterization and estimation of male abundance will also be discussed.

COLONIZATION OF FLORIDA NESTING BEACHES BY LEATHERBACK TURTLES: MICROSATELLITES AND MTDNA REVEAL THE DEMOGRAPHIC HISTORY OF THIS POPULATION*

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A wide array of molecular techniques has become available for answering critical questions pertaining to the management of endangered species. Among these, microsatellite markers have been used to investigate mating systems, delineate stock boundaries, and determine family groupings. For sea turtles, genetic analyses have been instrumental in confirming that natal homing exists in many species. For leatherbacks, Dutton *et al*. (1999) found some evidence of global population structure and therefore provisional support for natal homing. However, stock boundaries have been much harder to define because populations in close proximity are difficult to distinguish from one another genetically and there appears to be fairly low levels of genetic differentiation among female leatherback breeding stocks (Dutton *et al*., 1999) based on mtDNA. Defining stock structure is a critical element for the successful management of an endangered species because it allows evolutionarily significant units to be assigned and conservation priorities to be set (Karl and Bowen, 1999). We used mtDNA and microsatellites to determine how an increasing leatherback turtle population in Florida became established. The Florida rookery may have been established by a group of founding females that had successful nests and now their hatchlings, having reached maturity, are returning to their natal beaches. Alternatively, this rookery may represent a colonization event in progress, with adult female recruits arriving continuously from elsewhere. Our hypothesis was that the Florida rookery has resulted from a founding event. Skin biopsies were taken from nesting leatherbacks at Juno Beach, Florida from 2001-2006. First we determined mtDNA haplotypes for each turtle. Next, we determined each individual's genotypic fingerprint using microsatellites at 16 polymorphic loci. We constructed a family tree for all females identified through tagging (n=159) using the program KINSHIP. This program allows specific relationships between pairs of turtles to be determined (i.e. mother-daughter, full-sister, cousin) based on similarities in their

genetic fingerprints. Family groups can then be assigned based on these relationships and confirmed using mtDNA data. We found three distinct mtDNA haplotypes in Florida (Dc1-A, Dc3-C, Dc-17); Dc-17 was identified for the first time ever and is a unique global leatherback haplotype. From the genetic fingerprint analysis, we found a very low overall level of relatedness among the turtles and many more family groupings were identified than expected. Surprisingly, many individuals were only distantly related or not related at all to others in the population. There was also a significant heterozygosity deficiency in the population, which indicates that the population has either recently expanded or that there has been an influx of individuals with rare alleles. We can only conclude that this population is not the sole result of population growth but may be due in part to immigration of turtles to Florida reproductive habitats. The nesting beach origin of the colonizing turtles is expected to be found among the rookeries of the Caribbean. Identifying the source of these migrants and resolving the status of these assemblages as a metapopulation should become a high priority for management of leatherbacks in the Atlantic and Caribbean.

GENETIC STRUCTURE AND ORIGIN OF A JUVENILE AGGREGATION AFFECTED BY FIBROPAPILLOMATOSIS: POTENTIAL IMPACT ON ADULT RECRUITMENT

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Feeding grounds are important areas for sea turtle conservation because they are developmental and feeding habitats for juvenile and adult sea turtles. Furthermore, turtles in these feeding grounds come from many different rookeries. During their life time they permanently occupy these habitats except when they migrate to their breeding grounds. Given the importance of the feeding grounds in the life-history of sea turtles it is important to investigate how current threats (e.g. wildlife diseases, environmental changes and human activities) in these areas could affect adult recruitment to reproductive areas. Here, we studied how fibropapillomatosis (FP), a pandemic and often mortal disease, could affect adult recruitment. For this purpose we investigated what is the contribution of a FP-affected feeding ground to adult recruitment using a genetic approach. The Culebra Archipelago in Puerto Rico is an important feeding ground for juvenile green turtles. Here, juveniles are aggregated in two main areas, Manglar and Culebrita. FP affects most of the juvenile turtles in Manglar Bay (64%) and is much less common in the Culebrita aggregation (<1%). Using mtDNA as a molecular marker, we compared the population structure of Manglar and Culebrita aggregations to see if they were differences in their genetic structure. We also conducted a mixed stock analysis (MSA) to suggest the natal origin of the juvenile turtles and finally we conducted an inverse MSA to estimate the contribution of the Culebra feeding ground to adult recruitment. We collected samples from 103 juvenile green turtles from Manglar and Culebrita during in-water surveys from 2000 to 2006. We identified 11 haplotypes in the two aggregations, but there was no difference in their genetic structure (P=0.89). The data from the two areas were combined for the MSA. The MSA results suggest that the Culebra feeding ground is composed of individuals from diverse origins in the Caribbean (e.g. Mexico, Surinam, Florida) and south Atlantic (e.g. Brazil, west Africa) but mostly from Tortuguero (Costa Rica, 50%). In contrast, we did not observe a dominant contribution of the Culebra feeding ground to a single area but a more homogeneous contribution to areas throughout the Caribbean (~70%) and the south Atlantic (30%). This is evidence of the importance of the Culebra feeding ground for adult recruitment not only for Caribbean nesting and breeding areas but also reproductive areas in south Atlantic (i.e. Brazil and Africa). What causes FP is still unknown but is a subject of great concern given the spread of this disease around the world. Given the intimate connection established between feeding and reproductive areas it is high priority to concentrate efforts to recover affected feeding grounds as they can have a negative effect on future adult recruitment. For the endangered green turtle, the impact of FP could increase their vulnerability to respond to changing environmental conditions and other diseases.

NESTING DENSITY OF OLIVE RIDLEYS FROM ESCOBILLA, OAXACA DOES NOT CORRELATE WITH HIGH FREQUENCY OF MULTIPLE PATERNITY

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Mating behavior of female olive ridleys ranges from monogamous to highly polyandrous. The latter results in progenies sired by multiple fathers, a phenomenon known as multiple paternity (MP). The frequency of MP affects the genetic effective population size, and hence needs to be considered in the planning of conservation strategies. Nuclear microsatellite markers have been used successfully to study MP in olive ridleys. In this context, Jensen *et al*. (2006) reported frequencies from 20 to 92% in olive ridleys with a strong correlation between abundance of nesting females and MP levels. The world's highest density of olive ridley nestings occurs in Escobilla, Oaxaca. In the previous issue of this Symposium, Cortés-Rodríguez *et al*. reported a MP frequency of 100% for this rookery. However, they evaluated 103 hatchlings from only four clutches. We performed a more comprehensive analysis of MP in Escobilla, involving 319 hatchlings from 16 clutches. We found a MP pattern as follows: one progeny with two fathers, one with three, four with four, and two with five. The relative contribution of the fathers to the fecundation of the progeny was biased, with a maximum of 30 to 80% and a minimum of 7.5 to 20%. The global average of 50% MP in the clutches examined is lower than what Jensen *et al*. hypothesized on the basis of Escobilla's abundance and than the values reported by Cortés-Rodríguez *et al*. for the same rookery. The latter authors probably overestimated the frequency of MP in Escobilla because of their reduced sample size but our results still show that the high density of nesting females in this rookery does not correlate with a high frequency of MP. Different lines of evidence support a polygenic control of polyandry from insects to reptiles. Thus, the departure of our results from the hypothesis by Jensen *et al*. could have a genetic basis.

PHYLOGEOGRAPHY OF THE ENDANGERED HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) AROUND THE WORLD

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In this paper we explored the phylogeographic relationship between the hawksbill turtle from the Mexican Pacific and hawksbills from other regions. We took tissue samples from 25 hawksbill turtles from different Mexican Pacific localities and using the patterns of mitochondrial DNA (mtDNA) variation with respect to other regions to analyze the phylogeographic pattern. Analysis of sequence variation over 837 bp of the mtDNA control region revealed 9 haplotypes in the Mexican Pacific samples. To compare to the rest, we extract just 481 bp, revealing 2 haplotypes from Mexican Pacific and 62 in total from around the world. We got five different clades, one with Atlantic haplotypes, two with Indian haplotypes and the last two from the Pacific. This study revealed a close relation between Mexican Pacific hawksbill and Japanese hawksbills but also a big differentiation in Mexican hawksbill turtles from the Pacific and Atlantic. We suggest that this particular genetic pattern deserves special attention in order to implement special conservation efforts paying attention to this differentiation.

Nesting Status and Biology

THE STATUS OF THE NESTING POPULATION OF THE GREEN TURTLE (*CHELONIA MYDAS)* DURING LOW AND HIGH NESTING PERIODS IN 2006 AND 2007 WITH REFERENCE TO CYCLONE GONU IN RAS AL-HADD, OMAN

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The status of the nesting population of the green turtle (*Chelonia mydas)* during low and high nesting periods in 2006 and 2007 was analyzed with reference to cyclone Gonu in Ras Al-Hadd, Oman. The total number of turtle tracks on the nesting beaches, as well as the actual number of turtles that laid eggs successfully, were compared during low (March-May) and high (June-August) nesting periods in 2006 and 2007. In addition, number of recaptured turtles (based on the tag-recapture program at Ras Al-Hadd) was recorded. The numbers of dead and stray turtles were also counted. The effect of cyclone Guno in June 2007, which caused some damage to the nesting beaches, was related to the turtle population during this period. During low season, the total number of tracks and percentage of turtles that actually laid their eggs successfully were 2,320 and 39% in 2006 compared to 1,844 and 43% in 2007, while during high season, the total number and percentage of tracks were 24,450 and 62% in 2006 and 32,476 and 64% in 2007. Based on the above data, the total number and percentage of tracks of turtles that laid eggs were significantly higher during high season than over low season. However, the percentage of turtles that laid eggs were similar in both years. Apparently, Gonu did not inflict any harm on the nesting population. The total numbers of dead and stray turtles during low season were 16, 16 and 19, 0 in 2006 and 2007 respectively, while during high season, the total were 46, 509 and 13, 89 in 2006 and 2007 respectively. Although, the number of stray turtles was high in 2006, most of these turtles were rescued by the rangers. Total recaptures during the six month period in 2006 was 105 compared to 41 in 2007. Although this pilot investigation is limited to two successive years, the data indicates that the turtle population at Ras Al-Hadd is stable without any decline at least during the last two years. More data is needed in the future to provide more detailed information on the status of the green turtles at Ras Al-Hadd Reserve which is one of the most important nesting areas in the world.

ASPECTS OF THE DISTRIBUTION AND ECOLOGY OF NESTING SEA TURTLES IN GHANA

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A survey of sandy beaches of Ghana was conducted to locate nesting sites of sea turtles. Intensive studies on the nesting habits and intensities were undertaken along a prime nesting stretch of beach close to settlements located to the east of Accra, the capital of Ghana. The study confirmed that the olive ridley, leatherback, and the green turtles are the main species that nest on the beaches along the coast of Ghana. At the intensive study area, the olive ridley had the highest relative abundance of 91% at the study area followed by the leatherback turtle with 6% and the green

turtle 3%. Generally, the nesting season extends from August to March, and occasionally to early April. In this study, peak nesting was in October for the olive ridley; and between December and January for the green and leatherback turtles. The olive ridley turtles arrive first followed by the green turtle and then the leatherback turtle. No temporal or spatial separation was observed in the nesting periods of the three species. Sea turtles nest in a wide range of sediment type along the coast of Ghana. Beach sand with median grain size between 0.2-0.4 mm (medium to coarse sand) and sorting coefficient between 0.4-0.7 mm (well-sorted to moderately well-sorted) appear to be preferred by the nesting turtles along the coast of Ghana. Based on grain size characteristics, the potential sea turtle nesting sites in Ghana were determined for future observation. These sites stretch along the entire 550 km coastline and include popular stretches of beaches such as from Princess Town to Busua, Senya Bereku to Accra, Prampram to Old Ningo and Anloga to Denu. Estimated average clutch size for the olive ridley, green and leatherback turtle were 86, 83, and 81 respectively. However, those counted for the olive ridley and the leatherback were 100 (SD=6.64) and 85(SD=10) respectively. Emergence period for the olive ridley was 52 days, green turtle 56 days, and leatherback 63 days. Percentage hatching success was very high among all the three species with olive ridley turtle recording the highest with 92.40%. The percentage hatching success for the other two, green turtle and the leatherback were respectively 89.38, and 88.32. Destruction of sea turtle nests by dogs at the intensive study area was very high, but this problem was not widespread along the entire coast of Ghana. Percentage of false crawls was found to be higher within zones closer to human habitation.

IMPACT OF HIGH INTENSITY HURRICANES IN THE REPRODUCTIVE BIOLOGY OF MARINE TURTLES' BREEDING ROCKERY OF GUANAHACABIBES PENINSULA, CUBA

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Meteorological events of great magnitude that impacted the western region of Cuba generated profound transformations in the coastal zone, changing beach characteristics dramatically. Almost all coastal vegetation disappeared and sand movements generated new beaches. Equally, other beaches that previously existed were destroyed. This conditioned the evaluation of the status of the marine turtles nesting population because of the unknown effects that changes on beaches had on nesting behavior, especially considering the high fidelity that turtles show to a specific nesting place. Temporal behavior of nesting was similar to previous seasons, with a progressive increment to the month of July, although the biennial cycle observed before the first hurricane is not evident. Night interval for nesting attempts was neither affected, and the highest frequency took place between 12 and 2 in the morning. Regarding changes on the beach, there was an obvious increment of nesting events in areas without vegetation, because of the lack, or diminishment, of the vegetation zone. In the same way, distance covered from the sea before nesting also increased. Nesting success was also affected, not globally but in some beaches such as El Perjuicio and La Barca. The increment of rocks beneath the sand made nesting more difficult, and often impossible. Mean nest temperature also changed, with a general reduction, as opposed to what was expected considering the increase in radiation from the sun with no vegetation. Finally, the most important change after analyzing embryonic developmental success, was the presence of ant predation. This was related to the occurrence of nesting events in the palm vegetation, where ants are generally found.

SEVEN YEAR RESULTS OF THE TAGGING PROGRAM OF MARINE TURTLES IN GUANAHACABIBES PENINSULA, CUBA

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The University Project studying and conserving marine turtles in Cuba started a monitoring program in 2001 on the beaches of Guanahacabibes Peninsula. The objective of this program was to carry out an intensive tagging to identify all nesting females, to characterize elements of the nesting biology such as the number of nesting attempts per females and to determine the degree of filopatry. We also used tags to test certain theories of local people regarding turtle's biology. We have tagged 545 females which represent 20% of the total nesting emergences observed. On average, 16 turtles have been tagged every year although it varied (from 2 to 74) depending on nesting levels per season and monitoring effort. Each female performed on average, 1.72 nesting attempts and similar number of clutches. They spent around 11 days between nesting events. In this particular issue, we found no relationship between clutch size and number of days between layings. This supposed relationship is used by fishermen and other people to control when turtles come out to the beach. As for remigration, only 10% of all tagged females have returned, with an average interval of 3 years. Nevertheless, philopatry has been found to be high, with more than 75% of turtles returning to the same beach than in previous years. Within the season there are also some movements between beaches but they represent only 10% of the total turtles with more than 1 nesting attempt. Despite the effort, many turtles still come every year without tags or signs of previous tagging, therefore this program must continue during the following seasons to get an accurate idea of the total population size. Nevertheless tagging has proved to be an excellent tool in the research of marine turtle's biology.

MARINE TURTLE NESTING IN 2007 AT THE ARCHIE CARR NWR, FLORIDA, USA: GREEN TURTLE AND LEATHERBACK NEST PRODUCTION CONTINUE TO RISE, LOGGERHEAD ACTIVITY DECLINES

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The 2007 nesting season resulted in new record-high nest production by green turtles and leatherbacks at the Archie Carr National Wildlife Refuge in South Brevard County, Florida, U.S.A. Loggerhead nest production fell to an all-time low. This 21-kilometer stretch of beach is one of the most important nesting beaches in the western hemisphere for loggerheads, and in the United States for green turtles. Loggerheads, the most abundant nesting species, finished with the lowest number of nests since recordkeeping began in 1982. Green turtles and leatherbacks set new high records and nesting for both species is rising exponentially. The 2007 nesting season continues at time of abstract submission, so numbers here will not be exact, but this portion of the Carr Refuge has thus far accounted for 6,402 loggerhead nests, 3906 green turtle nests and 52 leatherback nests. Loggerhead nesting averaged 9,300 nests during the decade of the 1980s, then jumped by 52% in 1990, the year the Refuge was created. The average of the 1990s was 14,457 nests. Nesting by this species has declined from a high of 17,629 in 1998 to 7,599 in 2004, increased to 9,018 by 2006, only to decline again to an all time low of 6,402 nests in 2007. While the nesting beach has seen this decline, the subadult populations in the nearshore waters do not follow the same trend. Catch-per-unit-effort (CPUE) for inwater captures have remained steady during the same timeframe. Green turtle nesting has been rising exponentially from an average of 116 nests per season during the 1980s to 537 throughout the decade of the 1990s

to an average of 1,863 per season since 2000. Increasing CPUE of immature green turtles genetically linked to Florida in nearby developmental habitats suggests that the recovery of the Florida green turtle is underway. Leatherback nesting, while negligible at the Carr Refuge until the mid 1990s, has begun to increase at a rapid pace. Throughout the entire decade of the 1980s, only four nests were recorded. In the 1990s, a total of 65 nests was documented. Since 2000 there have been 207 nests, or an average of 26 nests per season. While this is not a high number when compared to some other beaches, it indicates that leatherbacks are expanding their nesting range in Florida and have found suitable nesting habitat in the Archie Carr National Wildlife Refuge.

NESTING EVALUATION (1994-2007) OF *LEPIDOCHELYS OLIVACEA* IN PLAYA CEUTA, MÉXICO, USING GEOGRAPHIC INFORMATION SYSTEM (GIS)

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Nesting by marine turtles often occurs during the summer on sandy beaches of tropical and subtropical areas. The objective of the present project was to evaluate the nesting of *Lepidochelys olivacea* in Playa Ceuta, Mexico using a Geographic Information System (GIS). For the construction of the GIS georefenced system, nesting data from 1994 to 2007 as well as a digital map of the beach generated with GPS technology was used. The main discovery was the existence of 4 main nesting areas. In 10 years of data analysis, a pattern in the preference of nesting site selection existed that could be determined by beach conditions and/or the population's behavior.

EFFECTS OF "EL NIÑO" CURRENT (ENSO) IN BLACK TURTLE (*CHELONIA AGASSIZII*) NESTING ACTIVITY IN MICHOACÁN, MÉXICO

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An analysis of the nesting activity of the black sea turtle (*Chelonia agassizii* aka *Chelonia mydas agassizii*) in relation to local climatic events and possible effects of "El Niño" current (ENSO) was carried out in Michoacán, Mexico. Temperature and rainfall data from 1985 to 2003 recorded from the black turtle nesting area in Michoacán coast and temperature anomalies from ocean surface waters associated with ENSO were correlated with the nesting activity of the black turtle in Colola Beach during the same period. We found that temperature increased by 1.8°C from 1985 to 2003 in the black turtle nesting area in Michocán. A correlation between temperature and rainfall and black turtle nesting activity was not found. Temperatures anomalies of ocean surface associated to ENSO (recorded in region 3 of the El Niño from 1985 to 2003) does not seem to be statistically correlated with black turtle nesting activity in Michoacán. Moreover, the occurrence of ENSO can affect the number of nesting females in Michoacán two or three years later in Pacific waters.

PULLING WEEDS FOR LEATHERBACKS: THE EFFECTS OF VEGETATION (*IPOMOEA PES-CAPRAE*) ON LEATHERBACK (*DERMOCHELYS CORIACEA*) NEST PRODUCTIVITY AT SANDY POINT NATIONAL WILDLIFE REFUGE, ST. CROIX*

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Between 2004 – 2007, the leatherback nesting beach at Sandy Point National Wildlife Refuge (St. Croix, USVI) has experienced a lack of summer erosion that has allowed native vegetation (*Ipomoea pes-caprae*) to spread seaward, and become established in leatherback nesting areas. This caused a decline in nest survival because nests placed in or near vegetation are susceptible to root invasion. Vegetation can actively seek out and effectively predate nests as a source of moisture and nutrients (Lazell & Auger, 1981). Moreover, hatchlings that successfully exit the egg often become entangled in the roots as they dig their way to the surface, and may also fail to locate the ocean because the vegetation poses both a physical and a visual barrier (Godfrey, 1997). Here, we describe the results of an experiment designed to quantify the effects of vegetation on leatherback nest productivity (hatching and emergence success), and to determine the most effective way to control vegetation from spreading. There were four types of plots in our experiment: (i) naturally vegetated, (ii) vegetated plots treated with herbicide, (iii) plots in which the vegetation was mechanically removed above ground, and (iv) non-vegetated (control) plots. Twenty nests were relocated into each of the four plot types then left to incubate naturally until the hatchlings emerged. After each emergence, the nests were excavated and the nest contents were recorded. Productivity was significantly reduced in all of the vegetated plots, compared to the control plot without vegetation. There were no statistical differences in productivity among the different vegetation removal treatments. This is because the vegetation treatments targeted the vegetation above the beach surface and were ineffective at treating the roots underground. The vegetation (*Ipomoea pes-caprae*)is a pioneering species that thrives in harsh conditions with a wide range of tolerability and can remain dormant underground until conditions become favorable for regrowth. This study shows that if not properly managed, vegetation can pose a serious threat to overall nest success and hatchling production. It also demonstrates that none of the conventional plant removal treatments were effective in preventing a decline in production from nests that were invaded by vegetation.

PLAYA LARGA: AN IMPORTANT SEA TURTLE NESTING BEACH TO 'BASTIMENTOS ISLAND NATIONAL MARINE PARK' PANAMA

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Sea turtles have been documented as an economic asset along the Caribbean coast of Panama since 1815. During the first half of the 20th Century, government officials issued lease-rights for various high-density nesting beaches in the Province of Bocas del Toro, to veladors or "stayers awake" who paid a nominal fee in return for the right to harvest all nesting hawksbills on a specific stretch of beach. An important step to protect hawksbills and other marine turtle species in the province was the establishment of a National Marine Park in 1988, designed with the intent to conserve the remnant hawksbill population on Bocas coast. In addition, the Wildlife Law of 1995 introduced a national prohibition on hunting and fishing of all threatened species. Today the “Parqué Nacional Marina Isla de Bastimentos” serves to protect two of the historically most heavily harvested sea turtle nesting beaches in the area- Playa Larga and the Zapatilla Cays. The park is managed by the Autoridad Nacional del Ambienté (ANAM) and protection of sea turtles during the nesting season, is accomplished in collaboration with the Endangered Wildlife Trust (EWT), the Caribbean Conservation Corporation (CCC) and the Wildlife Conservation Society (WCS). However, limited law enforcement capacity in beach areas and marine habitats continues to threaten sea turtle populations in the park and elsewhere along this coast. Protecting a total of 13,226 ha, the Bastimentos Island National Marine Park includes 11,586 ha of marine habitat. Playa Larga (9.31604N, 82.1227W; 9.33407N, -82.1424W)is located on the northern shore of Bastimentos Island and lies adjacent to private land currently the subject of extensive legal dispute. Despite the relative isolation of this bay, surrounding beaches and adjacent uplands are undergoing rapid tourist development, deforestation and private investment sales. This coastal development will have an immediate detrimental impact to nesting activity, by opening access, increasing vulnerability to egg poachers and by introducing artificial lights that could disorientate adult females and hatchlings. Playa Larga, 3 km in length, is the single most important beach for sea turtles on Bastimentos Island, annually hosting the majority of all documented leatherback, hawksbill and green turtle nests. Monitoring records for March through August of 2007 documented 140 leatherback, 21 hawksbill and 3 green turtle nests. Since the founding of the National Marine Park, a remarkable increase in the number of hawksbill nests located on the nearby Zapatilla Cays, suggests that numbers of critically endangered turtles nesting on Playa Larga could also rise, if protection on Bastimentos Island were fully implemented.

EVALUATING THE POTENTIAL EXTENT OF SEAGULL PREDATION ON TURTLE HATCHLINGS: LOGGERHEAD HATCHLING EMERGENCE TIMES ON ZAKYNTHOS, GREECE

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Sea turtle nests and emerged hatchlings attract a number of terrestrial predators. On the densely populated shores of the Mediterranean for example, populations of foxes and birds are generally high and result in high predator pressure of nests and hatchlings. Foxes are absent on the largest rookery of the region on the island of Zakynthos. However, a landfill site close to Sekania, a densely nested beach accounting for roughly half of the nests on Zakynthos, provides resources for a high population of seagulls. ARCHELON has monitored Sekania beach for over two decades and has witnessed a high number of seagulls visiting the beach and predating on newly emerged hatchlings. The main goal of the study was to evaluate the potential extent of this predation on the hatchlings of Sekania. As seagulls use visual cues for prey detection, we assumed that hatchlings emerging one hour before dawn and in daylight would potentially fall prey to seagulls. We therefore aimed to quantify the proportion of hatchlings emerged during this period. A random sample of nests that were observed being laid (ca. 70% of 545 nests recorded in Sekania in 2007) was included, representing the spatial and temporal nesting distribution. Boxes were placed over the study nests from 40 days of incubation onwards; and checked for emerged hatchlings at half hour intervals from 22:00 h until 6:00 h until the emergence of the first hatchling and during 9 nights thereafter. During these days, hatchling emergences outside the monitored hours were determined from hatchling tracks. However, 'daytime emergence events' were liable to inaccuracies. For example, when hatchlings emerge during a day of strong winds, the hatchling tracks may be erased; making it impossible to determine the exact number of hatchlings emerged during daytime. Post-hatching excavations were used to verify results. 33 nests were included; from which we directly observed 1,754 hatchlings. Visual examination of the night time emergence data revealed a peak in emergence time between 3:00 and 3:30 am with 18.2% of observed hatchlings emerging at this time. 6.2% of all directly observed hatchlings (83 hatchlings) emerged after 5:00 h and were therefore considered to be at high risk of seagull predation. Reliable data on daytime emergences was available from 21 nests. From these data we estimated that 16.7% of hatchlings emerged between 6:00 h and 22:00 h. Hatching showed a typical declining pattern with the first night hatches accounting for 35% of all emergences. Our results show that a large proportion of hatchlings on

Sekania emerged during or just before daylight hours and are thus vulnerable to predation. As this is a large proportion of hatchlings, it is likely that the population could be significantly affected by the increased bird numbers. Although we only speculate on the effect of this increased mortality rate at the hatching stage on the population, the high number of hatchlings potentially being predated is certainly of concern and thus offers justification to take action to reduce the predation pressure. Acknowledgements: The author wishes to thank Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, as well as two generous individuals: Carlos Peralta Quintero and Robert N. Allen, Jr and the Symposium for making this presentation possible.

CARETTA.CAT PROJECT: PRELIMINARY REPORT ON THE STATUS OF MARINE TURTLE POPULATION ON THE CATALONIAN COAST (WESTERN MEDITERRANEAN, SPAIN)

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Some nests of loggerhead turtles (*Caretta caretta*) were found on the western shore of the Mediterranean in the summer of 2006, even though this is not considered a common nesting habitat. More precisely, two nests were found in Spain (Premià de Mar/Barcelona and Puçol/València) and one in France (St. Tropez). The *Caretta*.cat Project started off in 2007, led by the Albera Tortoise Reproduction Centre and financed by the Territory and Landscape Foundation. The purpose of the project is to search for tracks of marine turtles that might appear on the Catalan beaches (about 600 km of beaches on the northeast of the Iberian Peninsula), to discover if there is a population that nests on these beaches and if so, to promote and work for their stabilization and conservation. The method applied consisted in a series of track surveys taken daily between the end of June until September. Most of the surveys were taken by the cleaning operators working on the greater part of the Catalan beaches. The operators were previously instructed in the detection of tracks of marine turtles on the sand. Several random surveys were taken on the few beaches that do not dispose of cleaning services. No tracks of marine turtles were found throughout this time. In addition, the project includes environmental education and physical studies of the beaches with lesser human impact. Seven temperature sensors were buried on the beach, which registered temperatures too low for the incubation of marine turtle eggs in the northern part of the area and more sufficient temperatures in the south. Some references of occasional egg laying on the Peninsula shores were found in an exhaustive bibliographic search and one author even suggested that nesting could have been important about 150 years ago. A first hand conclusion is that nesting of marine turtles on the Catalan beaches is sporadic. We recommend continuing the track surveys in the following years because of the annual variations and in order to obtain more reliable data. Also, temperatures should continue to be taken, especially since summer 2007 was cooler than the previous ones. We encourage the publication of this kind of "negative" results to serve as basic information that might be useful in the future, for example in the case that egg laying observations becomes more common, caused maybe by a behavioural change due to the climate change or for improving conservation policies of the species. Acknowledgements: AH gratefully acknowedges travel support from Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, Sandler Family Foundation, Carlos Peralta Quintero and Robert N. Allen, Jr., provided through the Symposium Travel Committee.

NESTING ACTIVITIES OF LEATHERBACKS (*DERMOCHELYS CORIACEA*) AND LOGGERHEADS (*CARETTA CARETTA*) AT TAYRONA NATIONAL NATURAL PARK, MAGDALENA PROVINCE – COLOMBIA

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Populations of sea turtles are important ecological components given their ability to maintain the equilibrium between different ecosystems and to “transfer substantial quantities of nutrients and energy from nutrient-rich foraging grounds to nutrient-poor nesting beaches.” The Tayrona National Natural Park has eleven beaches which are suitable for sea turtle nesting, three of which are located in the so-called Cañaveral sector. These latter beaches are the focal nesting beaches for leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) turtles within the Park. This study is aimed at conveying the changes that occurred in these species in this sector during the nesting seasons between 2005 and 2007. For this purpose, three beaches were monitored (Castillete, Playa Escondida and Cañaveral) during the period April – August, through day and nighttime ground surveys. The main objective of these surveys was to search for evidence of nesting activities such as tracks, nesting females and nests, which were then recorded. Nesting evidence increased in 2007 with respect to 2005 in both species (2005: 27 emergences and 14 nests; 2007: 48 emergences and 18 nests). Leatherbacks were the first species to appear in both seasons (March-June), followed by loggerheads (May-August). Unfortunately, poaching of most leatherback nests occurred during both years, which thus impeded the adequate collection and recording of data. The average numbers of eggs laid by loggerheads was 93.16 in 2005, and 103.4 in 2007. A tagging program was implemented in 2007, resulting in the interception of six females, three of which were tagged for the first time in the Park (loggerheads). Loggerhead hatchlings presented a similar carapace length (SCL = 42 mm) in both seasons. Although the hatching success decreased in 2007 (2005 = 68.48%; 2007 = 64.96%), a higher number of hatchlings emerged and were able to reach the sea (204 in 2005 and 763 in 2007). Nesting characteristics of the two species was not determined. Especially in the case of leatherbacks, the lack of adequate data made it impossible to perform any conclusive analysis. However, in the case of loggerheads, data generated enabled surveys and follow-up activities for this species within the Park. In order to evaluate the real situation of these species, it becomes of the utmost importance to set a standard for the collection of basic and essential data. However, what is indeed evident is that the poaching of nests within the protected area continues. This makes the implementation of increased nest surveillance, the use of protective measures ex situ, and the strengthening of environmental education in the neighboring communities a priority.

MONITORING OF OLIVE RIDLEY ARRIBADAS AT NANCITE BEACH, COSTA RICA DURING THE PERIOD 1997-2007

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Olive ridley arribadas at Nancite Beach have exhibited a significant decline between 1971 and 1996. This decline has been partially attributed to a reduced hatching rate as a function of accumulated organic matter, as well as to a possible shift in nesting behavior where turtles have shifted to other beaches in the region such as Ostional Beach in Costa Rica, and La Flor and Chacocente in Nicaragua, beaches that are reported to exhibit an increase in arribada

size. The objective of this study was to report arribada sizes at Nancite Beach over the last 11 years. As previously forecasted, our data verify that the Nancite assemblage has undergone a significant decline over the last two decades.

HATCHING SUCCESS OF LEATHERBACK SEA TURTLES, *DERMOCHELYS CORIACEA*, IN NATURAL AND RELOCATED NESTS ON GANDOCA BEACH, COSTA RICA

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The hatching success of leatherback sea turtles (*Dermochelys coriacea*) of natural, relocated, and hatchery nests was determined in the 2004 nesting season at Gandoca Beach, Costa Rica. Environmental factors such as nest temperatures, groundwater level, and the sand grain size distribution were examined for every nesting site and implicated on the hatching success. Natural nests as well as relocated nests showed a hatching success of 45%, whereas hatchery nests had a success rate of 57%. Natural and relocated nests showed fluctuations in temperature and were more likely to be affected by groundwater level, tidal inundation or beach erosion, while hatchery nests remained protected from environmental disturbance throughout the whole nesting season. Sand grain composition and size was uniform within the hatchery nests. Relocated and hatchery nests showed irregularities in grain size distribution. We concluded that the interactions of environmental factors had an influence on the stability of the nesting environment providing successful incubation of the eggs. The hatchery provides a stable nesting environment and leads to adequate hatching success rates. The relocation strategy performed by the ANAI Sea Turtle Project contributes to the successful development of nests, which are put in danger due to environmental disturbances.

BIOECOLOGICAL ASPECTS OF SEA TURTLE POPULATIONS IN FORAGING AND NESTING SITES ON THE CENTRAL COAST OF VENEZUELA

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There are five species of sea turtles in Venezuela. Four of them have been found on the Central Coast of Venezuela, *Eretmochelys imbricata*, *Chelonia mydas*, *Caretta caretta* and *Dermochelys coriacea*. El Banquito, Máspano, Playa Grande and Caracolito have been considered nesting beaches for *E. imbricata*, *C. mydas*, *C. caretta* and *D. coriacea*, since 1987, due to the presence of these species between March and August every year. Previous studies have not studied the potential feeding sites in the area. The principal aim of this work was to study ecological aspects of sea turtle populations in nine potential feeding sites and twelve nesting beaches in the Central Coast of Venezuela between August and December of 2001. The field methods consisted of seventeen site visits to characterize and describe both nesting and potential feeding habitats used by sea turtles as well as in water observations. The most important nesting beaches in the Central Coast of Venezuela were Máspano, El Banquito and Playa Grande. The principal nesting species at these sites were *D. coriacea* and *E. imbricata*. Fifty three nests and nine tracks were observed on these beaches. The most relevant potential place for feeding and/or nesting was Caracolito. The presence of two species, *E. imbricata* and *C. mydas*, were recorded at this foraging site. A total of forty sightings were made, thirty eight of them were *E. imbricata* and two were *C. mydas*. The main pressure at the evaluated

nesting sites was nest poaching by humans and the main pressure in the feeding areas was the incidental capture of turtles with nets.

FACTORS AFFECTING NEST PLACEMENT BY LOGGERHEAD TURTLES (*CARETTA CARETTA*) ON SEKANIA BEACH, ZAKYNTHOS, WESTERN GREECE

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Aspects of sea turtle life history when on land have been studied extensively; however the process of nest placement remains poorly understood. This gap in our knowledge limits the effectiveness of our management of their nesting habitat; thus, the study of nest site selection should be prioritised within nesting beach research. This is especially relevant for nesting areas within the Mediterranean, where nesting beaches are subject to pressures by tourism and suffer varying levels of degradation.This study set out to examine nest placement in the largest rookery within the Mediterranean, on the island of Zakynthos. There are six nesting beaches on Zakynthos; Sekania remains the only beach to be undisturbed by human presence or development. Nest site selection was studied on this beach as it allows observation of the process unaffected by confounding factors. Of 460 nests recorded during the 2006 season; 50 were randomly selected. On the morning following oviposition, the nest site was assessed according to the following factors: distance from the sea, distance from the wet sand, proximity to vegetation and elevation. The depth of the dry sand layer was measured at post-hatching excavation. Elevation was categorised as less than 25cm, 25-50cm, and greater than 50cm above sea level. An elevation map of Sekania was produced using the Emery method; and sample nests were then placed on the map. Graphical interpretation of the data shows that the majority of nests were placed at 16-20 meters from the sea. 62% of nests were laid at the vegetation line. There was no apparent relation between nest location and distance to the wet sand; nests were evenly distributed at 5 to 20 meters from the wet sand area. 56% of nests were located at 25-50cm elevation. However there was some variation, with 36% of nests falling into the 1st category. 97% of nests had a dry sand layer of less than 30cm. Results show that on Sekania, turtles prefer to nest at least 15 meters from the sea, most likely to avoid the clutch being inundated. This reinforces the importance of protecting the area at the back of the beach from development. Flattening of the dune system has occurred on some of the other beaches. Legislation on Zakynthos infers that the area closest to the sea is most suitable for tourist use; results from this study concur with this. However the vast majority of nests were laid in areas with a dry sand depth below 30cm. As deeper dry sand depths are found at greater distances from the sea this implies an upper limit to suitable nesting area. The gentle slope of this beach is considered to be one reason why Sekania has such a high nesting density. This means that the potential effects of sea level rise associated with climate change could be devastating. While nesting did peak just in front of the vegetation line, this may be more associated with the dry sand, as the presence of vegetation indicates a thicker dry sand layer. With thanks to Project GLOBAL Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Services, U.S. Fish and Wildlife Service, David and Lucille Packard Foundation, Sandler Family Foundation, Carlos Peralta Quintero, Robert N. Allen Jr and the Sea Turtle Symposium for assistance with funding.

SKIPPING 2 OR 3 YEARS FOR REPRODUCTION: THE ENVIRONMENTAL DETERMINANT AND THE EVOLUTIONARY CONSEQUENCES*

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Most marine turtles do not nest two years in a row but skip one or two nesting seasons. The advantage of such a life-history strategy is well understood from a theoretical point of view. However the proximal determinants that induce a 2 or 3 years return are still largely unknown in marine turtles as well as the consequence of such a dichotomy. Using a large database of tag returns of leatherback in French Guiana, we show that the probability of return at 2 or 3 years is influenced by the environmental conditions at alimentary sites during the previous years. When coming after 2 or 3 years, the females will not lay the same number of nests. The evolutionary implication of such a constraint will be discussed.

REGIONAL PATTERNS OF LOGGERHEAD REPRODUCTION ON THE YUCATAN PENINSULA, MEXICO*

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The coast of the state of Quintana Roo, in the Yucatán Peninsula, is the most important area for reproduction of loggerhead turtles (*Caretta caretta*) in México. This importance derives from the large number of registered nests and the fact that the loggerhead population from the Yucatán Peninsula presents the highest level of genetic diversity in the Atlantic Ocean, exhibiting haplotype endemism. Nevertheless, it has been demonstrated worldwide that loggerhead populations have diminished remarkably in the last years. Therefore, in order to design efficient conservation strategies, it is necessary to collect data on sea turtle population size and on the factors that may affect it. Nest abundance is an important and common indicator of population size in sea turtles. Generally this indicator is reported from isolated sites, with different beach conditions, protection strategies and methods used. For the first time, coordinated by the State Committee for Conservation of Sea Turtles in Quintana Roo, data from more than 30 nesting beaches in the state, distributed along almost 400 km of coast, were analyzed together. In this way we are able to evaluate the nesting activity and the factors that influence this for the most important Mexican loggerhead

population. We assessed nesting activity variability among the different beaches taking into consideration nest density, and evaluated hatching success taking into consideration latitude, nest management, clutch size, and clutch frequency. We found that some beaches had significantly more nests than others, decreasing with latitude. Hatching success was similar among beaches, but different between nest management strategies (in situ vs relocated). We assessed beach characteristics that may have influenced these patterns. These results are useful to direct conservation efforts and resources to the most important and vulnerable beaches, resulting in a more efficient use of resources and a more effective protection of these species in the region.

LOGGERHEAD SEA TURTLE NESTING ALONG THE SPANISH MEDITERRANEAN COAST: A NEW RECORD FROM VALENCIA (EAST SPAIN)

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The loggerhead sea turtle (*Caretta caretta*) nests in tropical and subtropical latitudes. In the Mediterranean in warmer months, this species nests regularly in the central and eastern basins. In the past a nesting map may have included more areas of the western basin of this sea. Unfortunately, as there is such scarce historical information about loggerhead nesting along the Spanish coast, it is therefore impossible to ascertain whether or not there was regular nesting in the past. Moreover, current coastal development and high tourism activity seriously hinder sea turtle nesting activity. Yet, despite this, some nesting evidence has been quoted in recent years, along with a further two more nesting reports in 2006. Below we present the data collected from one of the latest events. On 11 August 2006 a loggerhead turtle nest was reported on a tourist beach in Puzol (East Spain, Western Mediterranean). The chamber had been partially opened by waves and contained 78 eggs, although it is possible that the original nest size had been larger. The nest was relocated onto a beach close down to the public in El Saler Natural Reserve (Valencia, East Spain) and thus protected. On September the 20th, a total of 25 hatchlings emerged from the nest (mean Straight Carapace Length (SCL)±SD= 42.4±1.8 mm; mean weight±SD= 14.6±1.3 g; n= 15). Five days later one dead and two live hatchlings were found in the excavation of the nest. Genetic studies are in progress to determine the origin of the nesting turtle. But, in order to determine the importance of loggerhead turtle nesting activity a greater number of beach patrols are required along the over-exploited Spanish Mediterranean coast.

RESULTS OF THE 2007 NESTING SEASON FOR THE LEATHERBACK TURTLE NESTING BEACHES ON THE PENINSULA DE PARIA, SUCRE STATE, VENEZUELA

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The northern Paria Peninsula in Venezuela includes the most important nesting localities on the mainland for the leatherback turtle (*Dermochelys coriacea*) (northern area) and for the hawksbill turtle (southern area). The key localities in the north peninsula are Cipara Beach (10º45'N, 62º42'W) and Querepare Beach (10º42'N, 62º52'W). A few nesting females of the loggerhead turtle (*Caretta caretta*) and the hawksbill turtle (*Eretmochelys imbricata*) also nest on these beaches. Both beaches were patrolled every night from 20:00-21:00 to 05:00. Female leatherback turtles were tagged with metal tags in each foreflipper and a PIT tag in the right shoulder. The Cheloniidae species

only received metal tags. Curved carapace measurements (CL and CW) and general condition were registered. Most of the nests (n=275) were translocated to hatcheries to protect them from poaching, however, in Querepare Beach in 2007 some nests were left in situ (n=25) or were relocated (n= 20) in other places of the same beach, in the first attempt to leave as many nests on the beaches as possible. The field work was conducted between March 17th and August 31st. For the 2007 nesting season we obtained similar numbers than those for 2006: a total of 126 leatherback females were tagged. Almost 30 remigrants from 2001 to 2005 were encountered, although the majority of remigrants were from 2005. One interesting observation was a nesting turtle that had been first tagged in Canadian waters. The effects of a hurricane by mid August severely affected Cipara Beach, although most of the nests had already hatched. Field project activities were conducted under scientific permits from the Ministry of the Environment (MINAMB). Data available indicates that Cipara and Querepare beaches are the most important leatherback turtle nesting localities in Venezuela.

POTENTIAL SEA TURTLE NESTING HABITAT ON MACANAO PENINSULA, MARGARITA ISLAND, VENEZUELA, OBSERVATIONS DURING 2007 NESTING SEASON

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Margarita Island, with an area of 1,071 km^2, is the largest of the Venezuelan islands. Four sea turtle species nest on the island, and all of them are considered in danger of extinction by Venezuelan law. In spite of this, little information exists on the use of the nesting habitat at the Macanao peninsula, hampering the implementation of conservation measures. This study presents a preliminary evaluation of sea turtle nesting on Macanao's northern and western coasts. Three variables were selected to identify potential nesting areas during preliminary field trips: suitable substrate availability, absence of physical obstacles impeding female access to the beach and acceptable human activities impact. Additionally, inhabitants of local communities were interviewed in order to obtain information on nesting beaches, sea turtle species and reproductive seasons. 37 beaches were considered potential nesting sites. During periodical field trips between April and August, tracks and nest evidence was found in 13 sites; being La Auyama, La Mula, Boca de Macanao, La Pared and El Tunal the most used beaches. A total of 30 nesting events were recorded. From the 4 species reported as nesting in the island *Dermochelys coriacea* (25) was the most common, 3 nesting events of *Eretmochelys imbricata* were found and two of *Chelonia mydas*. No nesting activity of *Caretta caretta* was observed. Most nesting activity occurred during June (14) and May (7). Information from local people predicted La Pared, La Auyama and La Mula, as the most heavily used beaches, corresponding with field observations. These beaches are also the main tourist attraction of the northern coast of Macanao. Many of the beaches where nesting events occurred are within La Restinga National Park. It is urgent to evaluate the nesting trends in this region, as to facilitate conservation measures design.

CHARACTERIZATION OF KEMP'S RIDLEY (*LEPIDOCHELYS KEMPII*) SEA TURTLE NESTING ON THE UPPER TEXAS COAST IN 2007

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Record annual nesting activity along the Texas coast by the critically endangered Kemp's ridley (*Lepidochelys kempii*) since 2002 has coincided with an exponential increase in this activity on its primary nesting beach, Rancho Nuevo, Mexico. Although most ridley nesting in Texas occurs on and south of patrolled beaches along Padre Island National Seashore, the upper Texas coast has contributed annual increases to this activity over the same time frame. Kemp's ridley nesting on Galveston Island increased 350% between 2002, when the first 2 nests were documented, and 2006, when 9 nests were recorded. A lack of nesting patrols along beaches from Sabine Pass at the Texas-Louisiana border south to Matagorda Peninsula contributes to an informational void on the importance of the upper Texas coast to nesting sea turtles. Texas A&M University at Galveston (TAMUG) instituted the first formal nesting patrols of the upper Texas coast in 2007 by utilizing a cadre of 30 volunteers to conduct foot and ATV patrols of Galveston Island between 3 April and 13 July. The eastern portion of Galveston Island was divided into three 4.0-km long sections each patrolled weekdays by one individual conducting a round-trip foot patrol from 0800-1100 hours. The 28.7-km western segment was patrolled weekdays as a round trip circuit via the all-terrain vehicle (ATV) from approximately 0800-1200 hours. Combined patrols spent 796 hours monitoring 5271 km of Galveston beaches, on which 7 Kemp's ridley nests were documented. Collectively, these nests contained 676 eggs from which 590 hatchlings were subsequently released into the Gulf of Mexico. Four nesting females, all belonging to 1989-1995 year classes headstarted at the NOAA Fisheries Galveston Laboratory, were intercepted between 17 May and 26 May and equipped with Sirtrack Kiwisat 101 satellite transmitters. Satellite tracks indicated these four females maintained a fidelity to the upper Texas coast for a minimum of 15 days during their respective internesting intervals before beginning a post-nesting migration offshore or northeastward into Louisiana's waters. All four females were still in Louisiana coastal waters at varying distances west of the Mississippi River Delta as of 15 September 2007. Data from nesting patrols on Galveston Island as well as satellite tracks from these four nesters imply that the upper Texas coast holds unknown potential as viable nesting habitat for a Kemp's ridley assemblage exhibiting significant signs of population recovery. Nesting activity along the primarily unpatrolled and sporadically populated upper Texas coast is likely greater than currently documented, since prerequisite reporting is largely dependent on beach-goers not adequately informed to do so. The fact that TAMUG patrols were responsible for finding five of the seven nests located on Galveston Island in 2007 heightens the need for increased patrol effort along the upper Texas coast to: characterize this area's role in providing nesting habitat; document nester fidelity to this habitat; and identify internesting intervals and post-nesting movements. Acknowledgments are given to Texas General Land Office Coastal Management Program, Texas Master Naturalist and TAMUG undergraduate student volunteers, Dr. Tasha Metz and the Marine Biology Department of TAMUG, Ben Higgins, Shanna Kethan, Erin Seney, Mauricio Rodriguez, and Cain Bustinza of the NOAA Sea Turtle Facility, Galveston, Student Travel Awards: TAMU Wildlife and Fisheries Sciences Department, TAMUG Marine Biology Department, and ISTS Travel Fund (made possible by donations from Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, the Sandler Family Foundation, Carlos Peralta Quintero, and Robert N. Allen, Jr.).

SPATIAL AND TEMPORAL INFLUENCE OF METEOROLOGICAL AND SUBSTRATE FACTORS UPON LOGGERHEAD SEA TURTLE NESTS IN SOUTH CAROLINA

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Although the majority of loggerhead sea turtle nests that occur in the southeastern United States are laid in Florida, nests in South Carolina are important due to the cooler temperatures producing more males during the mid-third of incubation duration when sex is determined. The largest rookery north of Florida is also located in South Carolina at the Cape Romain National Wildlife Refuge. Loggerhead nest temperatures were recorded using temperature-humidity data loggers that were placed within the center of nests at three locations. Data loggers were deployed within four quartile periods between June and mid-August with most loggers allocated to the mid two quartiles when the majority of nests are laid. This design allows a spatial and temporal comparison of nest temperature, incubation duration, sex ratio and overall hatching success. Preliminary analysis suggests that there are within and between beach differences in temperature during the mid-third of incubation and incubation duration. Data also indicate that the cooler temperatures and longer incubation durations at the northern nesting beach would suggest a higher ratio of males compared to the southern nesting beaches. The southern locations produced female skewed sex ratios throughout the quartile periods of this study. Substrate was collected from each nest and analyzed for grain size and distribution, apparent density and color and meteorological data were recorded to determine the influence of these factors on nest temperature and hatchling outcome at these locations.

CARETTA CARETTA NEST TEMPERATURES IN HATCHERIES AT CAPE ROMAIN - SOUTH CAROLINA: DETERMINANTS OF SPATIAL AND TEMPORAL VARIABILITY

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A high intensity sampling of loggerhead nest temperatures was obtained from hatcheries at Cape Romain National Wildlife Refuge in South Carolina during the summer of 2007. This site represents the single most important nesting beach for *Caretta caretta* in South Carolina, USA. The experimental design involved datalogger placement (4 per nest) in every other nest in a series of hatcheries established over the nesting season. Within each nest sampled loggers were placed at the top, middle, side, and bottom of the clutch. Variation in temperature by space was accessed to determine 3D nest thermal regimes as well as broad-scale whole nest temperatures - potentially associated with conductive heat transfer from metabolic heat generation from the interior of nests. Variation in temperature by time was investigated based upon seasonal nest placement within each hatchery and correlation of temperature conditions within nests to recorded meteorologic conditions. Initial results at the time of abstract submission indicate a highly female skewed population of hatchlings being generated from the cooler first quartile period, with small numbers of males being confined to the bottom of clutches. The estimated sex ratio demographics from the hatcheries over the entire season are expected to be highly female skewed. Initial results also suggest that metabolic heat generation becomes important in the last third of the incubation period as evidenced by a switch to

higher temperatures in lower lying clutch regions. These results will be interpreted with regards to a contemporaneous natural nest study at this site to provide information that could be used for hatchery designs aimed at particular sex ratio outcomes.

HAWKSBILLS IN TRINIDAD

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Hawksbill turtles nest on both the north and east coasts of Trinidad. Past reports suggest that they are rare nesters and records of hawksbills nesting in Trinidad are few. However, it is generally accepted that hawksbills are the second most numerous turtle nesting in Trinidad, albeit not in numbers anywhere near that of the leatherbacks. Prior to this study, no nesting population estimates existed for hawksbills in Trinidad. There are a handful of recorded sightings of hawksbills from the east and north coasts of Trinidad, but most nesting is reported from the Bocas Islands off the northwest peninsula. Hawksbills also forage in the waters off the coasts of Trinidad, most likely in numbers larger than the nesting population. It is likely that the hawksbills that nest and forage in Trinidad are from different genetic stocks and that the foragers nest elsewhere, although genetic work would be required to confirm this. The beaches on the north coast of Trinidad were surveyed for nesting sea turtles from April to August in 2000 to 2004. Hawksbill nest numbers were recorded by night-time monitoring regularly throughout the nesting season, and by day-time track counting on some of the more remote beaches. The data were extrapolated from nest numbers over the season, and over the four years of survey. Nesting hawksbills (tracks and nesting adults) were seen on all the north coast beaches surveyed. A total of 71 clutches were seen laid over the four years. None of the encountered hawksbills were tagged. The nesting season began in early May and ended in late September, although it is likely that sporadic nesting occurs throughout the year. The estimated mean number of hawksbill nests per year on the north coast of Trinidad was calculated as 675 (approximately 150 nesting females). The number of nests that were laid on the east coast beaches and Bocas Islands is unknown. The same hawksbills could be nesting on both coastlines, as well as using the beaches on the nearby island of Tobago, where hawksbills are relatively common nesters. Threats to hawksbills in Trinidad include exploitation for their shell and meat, and they are also subject to bycatch in the local gillnet fishery and the shrimp trawl fishery in Trinidad's waters. It is currently unknown to what extent local fishing activities affect the population. Slaughter of hawksbills in their nesting environment is reported as being uncommon. However, there was some evidence of slaughter on the remote north coast beaches during this study, particularly in 2004. Trinidad supports a small, but significant nesting population of hawksbills in the Caribbean. Investigation into the reports of hawksbills on the east coast and the Bocas Islands off the northwest peninsula of Trinidad, and the hawksbills nesting in Tobago, along side tagging and genetic studies, are recommended for a full evaluation of the nesting population.

SEA TURTLE NESTING TREND ON POTENTIAL NESTING BEACHES OF THE MNAZI BAY - RUVUMA ESTUARY MARINE PARK, MTWARA, TANZANIA

Jairos Mahenge

Mnazi Bay – Ruvuma Estuary Marine Park, Mtwara, Tanzania

Tanzania has a coastline of about 1,400 km of which the last 45 km at the southern tip fall within the Mnazi Bay - Ruvuma Estuary Marine Park (MBREMP). The park was gazetted in July 2000 as the second Marine Park in Tanzania formed under the Marine Parks and Reserves Act number 29 of 1994. There are four potential turtle nesting beaches along the park's coastline named, Ruvula, Msimbati, Kingumi and Litokoto beaches. The first two fall in the Msimbati village area and the other two in the Litembe village area. The long term turtle conservation programme was developed and initiated in October 2003. This is a multifaceted strategy to safeguard these endangered species from threats which were identified to be: deliberate fishing (capture), slaughtering of nesting females and poaching of eggs from nests. This program is being implemented in collaboration with local communities. Since that time, there has been progress in turtle conservation activities which included beach patrols, protection of nests, tagging of nesting females, data recording on dead turtles and released hatchlings and collection of skin samples for DNA analysis. Awareness raising and transfer of knowledge on turtle conservation was actively undertaken to allow a large proportion of the park community to be aware of these issues. Number of nests recorded from 2004 to 2007 (up to the end of August) were 34, 19, 12 and 16 respectively. The corresponding numbers of hatchlings released as a result of the nests being protected were 2,122; 1,367; 514 and 314 (to date in 2007). During this entire period only one nest of a hawksbill turtle (*Eretmochelys imbricata*) was recorded during the 2005 season. The rest of the records were of green turtles (*Chelonia mydas*). The overall percentages of nesting contribution per village area for the entire period from the Litembe and Msimbati villages were 72.8% and 27.2% respectively. The Kingumi beach was the preferred nesting beach which contributed 51.9% to the total number of nests recorded. Despite the success, there were also challenges to the successful implementation of turtle conservation activities which included the unknowns surrounding natural cycles of nesting intensity, absence of trans-boundary conservation activities with neighboring Mozambique, local community perceptions regarding conservation, predation and beach disturbances (especially in the Msimbati area) due to various causes including hydrocarbon exploration and extraction activities. Some additional efforts are still required in order to safeguard marine turtles and their ecology in the Park.

CONSERVATION OF SEA TURTLES IN BRAZIL: ENCOURAGING RESULTS OBTAINED ON NESTING BEACHES

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Sea turtles are slow-maturing animals, requiring many years, in some cases around three or four decades or possibly more, to get to reproductive age. This sets the time scale for conservation programs, and consequently a relatively long period of time is generally necessary for the assessment of the effects of conservation actions on sea turtle populations. As pointed out by G.C. Hays in 2004, some conservation programs around the world have already produced sufficiently long time-series indicating noteworthy increases in nesting populations of sea turtles. Here we

present a compilation of results, some of them published in 2007, showing the positive outcome of conservation actions in Brazil in effect on nesting beaches since 1982 and carried out by Projeto TAMAR, the Brazilian sea turtle conservation program. We believe that these results are significant not only for Brazil, but also in international terms. The number of hawksbill (*Eretmochelys imbricata*) nests in Bahia and Sergipe was estimated to have changed from 199 in 1991/1992 to 1,345 in 2005/2006, a nearly 7-fold increase in 15 years; furthermore, between 185 and 475 nests were estimated to have occurred in 2005/2006 in a recently recognized nesting area in Rio Grande do Norte. The number of olive ridley (*Lepidochelys olivacea*) nests in Sergipe and Bahia was estimated to have changed from 252 in 1991/1992 to 2,606 in 2002/2003, an approximately 10-fold increase in 11 years, and in the 2006/2007 nesting season 3,872 olive ridley nests were recorded (the number of olive ridley nests in that season should in fact have been greater, as some nests have not been identified to species). For loggerheads (*Caretta caretta*), the number of nests estimated on the Brazilian coast increased 5 times between 1991/1992 and 2006/2007, from 1,200 to 6,000 nests. These results make the Brazilian loggerhead population one of the most important in the world for this species, and the Brazilian olive ridley and hawksbill populations some of the largest in the western Atlantic for each species. Although the leatherback (*Dermochelys coriacea*) population nesting in Brazil (in Espírito Santo) is relatively small, the number of leatherback nests increased from 6 in 1993/1994 to 100 in the 2006/2007 nesting season. In that season, about 18,000 nests of five sea turtle species (the four species mentioned above plus the green turtle, *Chelonia mydas*) were protected by TAMAR on 1,000 km of nesting beaches on both mainland Brazil and oceanic islands. These results are the consequence of work developed through a long-term partnership between government, a non-governmental organization, the private sector and local communities to promote nationally the protection of sea turtles, always giving strong attention to the incorporation of human and social issues into all of the conservation initiatives. However, despite the encouraging results, many threats are known to still endanger the Brazilian sea turtle populations, especially at sea, where fishing is an ever-present hazard. Moreover, the conservation of sea turtle populations is often a matter not just for local efforts but also calls for international collaboration.

THE DEMISE OF THE LOGGERHEAD POPULATION OF RETHYMNO, GREECE, AS NOTED FROM 18-YEAR NESTING DATA (1990-2007)*

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The nesting area of Rethymno on the Island of Crete, Greece, was discovered by ARCHELON in 1989, in the course of a wider investigation for nesting areas along the shores of Greece. Relatively high nesting levels led to the inclusion of this area, since 1990, in the standardized monitoring work of ARCHELON, which has unfailingly continued to this day (2007). The actual nesting habitat consists of a mosaic of sandy beaches, ranging in length from 462 m to about 2 km, separated by rocky outcrops and promontories. The suitable nesting area accumulates to 10.8 km, which is deployed over a coast length of about 15 km. The area has a northern orientation and its westernmost sector (Sector A: 2 km length) ends up at the town of Rethymno, gradually becoming the town's public beach. To the east of the nesting area the coast is mainly rocky for at least 80 km. Rethymno beach sectors differentiate greatly in physical and land use features, with development and human use increasing from year to year. Monitoring was conducted on foot during early morning surveys from end of May until middle October by trained volunteers supervised by experienced field assistants. All possible nests were excavated by hand until the appearance of top eggs in order to mark the exact site and put a metal cage over the nest to avoid trampling by beach visitors. A small number of non-located nests were recorded later in the season by hatchling tracks. A number of clutches were relocated to suitable sites either on the same beach or in hatcheries at nearby beach sectors. The reason for nest relocations was mainly to avoid inundation by seawater caused by the predominant northerly winds during the summer months. To mitigate hatchling disorientation, by bright artificial lights, most affected nest sites and the seaward path of emerged hatchlings were shaded by makeshift panels. The annual number of clutches over an 18-year period (1990-2007) ranged from 166 to 516 nests, exhibiting a clear downward trend with about 4% annual decline. Possible reasons of the decline are described in another study presented at the 28th Annual Symposium. It seems that despite long-standing conservation efforts and mitigation measures it has not been

possible to reverse or stop the noted decline. The Island of Crete is located at about the center of the eastern Mediterranean basin, around which the major loggerhead rookeries of the region are found (namely in Greece, Turkey, Cyprus, Libya, Lebanon and Israel). According to a regional genetic study the loggerhead population in Rethymno, despite its relatively low contribution to the total loggerhead nesting in the Mediterranean (7.7%), plays an important role by facilitating male-mediated gene flow and reduces the negative effects of inbreeding in other small populations (e.g. Israel, Lebanon). The loss of the Rethymno population will certainly reduce the overall genetic variability of the loggerhead turtle in the Mediterranean. The authors would like to thank all volunteers and field assistants who collected the data over the years.

POTENTIAL BIASING OF HATCHLING SEX-RATIOS IN RELOCATED LOGGERHEAD NESTS, ST. CATHERINES ISLAND, GA: A PILOT STUDY

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Loggerhead sea turtles (*Caretta caretta*) nest along the sandy beaches of St. Catherines Island (SCI), Georgia, USA each year. The beaches of SCI are extremely erosional, and the risk of repeated tidal inundation or nest washout forces the relocation of 80-90% of nests. Nests are relocated to the nearest suitable dune habitat, which is often used for loggerhead nesting. It is possible that the dunes in which the nests are relocated possess different thermal characteristics than the original nesting sites, thus introducing the potential to skew the sex-ratios of hatchlings away from what would naturally occur. Data loggers were placed into the egg chambers of in situ (n=2) and relocated (n=9) loggerhead nests (n=51 total nests) on St. Catherines Island during the 2007 nesting season. The data loggers (HOBO ProV2, accuracy +/- 0.2° C) were programmed to record the temperature every 20 minutes during incubation. The pivotal temperature for loggerhead nests on nearby Georgia barrier islands has been estimated to be 29.3° C and the transitional range of temperatures has been estimated to occur between 28.7° C and 30.1° C. The data collected by the loggers were used to estimate sex ratios on an individual clutch basis and allow for a comparison of estimated sex ratios from in situ and relocated nests. The duration of incubation was also used to estimate hatchling sex ratios for groups of nests deposited at similar times, since we were unable to place data loggers into each clutch. Preliminary results indicate that male-biased hatchling ratios are produced during the early, cooler portion of the nesting season, with an increase in female-biased hatchling ratios being produced as the season progresses and daily temperatures increase. There does not appear to be a difference in the sex ratios of hatchlings from relocated and in situ nests. This could be due to the small sample size, or because no such difference is actually occurring. The project will be repeated during the 2008 nesting season, with data loggers being deployed in a greater number of nests to attain a more complete picture of hatchling sex ratios and better statistical significance.

LOGGERHEAD SEA TURTLE NEST MANAGEMENT IN GEORGIA: STRATEGIES THAT MAXIMIZE HATCHING SUCCESS

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Georgia's barrier islands are owned and managed by numerous public and private entities, and loggerhead (*Caretta caretta*) nest management strategies vary across islands. Nest management strategies range from little nest manipulation to frequent nest relocations, but little experimental evidence exists to support the use of one management protocol over another. From 2002-2007, we investigated the effects of commonly used nest relocation strategies and predator deterrent methods on loggerhead hatching success on Sapelo Island, Georgia. We randomly applied one of five treatments to loggerhead nests (n=428). Treatments included 1)confirm eggs, no screen, no relocation, 2)confirm eggs, screen, no relocation, 3)confirm and relocate eggs, no screen, 4)confirm and relocate eggs, screen, and 5)control (do not confirm eggs, no screen, no relocation). Treatment effects were examined using ANOVA with hatching success (percent of total eggs that successfully hatched) as the response variable. Preliminary analysis indicates no significant difference between treatments (alpha=0.05). Mean hatching success among treatments ranged from 73.6% (treatment 4) to 64.0% (treatment 2). Treatment 5, the control, had a mean hatching success of 66.5%. This analysis suggests that hatching success on Sapelo Island would not be adversely affected by a more conservative nest management protocol. Our results contribute to a statewide management plan for Georgia's nesting beaches, in the effort to promote recovery of the southeastern U.S. loggerhead population.

WHERE DID THE LOGGERHEAD (*CARETTA CARETTA)* NESTING FEMALE POPULATION OF MASIRAH ISLAND (ARABIAN SEA) GO?

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The sea turtle population of loggerheads (*Caretta caretta*) nesting on Masirah Island, Arabian Sea, has been known since the 1970s as the largest population worldwide with at least 30,000 nesting females. These numbers have been again confirmed by studies conducted in the mid 1980s. During the 1990s, the population was monitored less intensively although the tagging programme continued and in the 2000s satellite tracking became a reality. However, studies conducted on the 14-Km-long Loggerhead Beach and on beaches on the East side of Masirah Island (totalizing another 20 Km extension of beaches), known as the nesting grounds for loggerhead turtles, during the loggerhead nesting season of 2005 (May – July), revealed a density of only 6-8 turtles/km/night during the peak of the nesting season (late May and early June), with higher densities on areas undisturbed by fishermen. Nests were distanced randomly from the high tide mark, and preferably on soft sand, where nesting frequency (# nests/ # tracks x 100) was about 68%. The overall nesting frequency per night was 70%. Many potential natural predators of turtle eggs and hatchlings were identified, although none was observed predating. Egg collection by humans may be less than 1%. This density of nesting females is much lower than expected as an average of 7 turtles/km/night (even lower when not at the peak of nesting season) on 34 km of nesting beaches over the nesting season (3 months), considering an average of 4 clutches per turtle, only indicates a nesting population of up to 5,000 ind. Is this population in decline or were early numbers overestimated? Perhaps the population neither is in decline, nor were early calculations overestimated, but it is possible that nesting females are shifting to remote beaches on the mainland (Wusta and Dhofar) and to the Al Hallaniyat Islands nesting grounds, all further south in the Arabian Sea.

HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) MONITORING AT DOCE LEGUAS KEYS, JARDINES DE LA REINA ARCHIPELAGO, CUBA: 1997-2006

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Doce Leguas Keys, (Jardines de la Reina, Archipelago) has long been recognized as the most important nesting site in the Cuban Archipelago for the hawksbill turtle (*Eretmochelys imbricata*). It is also the main feeding area for this species in Cuba. Monitoring and nesting surveys with a systematic methodology in that area were carried out between 1997 and 2006. Nest abundance and beach density index, annual mean number of eggs, mean size of nesting females, as well as remigration intervals and re-nesting intervals were gathered. This paper concluded that nesting has increased in Doce Leguas Keys where the average annual number of eggs per nest has stayed constant. Data on growth and movements of sea turtles in that region were also obtained in that period.

NESTING BEHAVIOUR OF MARINE TURTLES IN THE CANARREOS ARCHIPELAGO, CUBA (2001-2006)

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An analysis of nesting trends for green turtles (*Chelonia mydas*) and loggerhead turtles (*Caretta caretta*) was carried out based on quantifications of nests found at their main areas of reproduction in 2001-2006 at the Canarreos Archipelago. Our results indicate an increase in nesting, in greater or smaller degree, of green turtles for all nesting sites at the Archipelago and of loggerhead turtles at the beaches of San Felipe keys and Cayo Largo, as well as at the whole archipelago. Nevertheless, for the loggerhead there was a reduction from 46 to 24 nests at the south of Isla de la Juventud and from 75 to 17 nests on beaches from the keys to the east of the same island, possibly due to an increase of human predation in the first area and due to a change of beach configuration in the second one. However, there was an increasing trend in the whole study area for both species (from less than 1,000 to more than 2,000 nests for the green turtle and from 149 to 289 nests for the loggerhead turtle).

ESCUDO DE VERAGUAS ISLAND: ANOTHER IMPORTANT NESTING SITE FOR THE HAWKSBILL TURTLE (*ERETMOCHEYLYS IMBRICATA*) IN THE NGÖBE-BUGLÉ AUTONOMOUS REGION, BOCAS DEL TORO, PANAMA

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In the Bocas del Toro region of Panama, there exist several important nesting beaches for hawksbill (*Eretmochelys imbricata*) and leatherback (*Dermochelys coriacea*) turtles. Most notable of these is Chiriquí Beach, located in the autonomous indigenous region of the Ngöbe-Buglé. This area was once described by Dr. Archie Carr as the most important hawksbill nesting beach in the Caribbean, and today it remains a major nesting site for this species, in addition to hosting a regionally significant leatherback population. Sea turtles have historically played an important role in the economy of the region; for several centuries hawksbills were hunted extensively in the area, and in the 20th Century, the harvest supported the international tortoiseshell market, as well as local demand for hawksbill products. These hunting pressures were presumably the reason for the substantial decline in hawksbill nesting observed at Chiriquí Beach in the 1980's and 1990's. In 2003, a long-term project for the investigation and recovery of the hawksbill population was established in collaboration with the local Ngöbe communities. Several locations were chosen for inclusion in the project, including Chiriquí Beach, Escudo de Veraguas Island, and the Zapatilla Cays in Bastimentos Island National Marine Park. These areas were selected as historically they supported hawksbill nesting populations. Escudo de Veraguas, which lies 14 km off the coast of Chiriquí Beach, is an important center for artisanal fishing activities conducted by members of local indigenous communities. The surrounding reefs provide feeding habitat for hawksbills and green turtles; green turtles migrate through the area en route to nest in Tortuguero, Costa Rica. The island has 12 beaches that are used by nesting hawksbills, varying in length from small pocket beaches to 2 km. Because of the remoteness of the island, nesting surveys were conducted once every 15 days. All nests were marked and the locations recorded using GPS. Nest surveys conducted from 2003 to 2007 documented a minimum of 20 – 87 hawksbill nests per year. In addition, 5 – 10 leatherback nests and 2 – 5 green turtle nests have been recorded annually. The major threats to the continued survival of hawksbills nesting at Escudo are direct capture of adult and juvenile turtles in local waters by harpoon fishers and divers, illegal collection of eggs, erosion and predation. These factors threaten the success of the project, but it is hoped that with continued efforts aimed specifically at increasing the awareness of local fishermen to the impacts of their activities on hawksbills in the region, that positive results can be obtained. The monitoring results reveal the significance of Escudo de Veraguas as a nesting site for hawksbill turtles. They also justify the continued monitoring of the island and support calls by research personnel for improved protection endeavors by Panamanian authorities to reduce in-water capture of turtles and illegal take of eggs from nesting beaches. Legislation has recently been proposed to designate Escudo de Veraguas as a Natural Monument Protected Area which would benefit sea turtle conservation and indigenous communities under constant pressure to develop the island.

SATURATION TAGGING ON JEKYLL ISLAND, GEORGIA

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Nest monitoring had been conducted on Jekyll Island, Georgia from 1972-2007, with the exception of 1986-1989. Saturation tagging was conducted from 1972-1999, with the exception of 1986-1990. In 2007, with the inception of the Georgia Sea Turtle Center (GSTC), saturation tagging was once again conducted under the supervision of the Jekyll Island Authority (JIA) and Georgia Department of Natural Resources (GADNR). The tagging efforts were part of the Cooperative Marine Turtle Tagging Program (CMTTP) coordinated by the Archie Carr Center for Sea Turtle Research. Sea Turtle Interns or Staff conducted nighttime patrols between 9pm-6am from May 15-August 25, 2007. Daily dawn surveys were also conducted to check on each nest individually and perform visual inspections to note signs of depredation, emergence, hatchling disorientation, or wash-out/over by the tides and conduct post-hatching excavations. Forty-eight nests (47 loggerhead and 1 green) were laid on Jekyll Island during the 2007 nesting season. This was the 3rd lowest nesting season on record for Jekyll Island. The nesting female was encountered during 38 of the nesting events. In addition, females were encountered during 21 false crawls. In total, 16 individual females were encountered (15 loggerheads, 1 green). Of the 16 turtles encountered, 12 female turtles did not have any existing flipper tags, 3 had at least 1 existing flipper tag and were originally tagged on Jekyll Island in 1994, 1997 and 1998 respectively, and 1 had existing tags on both flippers and was originally tagged on Wassaw Island, Georgia in 2007. Turtles were also scanned for Passive Integrated Transponder (PIT) tags. Of the 16 of the encountered turtles, 10 did not register a PIT tag, 4 had an existing PIT tag from Jekyll Island (1 in 1999, 2 in 1998 and one in 1994), and 2 had existing PIT tags from other Georgia Islands (1 from Blackbeard Island in 2005 and 1 from Wassaw Island in 2007). From the saturation tagging efforts we were able to document 2 females that nested on Jekyll Island at least 5 times this season, 3 females that nested at least 4 times, 1 that nested at least 3 times, 3 that nested at least twice and 7 for which only 1 nest was documented. Data from the Jekyll Island project will be combined with that from other tagging projects throughout to determine which, if any, turtles may have nested on other islands throughout the season. However, these data indicate that there was a significant “resident” nesting population on Jekyll Island in 2007; correlation with data from past and future years will determine whether nest site fidelity continues across nesting seasons. Data from this season alone will help us predict number of nests laid per season per female and inter-nesting intervals for local nesting turtles.

MARINE TURTLE CONSERVATION IN QATAR: CHALLENGES AND OPPORTUNITIES

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Marine turtles in Qatar, in the Arabian Gulf, have been under research, monitoring and protection efforts since 2000/2001. These efforts started within the confines of one of Qatar's industrial cities but have since expanded to a nation-wide effort. The main species nesting in Qatar is the Hawksbill turtle (*Eretmochelys imbricata*). Green turtles (*Chelonia mydas*) are also found foraging in Qatar waters, feeding on Qatar's extensive seagrass beds and to a lesser degree on invertebrates associated to coral reefs. The turtle populations in Qatar are under increasing pressure from industrial and commercial development, which has reduced the available foraging and nesting habitat. Following wider-scope efforts by Qatar University in 2002 and 2003, a detailed field research and monitoring programme was conducted during the 2004-2005 nesting season under the auspices of Qatar's Supreme Council for the Environment

and Nature Reserves, including habitat identification, the provision of on-the-site training in research and monitoring techniques, and an assessment of threats and conservation opportunities. Five key beaches were identified hosting an estimated 200 or more females per year. Straight Carapace Length (SCL) averaged 65.4 cm and weight averaged 40.7 kg. Females laid an average of 2.21 clutches in 2005. Nearly 40% of turtles emerged only once, while only one individual nested six times. The average re-nesting interval was 12.2 days. Average egg diameter was 35.4 mm, and egg weight was 24.3 g. Clutch size averaged 82 eggs with 15 small infertile eggs in each clutch. Incubation periods ranged from 48 to 77 days and mean hatching success rate was 73.3%. Hatchlings averaged 36.8 mm SCL, 28.2 mm Straigth Carapace Width (SCW), and weighed an average of 11.4 g. In 2006 and 2007 conservation efforts were implemented, including polyethylene grids to protect nests against fox depredation, opaque screens to counter industrial lighting, fences to eliminate 4x4 vehicle traffic and daily beach patrols. We believe that the continuation of these efforts will safeguard Qatar's turtle population and possibly provide a secure haven for other turtles in light of the continued habitat loss in the region.

GANDOCA, WHERE ARE THE OTHER LEATHERBACK NESTS? (16 YEARS OF DATA, 1991-2007)

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The Sea Turtle Program from Asociación WIDECAST has been ongoing in the Gandoca - Manzanillo National Wildlife Refuge (9° 59.972’ N, 82° 60.530’ W) in Talamanca County, Limon Province, Costa Rica, from 1986 until the present. Playa Gandoca is the most important sea turtle nesting site in the South Caribbean coast of Costa Rica, with at least three nesting species: the leatherback (*Dermochelys coriacea*) as the most abundant, followed by hawksbill (*Eretmochelys imbricata*) and green sea turtles (*Chelonia mydas*). The leatherback nesting population at this index beach is the only one out of three existing index beaches for this species that shows positive nesting tendency over time. Since 1991, this program has been working under the same protocols and tagging every turtle that comes to nest; tags have been applied to the back flippers, and since 1999 this program started using passive integrated transponder's (PIT´s). This research analyzes sixteen years of data with the “WIDECAST Regional Marine Turtle Data Base” following the recommendations of Briseño-Dueñas and Abreu-Grobois in the publication “Data Bases” in 2000, and describes the remigration and fidelity of leatherback turtles to the same nesting beach. Since 1991, the Sea Turtle Conservation Program at Gandoca beach has tagged 2138 nesting leatherback females. Of those 2138 females 70.4% nested in just one season, 20.6% nested for two seasons, 5.9% for three seasons, 2.3% for four seasons, 0.6% for five seasons, and 0.1% for six seasons. If we consider what Gulko and Eckert say, “females mate every two to three (or more) years and can nest as often as 12 times during a reproductive year,” we can find that there is a lot of nests that this population could be laying on other nesting beaches. Where are those leatherback nests? It is really important to improve the regional data base and share the information among countries.

GEOMAGNETIC PROFILE OF SINGER ISLAND, FLORIDA: A CONDOMINIUM-DOMINATED SEA TURTLE NESTING BEACH

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Singer Island is located immediately north of West Palm Beach on the Atlantic Ocean in southeast Florida. It is a 2.6 km long stretch of sandy beach occupied by 37 condominiums or hotels of varying sizes and ranging in height up to > 30 stories. The aim of this project was to compare the geomagnetic profiles previously obtained on beaches relatively unaffected by large buildings at St. George Island, Florida, and Tortuguero National Park, Costa Rica. Of interest on a condominium beach was the suspected large-scale variation in total magnetic field intensity over short distances that is mainly due to the steel components in large buildings. This anthropogenic magnetic component was expected to disturb the geomagnetic field already present in the area. Our findings confirm this. We observe a rapidly varying field strength along the beach, even at the waterline. The buildings produce negative swings in field strength that are typically 100-200 nanotesla in magnitude, and which vary (alongshore) in width from 100-500m. The strength variations are about 2-4% of the local earth's field, which is similar to geomagnetic variability in natural settings that occur over much longer alongshore distances (5-10 km scale). However, extremely large fluctuations in the total magnetic field strength occur directly in front of steel seawalls that have been built to protect the infrastructure. The largest one causes a reduction in the earth's local geomagnetic field of 23,000 nanotesla, equivalent to half of the entire geomagnetic field. Such swings in the total magnetic field strength would never be experienced in nature by sea turtles, being more than 10 times larger than typical natural variation. Our aim is to quantify the alongshore frequency of emergence of nesting turtles over the last 10 years and compare it with the distribution of these anthropogenic magnetic features. Although Singer Island is not a statewide nesting index beach, local landmarks, now tied to our survey, have been used to determine the emergence locations. We do know that nesting emergences did decrease to virtually zero in front of both of the steel seawall locations immediately after their construction, even though excellent nesting beaches of similar character to adjacent stretches were present in front of the seawalls. Therefore we conclude that there is a possibility that the magnetic disturbance on these beach stretches has affected the emergence behavior.

A TALE OF TWO SEAWALLS: A CASE STUDY OF THE IMPACT OF COASTAL ARMORING ON LOGGERHEAD SEA TURTLE NESTING

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Previous research has shown that seawalls negatively impact loggerhead sea turtle nesting as there are fewer nesting attempts and fewer nests in front of a seawall. It has also been suggested that the further landward a seawall is located, the lower the impact on sea turtle nesting. Presumably this would lessen the likelihood that a nest is inundated or washed away during high water events. We analyzed loggerhead nesting attempts along a 6.7 km stretch of beach in Indian River County, Florida, where 2 seawalls have been installed. The Summer Place seawall was constructed in 1996 and provides approximately 5 m of beach above the high tide line. Data collected during the 2003-2007 nesting seasons showed there were significantly fewer loggerhead sea turtle nests in front of the seawall when compared to a similar length of unarmored beach. However, the density of false crawls in front the seawall was not greater than expected. The Sea Oaks seawall was constructed in the winter of 2007, and provides approximately 20 m of beach above the tide line. During the 2007 nesting season, there were fewer loggerhead sea turtle nests in front of this seawall when compared to unarmored beach. Additionally, there was no difference in nest density between the 2 seawalls. Preliminary analyses on hatching success indicate that the greatest impact of coastal

armoring on sea turtle nests occurs during large storm events. Thus, our data suggest that regardless of the width of beach in front of sea walls, sea turtles deposit fewer nests in front of seawalls than unarmoured beach. With the high incidence of storms that occur each year in Florida, seawalls continue to negatively impact the survival of sea turtles and pose a threat to their long-term survival.

ASUPMATOMA, A.C. COMPLETES TWELVE YEARS OF CONSERVATION OF THE OLIVE RIDLEY SEA TURTLES (*LEPIDOCHELYS OLIVACEA*) IN BAJA CALIFORNIA SUR (1995-2006)

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In 1991, Rancho San Cristóbal located in the Los Cabos region, became the first beach in Baja California Sur where sea turtles were protected. The initial area of protection was a 4.6 km stretch of beach, located at 22° 56' 75"N, 110 ° 05'W. In 1999, the protected area was extended by 17 km to include El Suspiro, 6 km to the south. From July to November biologists carried out night patrols to observe female turtles and to collect their eggs to place them in a protected area, primarily to protect them from human predation. This study is an analysis of 12 years of conservation in the aforementioned beaches which to date are not developed. Our aim was to compile a reliable database so that comparisons with other beaches can be made. In these 12 years of protection, there was an annual average of 89 nests at San Cristóbal and 220 nests at El Suspiro. 95.7% of all nests were removed to a safe corral for incubation which ensures the eggs won't be robbed or otherwise damaged. On El Suspiro beach there was an annual average of 4 nests pillaged by animals and 27 nests taken by humans. The percentage of live hatchlings that were obtained in the nest area was 73.3% at El Suspiro and 70% at San Cristóbal; more than 258,000 neonates were released. We can conclude that thanks to our year to year efforts, there has been an increase in the amount of nests collected and in the amount of tracks observed. These two positive indications help to confirm our commitment to the protection of sea turtles in the coming years. Our findings also confirm that we are one of the most northerly nesting beaches in the Oriental Pacific Ocean.

RELATION OF INCUBATION TEMPERATURE TO THE EMBRYONIC MORTALITY OF THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA)* IN THE PLAYÓN OF MEXIQUILLO, MICHOACÁN

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The embryonic development of marine turtles is affected by environmental factors like temperature, moisture, salinity and gaseous exchange. Temperature directly affects hatchling survival, embryonic mortality, incubation duration, the rate of breathing during development, and sex determination. In the present work we describe the effect of incubation temperature on the embryonic mortality of leatherback turtles (*Dermochelys coriacea*) in Mexiquillo, Michoacán, México. Incubation temperatures were registered in two hatcheries, The Farito and The Manzanilla, located at each end of the beach, and in situ clutches. The temperatures registered in the hatcheries and in situ did not show significant differences between them. Nevertheless embryonic mortality was greater in relocated clutches:

33.21% for El Farito, 30.89% for La Manzanilla, and 20.97% for in situ clutches. A high proportion of embryonic mortality was observed in the early embryonic stages (I and II) than in the late stages (VII and VIII). Temperatures recorded at every stage showed significant differences between early and late stages, but remained within the range of tolerance of 25-35º C for the species. The distribution of embryonic stages was similar in the hatcheries and in situ. The majority of the embryonic mortality was observed in November, the beginning of the season. The incubation duration did not show significant differences between the hatchery and in situ clutches; a minimal reduction in the incubation duration was observed as the season advanced. One concludes that in this study period there was no marked effect of temperature on embryonic mortality. Nevertheless, more studies as well as a bigger sample and the analysis of other variables are necessary.

QUANTITATIVE AND QUALITATIVE ANALYSIS OF BLACK TURTLE (*CHELONIA AGASSIZII*) NESTING BEHAVIOR IN TWO DIFFERENT NESTING BEACHES IN MICHOACÁN MÉXICO

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The importance of studying marine turtles has taken to us to investigate several aspects related to its life history. In the case of the black turtle (*Chelonia agassizii*) in the Pacific, an interest in the knowledge of its behavior on the beaches of Colola and Maruata in Michoacán has allowed us to determine the importance of this species. Much is known on the nesting behavior of marine turtles, nevertheless, studies on the black turtle are few. The nesting behavior of marine turtles is stereotyped and significant differences among the species at a world-wide level do not exist. Nevertheless, an important objective of this work is to analyze this behavior to determine quantitatively and qualitatively the possible differences in the nesting behavior of the black turtle (*Chelonia agassizii*) on the beaches of Colola and Maruata and its possible effects on some characteristics (dimensions of the nest, diameter and weight of egg, length of carapace, and fecundity). Data collection at Maruata, during the months of November - January during the 2006 – 2007 season, has now stopped. Night patrols were conducted for up to 5 hours to observe nesting behavior. The time spent on each identified category as well as observations and data on carapace length, nest dimensions, egg diameter and weight, nest weight, hour, date and zone of the beach were recorded. The data were analyzed and 8 categories of nesting behavior were identified in Maruata and Colola beach. The categories are: 1) Ascent to the beach 2) Search for the nesting site 3) Construction of the bodypit 4) Construction of the nest chamber 5) Egg deposition 6) Covering of the nest 7) Camouflaging of the nest 8) Return to the sea. The total time on average invested by the females on the beach of Maruata was 2:05 hrs ±0.976 hrs (range= 0.123 - 3.49 hrs), whereas at Colola it was 3.30 hours (range= 2.30 hrs - 5.30 hrs).

NEST SUCCESS AND REPRODUCTIVE SUCCESS OF LEATHERBACK TURTLES ARE DRIVEN BY ENVIRONMENTAL VARIABILITY AT PARQUE NACIONAL MARINO LAS BAULAS, COSTA RICA*

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Reproductive success can be measured as the number of offspring produced in a breeding season or during the reproductive life of an individual. We analyzed the effect of nest success on hatchling production and therefore, on the reproductive success of leatherback turtles at Playa Grande, Parque Nacional Marino Las Baulas in Costa Rica. We analyzed nest success by measuring hatching success and proportion of hatchlings emerged from the nest. We looked at the effects of temperature in the nest during incubation, and of local and global weather on nest success. We found that high temperatures during incubation resulted in lower hatching success and lower proportion of hatchlings emerged. There was a seasonal effect on nest success with more hatchlings being produced at the beginning of the season than towards the end. Nest success also differed between nesting seasons and was strongly related to local weather conditions. In particular, rainfall and ambient temperature explained 82% of the variation in monthly emergence success. Predicted emergence success based on local weather was also related to climate regime in the Pacific Ocean, with El Niño years corresponding to seasons of low emergence success and La Niña years to seasons of high emergence success. The environmental variability effect on hatchling production and ultimately, recruitment to the nesting population, may constitute an additional threat to the nesting population of leatherback turtles at Parque Nacional Marino Las Baulas.

SNACK OR FEAST? ENVIRONMENTAL PREDATOR MANAGEMENT EVALUATION OF BEACH AND NEARSHORE HATCHLING PREDATION BY SEAGULLS

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Low levels of beach predation may have contributed to Zakynthos Island (Greece) being the largest loggerhead (*Caretta caretta*) rookery in the Mediterranean. Nest and/or hatchling predation by sand-martens, rats, dogs and seagulls have been recorded. In 2006-2007, a population of about 500 yellow-legged seagulls (*Larus cachinnans*) was documented in area around Sekania beach, which represents 53.4% of the loggerhead-rookery nesting-effort. The seagull population primarily forage at a municipality rubbish-dump (operational since 1991) situated 3km from Sekania. Published literature indicates 5-13.5% hatchlings emerge between 06:00-20:00, when seagulls are active. While a 10% predation-rate on the beach is considered acceptable (Florida Fish and Wildlife Commission 2002), a change in hatchling predation-levels at Sekania may negatively impact future population parameters. In 2007, the National Marine Park of Zakynthos (NMPZ), in co-operation with the Hellenic Ornithological Society, investigated

the impact of current seagull numbers on hatchling survival-rates to determine appropriate predator management actions. From September 2007-June 2008 we conducted 21 surveys (48.5h) to delineate seagull population-numbers, age-classes and 24h beach-use. During the peak hatching-period between August-September, we conducted a further 15 surveys (67h) in the first 4h after sunrise at Sekania (when predation activity was most frequent) from a remote observation point using a Nikon telescope. Simultaneous beach-based observations were collected to corroborate our records. The 35 surveys indicated that (i) gulls are inactive at night, roosting on remote cliffs, (ii) gulls arrive at Sekania about 0.5h after sunrise and depart 0.5h before sunset, (iii) a mean 15 seagulls (range:0-180) frequent Sekania between 06:00-10:00, peaking about 07:30 and dispersing by 09:00 (iv) a mean 183 seagulls (range:38-428) frequent Sekania between 13:00-19:00, (v) 87% observed seagulls were adults/sub-adults (~5yr) (vi) beach/nearshore behaviour included preening, drinking, roosting, flying/circling and predation (hatchlings, fish). During the 15 post-sunrise surveys we recorded a total 76 successful predation events (beach and nearshore combined), obtaining an average predation-rate of 5 hatchlings/survey (range:0-17). From this, we calculated that 1330 hatchlings would be predated by seagulls over a 76 day hatching-period, assuming a constant predation-rate between 06:00-20:00. A 61.7% hatchling emergence-rate (NMPZ field-data) indicates that, out of 460 hatched nests (2007 mean: 108.7 eggs/nest), a total of 30851 hatchlings emerged at Sekania in 2007. We therefore calculated a 4.3% seagull predation-rate at Sekania. The observed predation-rate on all other nesting beaches was <1%. The above data strongly supports that the predation-rate at Sekania and for the Zakynthos rookery is lower than the maximum acceptable predation threshold. While a high number of yellow-legged seagulls frequent Sekania, predation-rates remain low due to the natural tendency of loggerhead hatchlings to emerge at night. The NMPZ intend to continue monitoring all predation activity; building a scientific database in the event that active management is required in the future. An understanding of the biological role of seagulls on the NMPZ marine coastal ecosystem is required to also evaluate the impact of seagull population growth on threatened/endangered seabirds (i.e. cormorants, shearwaters) inhabiting the area. We thank TyAnn Lee and Ines Palomares; the Symposium Travel Fund and donors for assistance.

THE EFFECT OF SHADING ON SAND TEMPERATURE AND ITS POTENTIAL TO INFLUENCE HATCHLING SEX RATIOS IN *CARETTA CARETTA*, USING TEMPERATURE RECORDS OVER THE 2006 NESTING SEASON ON GERAKAS BEACH, ZAKYNTHOS, GREECE

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Sex ratios of sea turtle hatchlings are determined by sand temperatures. Temperature during the second trimester of embryonic development in the nest has been shown to determine gender. Artificial shading may affect the sand temperatures and therefore resulting sex ratios of hatchlings. To be able to understand the effect that shading has on sand temperature would help to implement management and conservation plans for nesting areas where infrastructures are present. The effect of shading on nest temperatures was investigated at Gerakas Beach, Zakynthos Island, using electronic iButton temperature loggers at locations where permanent thatched umbrellas were situated. Temperature records at a total of ten sites, five in the shade and five in exposed sites, were compared. The time period analysed corresponded to the average incubation period of 56.2 days at Gerakas, commencing at the onset of continuous nesting activity during the 2006 nesting season. Temperature was measured at a typical nest depth of 45 cm, corresponding to average nest depth at other loggerhead nesting sites in the Mediterranean. All of the sites exhibited significant temperature differences during the thermo sensitive period between exposed and shaded nests. This study showed that shading from umbrellas alters sand temperatures at typical turtle nest depth. This may influence the resulting gender of *Caretta caretta* hatchlings and therefore alter population dynamics especially in areas and at times when sand temperature is close to pivotal temperature. The results suggest that shading could have the potential to aid conservation workers in a situation where an increase in numbers of male hatchlings was deemed to be beneficial to the population. The possible implications of umbrellas, buildings and trees on nest

temperatures, and therefore sex ratios, should be considered especially when relocating nests. Further study would be required to determine whether impacts of umbrellas on turtle nesting beaches could be minimised by placing them closer to the water level. Acknowledgments: I gratefully acknowledge travel support from Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service, David and Lucille Packard Foundation, Sandler Family Foundation, Carlos Peralta Quintero and Robert N. Allen, Jr, provided through the Symposium Travel Committee.

LEATHERBACK TURTLE HATCHLING SEX RATIOS FROM 1997-2007 AT PLAYA GRANDE, COSTA RICA*

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At the last major Pacific leatherback turtle (*Dermochelys coriacea*) nesting beach we have 10 years of direct thermal data from monitored natural and relocated nest sites. The empirical relationship between nest temperature and hatchling sex observed in this population allows us to estimate sex ratios for in situ and hatchery nests from 1997 to 2007. We further estimate variation in sex ratios based on the spatial and thermal variation present at Playa Grande, Costa Rica intra- and inter-seasonally. We also provide bootstrapped confidence intervals of these estimates given that we have a subset of monitored nests, and for the beach overall there are near-saturated levels of observation of nesting events throughout each season. Finally, we provide indirect estimation of how sex ratios change in relation to intra-seasonal differential mortality and prevailing weather conditions. These relationships, respectively, are based on the monitoring of hatching success in a subset of natural nests and all hatchery nests and correlation with monthly precipitation and air temperatures measured at a local weather station. Our estimations form a comprehensive description that incorporates phenomena known to significantly influence sex ratios — phenomena which are often addressed piecemeal in the literature.

RESULTS OF THE UNIVERSITY PROGRAM IN PROTECTION AND CONSERVATION OF THE MARINE TURTLE (*LEPIDOCHELYS OLIVACEA*) IN PLAYA CEUTA, SINALOA, MEXICO, SEASON (2006 – 2007)

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Human activities related to marine turtles at nesting beaches cause mortality at different development stages (nesting females, eggs). They are vulnerable to diverse, potentially lethal, situations that include direct predation and modification of the habitat. Marine turtle programs exist to develop, support and to implement investigations that promote the restoration of healthy populations of marine turtles that carry out their ecological functions fully and involve the local communities in conservation activities. Since 1976 the Universidad Autónoma de Sinaloa has as its main function to cooperate with the conservation and investigation of coastal resources, while supporting educational activity and all the related practical academic and thesis projects; they have a center for marine turtle conservation in Playa Ceuta, in the municipality of Elota Sinaloa, Mexico. On this 37-km beach, data was collected on sea turtles during night patrols from June to January (2006-2007). The month of September had high nesting. A percentage of appearance of 80% was obtained during the period.

SEA TURTLE NESTING ECOLOGY IN THE COMMONWEALTH OF DOMINICA, WEST INDIES IN 2007

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The Rosalie Sea Turtle Initiative (RoSTI), a project of the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), was launched in Dominica in 2003 as a community-based research and conservation program. Partnering with government agencies, local communities, and the private sector, RoSTI initially sought to quantify basic parameters of marine turtle nesting ecology at Rosalie Bay in southeastern Dominica. Since its inception, RoSTI has expanded its study sites to incorporate additional beaches along the southeastern and northeastern (Atlantic) coasts. The project also maintains a national Sea Turtle Hotline, fielding calls in order to provide a more comprehensive picture of island-wide nesting. Here, we summarize results collected during the 2007 field season and provide recommendations for future sea turtle conservation efforts on the island. Dominica's Atlantic beaches support low-intensity leatherback, hawksbill, and green turtle nesting. The leatherback is the predominant species recorded on the Atlantic beaches and maintains a well-defined, late March to mid-July nesting season. Anecdotal reports and irregular patrols additionally indicate low-intensity hawksbill nesting elsewhere on the island, particularly along the west coast. The 2007 season documented a 6-fold increase in confirmed leatherback nests compared to previous seasons, similar to trends reported elsewhere in the region. Recent international leatherback tag returns have included individuals originally marked in Trinidad and Tobago, Grenada, St. Lucia, Martinique, Guadeloupe, and Puerto Rico.

PHENOLOGICAL SHIFTS IN A NESTING COLONY OF HAWKSBILL SEA TURTLES IN ANTIGUA, WEST INDIES

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Shifts in the timing of seasonal events (e.g., reproduction) have been documented in taxa ranging from avifauna to herpetofauna worldwide. Researchers often link such phenological changes to increasing temperatures, thereby demonstrating some of the potential ecological implications of global climate change. Using data collected from the Jumby Bay Hawksbill Project (JBHP), a long-term saturation tagging study based on Long Island, Antigua, we examine potential phenological shifts of a colony of nesting hawksbill sea turtles. We assess if and how the onset, peak, and duration of the nesting seasons of the JB population have shifted over the past 2 decades. We use regional sea surface temperatures to predict the timing of the nesting season. Additionally, we explore alternative hypotheses (e.g., individual reproductive experience) to explain possible shifting phenologies. Finally, we discuss the significance of phenological changes in species so inextricably tied to temperature and influenced by small changes in climatic conditions.

BEACH FEMINISATION: AN EXAMPLE FROM AUSTRALIA OF A FUTURE GLOBAL WARMING EFFECT ON FLATBACK (*NATATOR DEPRESSUS*) SEA TURTLES*

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This study was conducted to determine hatchling sex ratios of the Flatback sea turtle (*Natator depressus*) in consideration of potential global warming effects. The study was conducted on Bare Sand Island, NT, Australia during the peak nesting months of June and July with a follow through continuing into mid September of the year 2005. Temperature data and gonadal investigations determined that Bare Sand Island as an entire rookery had been effectively feminized for the year, i.e. gender biased for female hatchling production. Environmental conditions proved to be atypical from previous years which the authors believe may be the beginnings of an enduring trend due to climate change and is supported by historical and anecdotal data. During the time of investigation this was the first evidence of an entire rookery being feminized for an entire season.

FILLING THE GAPS: SEA TURTLE NESTING IN DOMINICAN REPUBLIC

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Based on historical data and current assessment of nesting rookeries, sea turtle nesting in the Caribbean has experienced massive reductions mainly due to human exploitation. However, although many rookeries are well assessed, there are gaps in the regional monitoring efforts that must be filled to allow a holistic overview of status and effective management. The rookeries of the Dominican Republic (DR) represent one of these gaps, with very few data available and no systematic surveys undertaken. The present study compiles two years of data (2006-2007) of regular nesting surveys at regionally significant rookeries. Parque Nacional Jaragua (Jaragua National Park, JNP; Southwest DR) was the most important nesting area for leatherbacks (*Dermochelys coriacea*), despite showing significant differences between years (12 clutches in 2006 vs. at least 179 in 2007). In addition, ca. 20 nests/year of hawksbill turtle (*Eretmochelys imbricata*) were recorded in the beaches of JNP. Recent data show that the most important area for this species was Saona Island, Parque Nacional del Este (East National Park, Southeast DR; >50 nests/year). Two nests confirmed, one at Playa San Luís (JNP; 2007) and other at Saona Island (2007), plus four possible nests also at Saona (2006) indicated that the green sea turtle (*Chelonia mydas*) still nests in the country, but in very low numbers. Apart from Saona and JNP, additional sporadic nesting of leatherbacks and hawksbills seems to occur throughout the country (estimated at 25 nests per annum). However, many of these small nesting rookeries face likely extirpation, based on current nest numbers, interviews with local people regarding exploitation patterns, and previous reports. Peak leatherback nesting occurs in April and May, although nesting can be extended till August. Hawksbills nest throughout the year, but the main nesting season at Saona and JNP is concentrated between June and October. Illegal take of eggs and turtle capture for meat and, in the case of the hawksbill, for the shell are the main threats detected. There is an urgent need to build conservation efforts across the country although a protective legal framework already exists.

LEATHERBACK, *DERMOCHELYS CORIACEA*, NESTING BEACH CONSERVATION IN THE PACIFIC COAST OF NICARAGUA BETWEEN 2002-2007

Perla Torres and Jose Urteaga

Fauna & Flora International

Conservation and monitoring actions on the near extinct Pacific leatherback, *Dermochelys coriacea*, were conducted between 2002 and 2007 from the end of September to the beginning of April. The area of study encompassed the northern coast of the Rio Escalante, at Chacocente Wildlife Refuge. This area is one of the most important nesting sites for this species in Nicaragua. An average of ten community team members (most of them were ex-poachers) worked each season. The teams worked under the supervision of a biologist and were trained on protocols designed for beach monitoring and hatchery operation. Due to high poaching incidence, nests of three different sea turtle species were relocated in a hatchery. Leatherback, black turtle (*Chelonia mydas agassizii*), and olive ridley

(*Lepidochelys olivacea*), nests were relocated using a density of 2 nests/m^2. During the five seasons, 41 different leatherback females were tagged using Microchips (PIT Tags). They laid 235 nests, 222 (94%) of which were protected. During season 2006-2007 seven of the fourteen females identified were remigrants (tagged within the past three to four years). This finding confirms the importance of the beach in providing a small but important nesting colony, which leads to high beach fidelity. This presentation aims to expose the results obtained during five years of a leatherback nesting beach monitoring and hatchery operation work in the Pacific coast of Nicaragua as well as perspectives for future interventions of conservation initiatives targeting this species in Nicaragua.

FACTORS AFFECTING HATCHING AND EMERGENCE SUCCESS AT TWO IMPORTANT LOGGERHEAD TURTLE (*CARETTA CARETTA*) NESTING BEACHES IN WESTERN AUSTRALIA

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The loggerhead turtle (*Caretta caretta*) nesting population in Western Australia is estimated to consist of about 1,500 females, and is consequently the largest nesting population in Australia. However, while the Eastern Australian stock has been extensively studied and monitored since 1968, no long-term data is available for any Western Australian index beach. Dirk Hartog Island, within the Shark Bay World Heritage Area (Gascoyne region), is by far the largest loggerhead turtle nesting ground in Australia and current data suggests that loggerhead turtles nesting at Dirk Hartog Island represent 70-75% of nesting loggerheads found in the whole Eastern Indian Ocean. This study aims to assess several biotic and abiotic factors affecting hatching and emergence success in two loggerhead turtle nesting beaches in Western Australia: Turtle Bay on Dirk Hartog Island and the smaller mainland nesting beach located at the Bungelup section of Cape Range National Park (North West Cape Peninsula, Pilbara region). Nest temperature, nest position across and along the beach, other environmental parameters, nest characteristics, nest predation and nesting female health parameters have been correlated to hatching and emergence success, as well as to the prevalence of embryonic and hatchling deformities. The preliminary results of the data collected during the nesting season 2006-2007 will be presented and discussed. First results show that in Cape Range National Park nest predation by ghost crabs (*Ocypode* spp), monitor lizards (*Varanus giganteus*) and feral European red foxes (*Vulpes vulpes*) considerably reduces hatching and emergence success. In fact, 76% of the monitored nests showed signs of nest predation. Nests with signs of confirmed and suspected predation in Cape Range National Park had a statistically significant smaller clutch size at excavation than nests without any signs of predation (P=0.003). Further investigations will be necessary during the next nesting seasons to better understand the impact of introduced and natural predators and assess the success of the ongoing fox baiting program, so that appropriate management actions can be undertaken. In contrast, Dirk Hartog Island is fox free and natural predators as well as the only introduced predator, the feral cat (*Felis catus*), have only a limited impact on hatching and emergence success. However, nest position across the beach and other environmental parameters seemed to significantly influence both hatching and emergence success. To conclude, this study takes an important first step towards obtaining crucial information on loggerhead turtle nest ecology and nesting turtle health in this region. Acknowledgements: Funding for this study has been provided by BHP-Billiton, The Department of Environment and Conservation and The Hermon Slade Foundation. ST gratefully acknowledges travel support from Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, Carlos Peralta Quintero and Robert N. Allen, Jr., the Sea Turtle Symposium and the Murdoch University Veterinary Trust (Weston-Fernie Research Fund).

2007 HAWKSBILL NESTING ACTIVITY ON MONA ISLAND, PUERTO RICO

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We report on the nesting activity observed during 2007 on Mona Island, Puerto Rico. Mona Island is the second largest hawksbill breeding colony in the Caribbean and the largest under U.S. jurisdiction. The principal nesting activity index increased to 436 nests in 2007 from 412 nests in 2006, a rise of 5.8% year-over-year. Number of nests deposited on Mona during the larger 4 month survey period of all the island's beaches was more than 1,000 nests, whereas we estimate that the total annual number of hawksbill nests deposited on Mona to be about 1,250 nests, representing the nesting activity of around 278 females. Hawksbill nest productivity was about 77% during 2007. No predation by feral pigs was observed. The significant increase observed in the Mona Island breeding hawksbill population during the last decade is attributed to local and regional conservation and management measures.

BEACH RENOURISHMENT IMPACTS OF SEA TURTLE NESTING AND LIVE HATCHLING PRODUCTION RATES IN BROWARD COUNTY, FLORIDA, USA

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The Broward County Shore Protection Project was conducted in Hallandale, Hollywood, and Dania Beach, FL USA during sea turtle nesting season 2005. Data was collected during pre-, concurrent, and post-construction seasons to establish if the renourishment may have had any negative impacts on nesting sea turtles and hatchling production rates. Nests deemed in threat of disturbance or destruction within the construction zones were relocated to either a restraining hatchery or zones within John U. Lloyd State Park (JUL). Relocating nests to JUL greatly decreased the hatchling production of all nests within this relocation area due to extensive raccoon predation (58% of nests). Emerging adults occasionally encountered construction equipment resulting in non-nesting crawls but the nesting success (nests / total crawls) in the construction year was not significantly different than the average of the five preconstruction years. Compared to the two years prior to construction, incubation time of the eggs was slightly lower in 2006 and not significantly different in 2007. Hatchling production rates during the five years preceding construction and the two post construction years averaged 75.8% and 79.4%, respectively. The slight post-construction increase may have been due to the larger percentages of in situ nests in those years. It appears that the re-nourishment project had no obvious adverse impacts on the quality of the nesting habitat.

EASTERN PACIFIC LEATHERBACK, GREEN AND OLIVE RIDLEY SEA TURTLE NESTING AT PLAYA NARANJO; FIRST CENSUS IN EIGHT YEARS

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Playa Naranjo is an isolated, five kilometer stretch of beach located on the northwest Pacific coast of Costa Rica. The beach is part of Santa Rosa National Park (Guanacaste), which was established on March 20, 1972 and protects 37,117 terrestrial hectares and 78,000 marine hectares. Over the years, several researchers have monitored sea turtle nesting activity at Playa Naranjo. The results of these studies indicated that Playa Naranjo was the second most important nesting beach for the leatherback (*Dermochelys coriacea*) sea turtle on the Pacific coast of Costa Rica, second only to the Playa Grande complex. Sea turtle nesting activity however, has not been monitored at Playa Naranjo since the 1998-1999 nesting season. From November 23, 2006 to February 7, 2007 efforts were conducted by PRETOMA (Programa Restauración de Tortugas Marinas) to record leatherback and other sea turtle nesting events at Playa Naranjo. Project monitoring dates for this study (77 days) represent roughly 50% of those monitored during the most recent 1998-1999 study (140 days). Despite this fact, during our study we recorded 58.33%, 74.32%, and 979.16% the number of leatherback, olive ridley and green turtles, respectively, when compared to the numbers recorded during the entire 1998-1999 season. We present these and other findings from our monitoring efforts at Playa Naranjo, Costa Rica, and recommend future research and conservation measures in the area.

Other

PREDATION OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) HATCHLINGS BY MAHI-MAHI (CORYPHAENA HIPPURUS) IN THE SINALOA COAST (GULF OF CALIFORNIA, MÉXICO)

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As far as we know, this is the first record of olive ridley hatchlings in the gut contents of the Mahi-mahi in the Mexican Pacific coast. For this study, the fishing zone was enclosed between 22º46'32"N, 106º15'58"W and 22º43'00" N and 106º20'41" W, about 18 km perpendicular to the coast line, just in front of Isla de la Piedra beach and Caimanero beach, south of Mazatlan. Those beaches are nesting habitats for olive ridley turtles, between July and December, this area is monitored and protected by conservation programs. Mahi-mahi are incidentally captured by the commercial fleet. For this study, Mahi-mahi were caught with longlines of 500 hooks of #4, fishing trips were carried out between 7 and 13 hours. On November 8, 2006, gut analyses were conducted on 31 Mahi-mahi, 4 olive ridley hatchlings were found in one female of 101 cm in length (LF). The straight carapace length (scl) range was 4.0 to 4.4 cm. On November 12, 2006, gut analyses were conducted on 27 Mahi-mahi, 2 olive ridley hatchlings were found in one female of 106 cm LF. The scl range was 4.0 to 4.2 cm. In both cases, the hatchling's digestion state was not advanced, it suggests turtle ingestion occurred just before the predators were caught. Turtles were dissected,

yolk sac was present in all turtles, the yolk sac weight (WV) range was 0.08 to 0.5 g, this would suggest that the olive ridley hatchlings were caught not more than 4 or 6 days after hatching. Just in front of the nesting area at the southern tip of Mazatlan, massive drift lines form, especially in September and December. This accumulation of buoyant organic material may be used as shelter or feeding zone by olive ridley hatchlings, as well Mahi-mahi naturally aggregate around floating objects. During this period, the commercial fleet fish with longlines through drifting objects. Supposing that olive ridley hatchlings and Mahi-mahi coexist, it is necessary to determine the impact to olive ridley hatchlings by Mahi-mahi predation.

MANIFEST SOFTWARE TO FACILITATE COLLECTION AND TRANSFER OF NESTING BEACH SURVEY DATA

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MANIFEST (Mote's Automated Nesting Information Forms for Sea Turtles) is a computer program designed to facilitate the collection and transfer of nesting survey data for Mote Marine Laboratory's Sea Turtle Conservation and Research Program. Software development and field testing were completed in 2007. Mote’s sea turtle nesting survey datasheet was inputted into fourteen screens through MANIFEST on an HP iPAQ RX19955 Pocket PC. The host portion of MANIFEST leveraged Microsoft ActiveSync to coordinate the transfer of data collected from the handheld device to the master database. MANIFEST also handled the uploading of previously entered nesting data to the handheld device to be used on the beach for excavations. Future developments include: map-based selection of nesting locations, summary mapping of a season's nesting activity, and upgrade of the application to address next season's data points. Due to the specific nature of the data, the MANIFEST applications are currently tailored solely for Mote Marine Laboratory; however other projects could use this as a framework for their own data entry. MANIFEST is freely available for download and testing at www.turtlegeek.com.

OFFSHORE SEA TURTLE SIGHTINGS IN MELANESIA: JUNE 2005 TO JULY 2006

Abigail Alling, Kitty Currier, Orla Doherty, Sylvia Kowalewsky, Katie Olds, and Mark Van Thillo

Planetary Coral Reef Foundation, Pacific Palisades, California, USA

This poster will illustrate sea turtle observations logged by officers onboard the Planetary Coral Reef Foundation (PCRF)'s sailing vessel while in Fiji, Vanuatu, Solomon Islands, Papua New Guinea and Australia from June 2005 and July 2006. The sightings include: 32 observations from Fiji (June – August 2005), 51 observations from Vanuatu (August – October 2005), 17 observations from the Solomon Islands (December 2005 – February 2006), 23 observations from the southern islands of Papua New Guinea (March – April 2006) and 30 observations logged off the NW Great Barrier Reef (May – July 2006). Species identified included Green Turtles, *Chelonia mydas*; Hawksbill Turtles, *Eretmochelys imbricata*; and Loggerhead Turtles, *Caretta caretta*. All turtle sighting data is posted at www.pcrf.org.

THE IUCN GLOBAL MARINE SPECIES ASSESSMENT - LAYING THE FOUNDATIONS FOR MARINE CONSERVATION

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World Conservation Union/Conservation International GMSA Initiative, Biological Sciences, Old Dominion University, Norfolk, Virginia, USA

The Global Marine Species Assessment (GMSA) is the new initiative of the Biodiversity Assessment Unit (BAU) of the World Conservation Union/ Species Survival Commission and Conservation International/ Center for Applied Biodiversity Science. The growing realization of the seriousness of increasing threats, such as global warming, over-fishing and coastal development, to marine biodiversity has prompted successful BAU methodology to be applied to the marine realm. The GMSA programme compiles important baseline information on individual marine species, and using IUCN Red List Criteria, assesses their threat of extinction. This essential species-level information will be used to generate regional and global marine hotspot analyses and identify key marine biodiversity areas, as well as being used for species level conservation efforts. The GMSA is collaborating with a number of marine conservation initiatives, together with expert taxonomist and ecologist consultation to determine the Red List status of large clades of marine species. The GMSA aims to assess all boney fishes, primary habitat-producing species and selected echinoderms and mollusks (approximately 20,000 species) by 2010.

WEAVING FOR NATURE

Didiher Chacon-Chaverri, Xiomara Sosa, and Idelina López

Gandoca Sea Turtle Project-WIDECAST

This project was developed in three communities in two countries, since November 2006 to the present. Gandoca and Puerto Jimenez in Costa Rica and Changuinola in Panama were the locations selected for the Sea Turtle presence and conservation actions in place. For decades conservation organizations and governments were looking for projects with several focused of actions, aimed specially at those who handle environmental and socio-economic issues. On the other hand, pollution by plastics is one of the most important threats especially for sea turtles and Marine Mammals in coastal waters. Costa Rica imports 73,000 tons of plastics annually and 65% of those plastics and at least 50% of this post-consumer plastic are plastic bags. After a training by the "Tejedoras Association" of the Fundación Titi Cabeciblanco in Colombia, during November 2006, several Central American women started their own projects and working groups. Now, at least 12,000 plastic bags per month are collected, recycled and transformed in very nice and useful items by weaving bags using the crochet technique, with a production of 3 weaving bags/week the average income for each woman is around $180/month. Currently, 50 women in total are participating in the project marketing and selling in several places, at the national and international level. At the same time, they have developed an agreement with one of the most important supermarket companies to install plastic bag collectors in all store locations in Costa Rica.

SEA TURTLE NESTING HABITAT ON THE U.S. NAVAL STATION, GUANTANAMO BAY, CUBA

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Sea turtle species observed nesting at the U.S. Naval Station at Guantanamo Bay, Cuba (GTMO) include greens (*Chelonia mydas*) and hawksbills (*Eretmochelys imbricata*). This study used an observational dataset of 318 nests collected by volunteers from 1999 to 2001 and measured habitat variables on four beaches within 50 m wide zones. The goal was to develop habitat suitability index (HSI) models in a geographic information system to help managers generate hypotheses and experiment with management options. We tested three model-building approaches, and the best performing model used a multiple regression approach for the purpose of weighting variables (r2=0.89; p=0.08). Moderate model performance may be attributed to low samples sizes, problems with the assumptions of regression, and/or nest site fidelity that is unrelated to environment factors. We present both the relative weights of the environmental variables in the regression model and the variables individual correlations with nest density derived from a simple correlation matrix. The following table contains the environmental variable, the rank in regression model, and the individual R with nest density. Low Compaction, highest (0.628); debris %, 2nd (0.466); illuminance, 3rd (-0.310); Sand %, 4th (0.565); Man-made obstacle %, Lowest (-0.547). Low compaction was almost twice as influential as the other variables in the regression model and, individually, was positively correlated with nest density, indicating that the looser the sand, the more suitable the habitat. Most nesting occurred in zones where the cone penetrometer reached eight to 11 inches below the surface of the substrate at 250 pounds per square inch. The second highest ranked variable, percent of debris and trash in the sand, was half as influential as low compaction in the regression model and was positively correlated with nest density. Almost no nesting occurred in zones with less than 38% debris. Illuminance was sampled with a light meter and was negatively correlated with nest density; zones with more than three lux of light received very little nesting. Percent of sand compared to pebbles or dirt was ranked fourth in the regression model, and nest density increased almost linearly with sandiness. Percent of man-made obstacles, such as cabanas, had the least influence in the regression model, and was negatively correlated with nest density. Most nesting occurred where obstacles covered less than 4% of the zone. Slope, width, and vegetation percent were not used in the regression model due to significant colinearity with other variables; however, they may be important for habitat suitability. Individually, slope was correlated with nest density at (R = 0.390), width at (R = -0.401) and vegetation percent at (R = -0.386). As Cuba and its neighbors continue to develop coastlines, all efforts should be made to preserve this regionally important nesting refuge. On GTMO we recommend prohibiting all beach driving, night-time lighting, sand renourishment projects, and any further beach development until a longer study over a larger study area can be performed.

ECOLOGICALLY SENSITIVE URBAN NIGHT LIGHTING

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Many large cities contain urban parks, greenways, beachfronts, and nature reserves within their boundaries. To encourage nighttime use of these areas, lighting is often installed; unfortunately, this is typically without consideration for the negative effects this lighting may have on the ecosystems and wildlife that exist within the area. This paper will provide examples of the adverse effects lighting can have on the flora and fauna that exist in

typical urban parks; it will also give recommendations on how to minimize these effects, maintain nighttime utility, and enhance the nighttime ambience of the city.

A SURVEY OF SEA TURTLES AT THE LANGUE DE BARBARIE NATIONAL PARK AND IN THE SALOUM DELTA, SENEGAL

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With 700 km of coastline, Senegal has a rich coastal and marine biodiversity. The majority of protected areas have a marine zone that includes nesting sites, feeding grounds and migration routes for six of the eight species of marine turtles (*Chelonia mydas*, *Caretta caretta*, *Lepidochelys olivacea*, *Eretmochelys imbricata* and *Dermochelys coriacea*). Within the Langue de Barbarie National Park, four of the six species have been recorded. On 216 beach surveys between 2000 and 2006, the carapaces of 2 olive ridleys, 4 hawkbills, 7 greens and 7 leatherback turtles were identified. In 2007, a green turtle nesting site was identified and 8 carapaces were collected. The Delta of Saloum is a nesting and feeding area where six species of sea turtle are found. The green turtle is considered abundant and leatherbacks, hawksbills, olive ridleys and loggerheads also occur; the Kemp's ridley is considered rare. Between July and August 2007, a strong presence of green turtles was noted on Bird Island, an important reproduction and nesting area. The Palmarin Reserve is among the highly frequented areas by sea turtles in Senegal with many nesting sites recorded. An important seagrass and algae pasture in Jaol Fadiouth constitutes a reproduction area and nursery for *Chelonia mydas*. Three reproduction zones were identified in July 2007 with approximately 105 eggs, 4 emergences, 5 carcasses and 1 live subadult. An updated status and a national action plan for the integrated management of sea turtles are being planned between 2007 and 2008.

CASE OF ABERRATION OF SCALE AT *L. OLIVACEA* (ESCHSCHOLTZ, ON 1829) IN GULFS OF BENIN AND BIAFRA

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Studies on the sea turtles in the waters along the West African coast since the 90's have enabled us to improve the fragmentary knowledge we have had so far on the status of the different species. The research on *Lepidochelys olivacea* (Eschscholtz, 1829), carried out by some projects in several countries in the Gulf of Guinea have allowed us to discover or to confirm the existence of nesting beaches for the species. The presence of adult females nesting, of males sometimes captured out at sea, of hatchlings, of shells found in villages or sold on mascot markets, has permitted us to make many observations. The presence of individuals of a bigger size than in the West of the Atlantic Ocean has been recorded. Contrary to other sea turtles, the scales of the carapace of this species vary a lot with a number of vertebral plates from 5 to 9; the number of costals also varies from 5 to 9, but in an asymmetrical way on each side. On this subject, Pritchard uses the word "multi amination". In Togo, Benin and Cameroun, the absence of nuchal plate or the absence of the joint between the nuchal plate and one of the first vertebrals has been observed on many carapaces.

A PHOTOGRAPHIC ESSAY OF A LEATHERBACK IN CAPTIVITY: HATCHING TO 2 1/4 YEARS

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This photographic essay highlights the life of one hatchling from a group that was brought to the Animal Care Center, University of British Columbia. The hatchling was collected from Lambert's Bay Beach, Tortola, British Virgin Islands on July 2nd 2005 on the night of emergence from its natural nest. The photos depict the changes in morphology from hatchling, yearling to young juvenile stage of Dc 14. The weekly weighing and measurements, the holding tank and feedings are all documented. Aspects of the difficulty in rearing leatherbacks are shown. Due to the oceanic-pelagic nature of leatherbacks they must be tethered to keep them from swimming into tank walls and bottom. Dc 14 was tethered using Velcro attached with cyanoacrylate cement to a monofilament line with swivel attached to PVC pipe across the top of the tank. As Dc 14 increased in mass (> 10 kg) a special harness was designed using Tygon tubing and 100 lb. test fishing line. Leatherbacks are dietary specialists (gelatinovores) feeding solely on jellyfish and ctenophores thus a squid jello is made consisting of blended squid, gelatin, vitamins and calcium. Dc 14 was hand-fed strips of squid jello below the surface of the water. Up to its death, Dc 14 weighed in at 42.65 kg and had a carapace length of 76 cm.

IMPACTS OF "SWIMMING WITH TURTLES" TOURIST ATTRACTIONS ON GREEN TURTLES (*CHELONIA MYDAS*) AROUND BARBADOS

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The feeding of juvenile green turtles (*Chelonia mydas*) as a means of aggregating them for the purpose of viewing by tourists, occurs at several sites along the west coast of Barbados. It started incidentally at one site on the west coast when green turtles were attracted to offal thrown into the water by fishermen gutting their catch from boats. Visitors expressed interest at being able to see turtles at close hand while swimming and snorkeling, eventually leading to glass bottom boats, small motor boat operators and the larger catamaran community initiating additional feeding sites. "Swimming with Turtles" is now one of the most popular tourist attractions on the island. A monitoring programme initiated by the Barbados Sea Turtle Project has identified a number of negative impacts on green turtles at feeding sites, through comparisons of provisioned green turtles with un-provisioned green turtles elsewhere in Barbados. These include a higher incidence of injuries caused by watercraft strikes, incidental hooking on fishing lines, and higher rates of weight gain. Some positive conservation benefits have however also been identified. These include widespread recognition that live turtles are of great value to the economy, which has perhaps smoothed the imposition of the indefinite moratorium on capture of sea turtles that was passed in 1998. In addition, the ease with which tourists are able to view green turtles may have reduced the demand for viewing hawksbill turtles (*Eretmochelys imbricata*) which nest in large numbers on Barbados' beaches. In this way, the negative impacts of wildlife viewing are focused on the juvenile life stages of the less endangered green turtle, rather than on breeding adults of the more endangered hawksbill turtle. Several recommendations are proposed to improve the regulation of feeding sites and to reduce negative impacts on the turtles. These include: Limiting the number of sites where feeding is permitted; cordoning off feeding areas to restrict access by boats and jet skis; imposing speed limits on watercraft in the area; feeding of more appropriate food types; banning of fishing; enhancing information for boat operators and visitors and developing a code of conduct and certification scheme; broadening of the existing

monitoring programme to improve assessment of the impacts on turtle health and behaviour; and the establishment of a multi-sectoral committee to address issues that arise concerning “Swimming with Turtles” attractions, further develop guidelines and incentives, and to propose new legislation as necessary.

BY AIR, BY LAND AND BY SEA: ASSESSING THE SEA TURTLE POPULATION WITHIN THE KAHOʻOLAWE ISLAND RESERVE, HAWAIʻI

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The Kahoʻolawe Island Reserve Commission, Ocean Resources Management Program conducted a baseline assessment of sea turtle ecology and population within the Kahoʻolawe Island Reserve (KIR), HI from 2002-2006. To survey the ~47-km coastline of this island that was used as a bombing range (1941-1990), consistent aerial and in-water research methodologies were designed to be augmented with cultural insight, incidental sightings and opportunistic reports. Sporadic nesting and basking may have occurred historically, but are now very rare occurrences. Turtles were most commonly found swimming individually in clear, shallow water (3-6 m depth) in coral reef habitats. Besides one adult female hawksbill (*Eretmochelys imbricata*) sighting, all were greens (*Chelonia mydas*) with no evidence of fibropapillomatosis. Immature turtles predominated and were fairly evenly distributed with a few areas of higher density, namely Hakioawa, Kākā and Kealaikahiki. Using photo-identification techniques, an 815-day resight interval was the strongest example of site fidelity. Sixty-seven nearly island-wide snorkel transects yielded a 1.31 turtles/hr mean (transect SD= 1.8, range 0-8, n= 82). Thirty-nine standardized helicopter surveys averaged 7.0 turtles per ~60-minute circumnavigation (SD= 3.4, range 1-14, n= 272). Generating correction factors for submerged turtles during aerial surveys and collating all sightings and references, these results roughly estimate that <500 turtles inhabit the KIR. This is a relatively insignificant contribution to the extant population of Hawaiian sea turtles. This baseline estimate allows for a) future comparisons using these standardized monitoring protocols, and b) the prioritization of restrictions to important KIR habitats, with implications for management on other Hawaiian islands.

MODELING NESTING HABITATS IN THE MEDITERRANEAN

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Sandy coastlines serve as the habitat for numerous species. Degradation of such coastal ecosystems and alterations in their long-established environmental regimes are serious issues that trigger substantial threats to biodiversity. In the Mediterranean, uncontrolled development is posing unforeseen impacts to its coastline. Correspondingly, the loggerhead turtles (*Caretta caretta*) that are accustomed to certain coasts for nesting get noticeably affected. The loggerhead turtles’ current situation as endangered species has reached an alarming state. Hence it is imperative to understand and conserve the mechanisms that sustain such turtles’ breeding habitats. The endangered loggerhead sea turtle nests on sandy beaches that represent certain characteristics. These beaches incorporate varying biotic and abiotic conditions. The environmental parameters that govern nesting behavior of sea turtles have not been adequately understood yet and are the subject of many hypotheses. The aim of this study is to identify and picture the loggerheads nesting habitat suitability criteria in the Mediterranean region. This research is multi-faceted in the sense that it investigates the sea turtle nesting habitat suitability criteria at three distinct spatial scales. One methodology studies a set of environmental variables within the 30 to 50 cm depth of the nest chamber and their relation with nesting density. For this part of the study, nesting sites in the Greek Islands of Crete and Zakynthos are

investigated. Then at beach scale, a spatial analysis is performed for the known nesting beaches in Greece, Turkey and Cyprus using open source internet-based data. The third methodology develops a GIS-based model to analyze nesting density and its dependency on selected oceanographic variables at a Mediterranean scale. At nest-scale sand size, temperature regime, humidity and salinity were investigated. At local scale, a combination of marine and terrestrial factors was analyzed. At Mediterranean scale a Maxent model was used to predict the potentially suitable coastal areas based on sea bathymetry, sea surface temperature and radiation. The results of the study imply that long term uncontrolled anthropogenic impacts counteract the predominant environmental nesting suitability factors.

CHANGE IN THE BODY WEIGHT OF ADULT FEMALE HAWKSBILL TURTLES DURING THE 2006/2007 NESTING SEASON, ON THE SOUTHEAST COAST OF RIO GRANDE DO NORTE STATE, BRAZIL

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Female hawksbill turtles (*Eretmochelys imbricata*) nesting along the southeast coastline of Rio Grande do Norte State, Brazil (6º13'40"S, 35º03'05"W) were captured and weighed during the four months from January to April 2007, in the course of the annual egg-laying season, which extended from November 6th, 2006 to May 30th, 2007. In all, 99 weight measurements were performed. On first contact the females exhibited an average post-oviposition weight of 79.1 kg (range 56.2-98.9 kg, SD = 10.9 kg, n = 44 females). Those individuals which were subsequently recaptured showed a mean weight loss of 1.7 kg (range –0.7-4.5 kg, SD = 1.0 kg, n = 39 sets of measurements on 20 females) in the interval between two consecutive post-ovipositions, separated by a maximum time interval of 17 days. In the cases where the female aborted the nesting process, the pre-oviposition weight was measured. The clutch weight, that is to say, the weight loss between consecutive pre-oviposition and post-oviposition measurements (separated by a maximum time interval of 3 days), was found to be 5.2 kg (range 4.3-6.0 kg, SD = 0.9 kg, n = 6 sets of measurements). This value is significantly higher (t-test, $p<0.001$) than the loss between two consecutive post-oviposition measurements with the same female. The mean recovery in body weight, that is to say, the average gain in weight between successive post-oviposition and pre-oviposition captures of the same individual (separated by a time interval of 12 to 17 days), was found to be 3.0 kg (range 1.9-4.3 kg, SD = 1.0 kg, n = 4 sets of measurements) Although the small sample size makes it unwise to generalise, the recovery in body weight was found to be always significantly lower (t-test, $p<0.005$) than the clutch weight. This fact is in agreement with the observed weight loss tendency throughout the breeding season for this species. Considering the clutch weight and the internidal recovery in body weight we found that the total weight loss of the adult hawksbill females after three to five nesting events varied from 10.4% (range 8.7-11.9%, SD = 1.6%, n = 3) to 14.1% (range 11.8-15.4%, SD = 1.3%, n = 6) in relation to their initial pre-oviposition weight. If there were no body weight recovery during the internesting interval we estimate that a female that nests three to five times in the course of the season would lose from 19% to 31% of its initial weight. We emphasise that our clutch weight estimate was performed by weighing the females and not by multiplying the number of eggs in the nest by their average unit weight. In this way, our measurements take into account the loss of liquid during the oviposition. Despite the unequivocal evidence of body weight recovery during the internidal interval, it is not clear if the cause of this process is rehydration or feeding.

QUANTIFYING NESTING RESPONSES TO HURRICANE EROSION: A UNIQUE APPLICATION OF LIDAR REMOTE SENSING

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The Archie Carr National Wildlife Refuge located on the Atlantic coast of Florida represents one of the most important nesting beaches for green turtles (*Chelonia mydas*) in the United States and for loggerhead turtles (*Caretta caretta*) in the Western Hemisphere. This coastline is one of many throughout the southeastern U.S. that becomes vulnerable during the annual hurricane season (June-November), which closely overlaps the sea turtle nesting season (May-September). Although a few studies have quantified direct effects of hurricanes on turtle nesting, broad-scale (landscape level) effects have not been quantified. Using LiDAR (Light Detection and Ranging) remote sensing, we assessed dynamics of dune morphology throughout the refuge caused by an unusually active 2004 hurricane season. It was concluded that the hurricanes led to significant erosion along most of the shoreline. Nesting in pre- and post-hurricane years was analyzed alongside the LiDAR data to determine the overall impact of erosion on sea turtle nesting behavior (such as the proportion of false crawls to nests and nest site selection). The use of LiDAR technology has the potential to be a practical tool in evaluating turtle nesting habitat as it allows for broad surveys of the shoreline.

RADARGOLF BALLS AS A RECOVERY TOOL IN SEA TURTLE RESEARCH

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Geospatial locations of nests enable critical measurements of turtle nesting behavior such as nest site selection, nest fate, and hatchability. However, many turtle rookeries in storm seasons face a common monitoring problem, i.e., nests lost when marker stakes are missing after high wave wash activity. Above-ground marker stakes are a standard protocol at many beaches, but a need exists for a supplemental method of marking nests that would potentially meet multiple objectives: (1) allowing a fast and accurate back-up method to find nests if marker stakes go missing, (2) providing an investigator with a discrete method of marking locations, (3) serving as a recovery tool when multiple nests or locations must be found at a later date for valuable research samples or data loggers, and (4) operating as a backup to either triangulation or GPS locations. Lastly it is desirable that such a method would be (5) quick and practical during field use and (6) relatively low cost. We report on relocation trials using RadarGolf™ balls and hand-held detectors (Radar Corporation, San Ramon, California). In principle, these are golf balls with an embedded harmonic radar antennae system. A golf ball is similar in size to a turtle egg and waterproof so that it can be buried safely without detriment to a nest. However, detection of the devices when placed underground differs from the intended design specifications for above-ground use on golf courses where detections of 3-11 m are claimed. Therefore we undertook a series of tests that would characterize whether such devices were suitable for application on a turtle rookery. We tested radar golf balls systematically as a nest location and recovery aid in several field situations. We specifically evaluated the detection performance of golf balls buried at different distances (0-9 m) and depths (5-80 cm) to evaluate effects of sand drift or different nest depths. We evaluated potential differences of substrate conditions (nourished and non-nourished beaches). We report on field experiments for the golf balls from relocation of nests or data loggers tested at 24 beaches to evaluate the device's applicability to a broad range of turtle habitats. We tested the time taken to relocate a nest or device when using radar golf balls against triangulation

methods to evaluate potential time savings in field work. We provide recommendations on specific circumstances under which these devices were useful for field research.

PRELIMINARY APPROACH TO STUDY THE PRESENCE OF SEA TURTLES IN THE BASQUE COUNTRY WATERS

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The Bay of Biscay is located in the North Atlantic Ocean, in the most oriental part of the Cantabrian Sea. It comprises the costs of Cantabria, Basque Country and Aquitania. With this preliminary study we want to check the seasonal variation in the presence of sea turtles in the Basque Country waters, where few data of sea turtles have been collected up to date. Only 3 species have been cited: loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*) and Kemp´s Ridley sea turtle (*Lepidochelys kempii*). The first leatherback cited in the Basque Country waters was an individual accidentally captured by a tuna fishing boat in 1947. In relation to loggerheads, their relative frequency is greater in southern waters of the Bay of Biscay, specifically in those of the Basque Country. In contrast, leatherbacks present a more meridional appearance. In the Basque Country, a total of 60 sea turtles have been cited: 53 loggerheads (data obtained from strandings and sightings), 6 leatherbacks and 1 Kemp´s Ridley sea turtle. All these data suggest the importance of the Bay of Biscay as a seasonal habitat for these species. Some data also suggest a leatherback´s seasonal pattern in the Bay of Biscay, similar to the pattern of British and Irish waters. This pattern has a sighting peak in August and strandings one or two months later. The American origin of a part of Cantabrian turtles was confirmed by the capture and later release in the Bay of Biscay of an adult female leatherback previously tagged in French Guiana, and by one satellite-transmitter experiment. With all those antecedents, we conclude that there is a need of study in order to increase the knowledge during the following years. The main goals for future studies are collecting all data and information, and monitoring those species so little known in the Cantabrian Sea, especially in the Basque Country. This is why during the summer of 2007 the “Itsas Dordoka” team (the sea turtle group of the Aranzadi Sciences Society´s Herpetological Observatory) has started a preliminary study of three years of duration, to increase the actual information and to deal with the investigation of sea turtles in the waters of the Basque Country. The aim of the study is to observe the geographical distribution, seasonal patterns and population structure of leatherbacks and loggerheads. Our team is carrying out monthly exits to the sea in a boat since August of 2007, taking samples by means of random transects. It is necessary to emphasize the importance that the collaboration of local fishermen and the information derived from the stranding network (already existing) have in the achievement of the project.

Population Biology and Modelling

USING DEMOGRAPHIC AND GENETIC DATA TO ASSESS POPULATION PERSISTENCE UNDER EXPLOITATION PRESSURE IN SE ASIA*

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In some parts of the world, the green turtle (*Chelonia mydas*) is highly valued for its meat and is a commercially important species. Harvesting and international trade have caused overexploitation and threaten local populations with extinction. The collapse of local turtle populations will impact the local human communities, which rely on this resource for subsistence. In other parts of the world numbers of green turtles seem to be increasing, presumably as a result of long term conservation programs and legislation. This species currently appears on the IUCN red list as globally endangered, but the observed regional population increases have led to suggestions that, on a global scale, this species is not truly threatened with extinction. While the green turtle is indeed globally distributed, there is strong genetic divergence between Atlantic and Pacific populations. The global population of green turtles has thus evolved into separate units that might differ in terms of ecology, geology, or life-history traits. In other words, the genetic data suggest two Evolutionarily Siginificant Units (ESUs) - one in the Atlantic Ocean and the other in the Indo-Pacific. Therefore, inferences for the green turtle population status based on conditions within the Atlantic region cannot necessarily be extrapolated for the Indo-Pacific region. We show, based on a case study in the Indo-Pacific region, that information on genetic diversity can be used to assess the persistence of regional stocks under pressure of harvesting. We use demographic and genetic data to investigate the potential threat posed by commercial exploitation to the viability of several genetically distinct stocks that forage at feeding grounds in Aru, SE Indonesia. The Aru stock is predicted to persist under the influence of the estimated harvest pressure at the Aru feeding grounds. However, the composition of the Aru stock will change. The proportion of different stocks foraging in Aru and breeding remotely is expected to decline. Population projections under various harvest regimes as well as projections after implementation of management scenarios can help in management decision-making. Because management objectives stem from public policy, which differs among countries, criteria for IUCN red-listing must be assessed on a case-by-case basis.

IS BONE GROWTH RELATED TO CARAPACE GROWTH IN ATLANTIC GREEN SEA TURTLES?

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To assess the status of regional populations of Atlantic green sea turtles (*Chelonia mydas*), gaps in the knowledge of the life history of this species must first be addressed in order to generate accurate population models. Specifically, estimates of the average age at maturity, durations of each life stage, and growth rates are needed for Atlantic green sea turtles. However, given the challenges inherent in mark-recapture studies of highly migratory marine animals, age and growth rate data have been difficult to obtain for this species. Although skeletochronology can potentially

be a valuable tool in obtaining life history information for sea turtles, to use the technique with any confidence it must first be known: 1) if there is a relationship between a measure of bone and somatic growth, and 2) how often skeletal growth marks are deposited. In this study, we have addressed the first issue by determining if a relationship exists between measurements of the humerus, which is the bone most often used for skeletochronological analysis in sea turtles, and somatic measures for green turtles from our study site. Humeri were obtained from 74 green turtles (23.4 to 101.4 cm SCL) that had stranded dead in Virginia, North Carolina, and along the Atlantic coast of Florida. Straight carapace length (SCL), measured from notch to tip, was taken by observers at the time of stranding. For the humeri, we measured medial width, which is the diameter of the humeral diaphysis near its narrowest point, just distal to the deltopectoral crest, which is also the site from which histological sections are taken for skeletochronological analysis. A significant correlation was found between humerus diameter and SCL when the two were plotted against each other using a least squares linear regression (R2 =0.98, p*et al*. (2007) found for loggerheads. Therefore, these results may enable growth rates to be calculated and ages to be estimated using skeletochronology for green sea turtles in the Atlantic Ocean. Acknowledgements: LRG would like to thank the University of North Carolina Wilmington Graduate School for travel support. References: Snover, M.L., L. Avens, & A.A. Hohn. 2007. Back-calculating length from skeletal growth marks in loggerhead sea turtles *Caretta caretta*. ESR 3: 95-104.

POPULATION ECOLOGY OF HAWKSBILL TURTLES, *ERETMOCHELYS IMBRICATA*, ON DEEP WATER FORAGING GROUNDS IN BARBADOS*

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Most foraging ground studies of hawksbills (*Eretmochelys imbricata*) have taken place at relatively shallow depths. This study examines the dynamics of a population of juvenile hawksbill turtles in primarily deep water foraging habitat on the western fringing and bank reefs of Barbados. Fifteen sites, representing a variety of habitats and depths, along 18 km of coastline have been regularly monitored for turtles since 1998. All turtles were hand caught while scuba diving at depths ranging from 6 m to 44 m. From 1998 to 2007 a total of 1,546 dives, comprising 2,310 hours of search time, were logged, resulting in 1,790 captures of 904 different individual hawksbill turtles. Mean capture depth was 21 m with an average catch per unit effort (CPUE) of 0.77 turtles per hour of search time. Of the total captures, 91 were breeding adult male and female turtles while the remaining 813 animals were considered foraging juveniles and/or sub-adults. Most previous foraging ground studies on hawksbill turtles in the Caribbean have found a heavily female biased sex ratio. However, laparoscopic examinations conducted on 228 individual juvenile turtles in this study revealed a significantly male biased sex-ratio of 1.51:1. Sixty seven percent of 207 hawksbill feeding observations involved consumption of one species of sponge, *Geodia neptunii*. These results corroborate findings of other studies carried out for the species at several locations throughout the Caribbean region. Capture-mark-recapture profiles for the 813 juvenile and sub-adult hawksbill turtles were analyzed using the Cormack-Jolly-Seber modeling approach to determine annual survival probability. These are the first such estimates to have been derived for the species. Immature turtles were classified as large (>55cm) or small (*Geodia neptunii*) or non-sponge site (low density *Geodia neptunii*). The best fit CJS model that accounted for different survival probabilities from 1st capture (0.512) to subsequent captures (0.818) for small turtles at the non-sponge sites was a Brownie-Robson type model. At these sites, small individuals appear very transient as they are looking for suitable foraging habitat. All other size class/site combinations exhibited higher annual survival probabilities of 0.885. Recapture probabilities ranged from 0.243 to 0.567. Large animals at non-sponge sites had the lowest recapture probabilities, a probable reflection of their migration out of the study area to either deeper water habitats or more suitable foraging localities. A GAM regression analysis of 438 growth rate intervals for turtles ranging in size from 23.7 cm (CCL) to 79.8 cm provided similar growth rates to other sites in the Caribbean. Female turtles showed a tendency to grow faster than male turtles, while animals at high density *Geodia neptunii* sites had a tendency for higher mean growth rates. A Horvitz-Thompson estimator was used to derive abundance estimates for resident juvenile hawksbill turtles on the western fringing and bank reefs. Estimates ranged from 230 individuals in 1999 to 440 individuals in 2003. This study provides the basis for further comparative work in the Caribbean and other ocean basins.

MODELS LOOK BETTER: COMPILING AND PRESENTING GLOBAL NESTING DATA THROUGH THE STATE OF THE WORLD'S SEA TURTLES (SWOT) EFFORT*

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Presenting global sea turtle nesting data and monitoring nesting trends on a broad-scale presents challenges due to data deficiencies and incompatibility between sites. Furthermore, many known nesting beaches are not regularly monitored for practical reasons. The State of the World's Sea Turtles (SWOT) effort seeks to address these challenges by developing global minimum standards for nesting beach monitoring, and ecological models that compensate for incompatibilities in data types and varying levels of monitoring effort. A workshop was held on 18-20 January 2008, prior to the 28th Annual Sea Turtle Symposium, to develop a plan to address these challenges. This presentation summarizes the discussion and results from that workshop.

MARINE TETRAPOD STRANDING NET IN PLAYA CEUTA, SINALOA, MEXICO

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The proper analysis of stranded marine tetrapodes, caused by accidental and non-accidental capture, animal predation, natural death, etc, is a powerful tool that allows us to elucidate aspects of their natural history such as ecology, pathology, growing, and intra and interspecific interactions. Each year numerous strandings of marine tetrapodes occur in Playa Ceuta, Sinaloa, Mexico. The goal was to determine species and size of stranded animals, as well as investigate the most probable cause of death. Between January and December 2006, the 37 km of beach was patrol on a weekly basis and after writing down the waypoint of the stranding place, the corpse was taken to the camp site to undergo identification, measurement and necropsy. The olive ridley turtle, *Lepidochelys olivacea,* was the highest encountered and the Californa Sea Lion *Zalophus californianus* was found to a lesser extent. Additionally, strandings of species never registered in the area is described.

HOW MUCH MONITORING IS NEEDED FOR ONE OF THE WORLDS LARGEST AGGREGATIONS OF NESTING LEATHERBACK TURTLES?

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Although nesting occurs along the West African coast between Mauritania and Angola, it has become apparent that the rookery in Gabon (Equatorial Africa, South Atlantic) represents one of the world's largest leatherback nesting aggregations. Constructing a robust country-wide estimate of the annual female population size, derived from counts of nesting activity, is important to monitor status and inform the development of biologically-relevant spatial planning, which seeks to minimise human-leatherback interactions both on the nesting beach and in neritic and pelagic habitats (e.g. illegal harvest, interactions with fisheries). Using data from aerial surveys conducted along the extent of the Gabonese coast (n = 9, 3 surveys per season: 2002-2003, 2005-2006 and 2006-2007) we describe the spatial patterns of nesting along ~650 km of South Atlantic coastline. Surveys were sequenced to occur prior to, during and after the presumed seasonal peak of nesting. Data were contextualised using ground counts indicating this methodology provides an accurate approach with which to gather a synoptic picture of leatherback nesting over extended distances. We quantify the temporal and spatial variation of activities both within and across seasons. Nesting density was spatially consistent through time within and between seasons, with the greatest densities occurring in the North and South of Gabon, within Pongara and Mayumba National Parks respectively. Given the cyclical nature of nesting, returning every 3 to 6 years, we recommend the continuation of aerial surveying so that any trends in the number of nesting activities can be robustly described. National Parks bordering the South Atlantic (n = 6, 340 km of aerial survey transect) received 75 ± 3% of activities per season, suggesting that as long as there are no major shifts in nesting density and adequate management, the geographic extents of the National Parks are well placed to protect a large majority of leatherback activity within Gabon.

Public Education and Advocacy

COMMUNITY AND BIOLOGY BENEFITS OF SEA TURTLE MONITORING PROGRAMS

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The development of management programs for wildlife of conservation concern is challenging, especially for those species that are long-lived and migratory. In addition, management programs are not always accepted by stakeholders, or successful, and reasons for the range in outcomes for these factors span disciplines from ecological science to social science and anthropology. In particular, lessons from fisheries management indicates that some of the primary reasons determining success is whether stakeholders believe that management is needed and their trust in the science that underpins management. Marine turtle management is no exception and thus they present a useful case study. Marine turtles are totemic species, highly regarded by Torres Strait Islanders and populations of turtles in the Torres Strait and northern Great Barrier Reef region are showing early warning signs of decline. To improve both the biological data on the populations and raise awareness among Torres Strait islanders about turtles and their management, we involved islanders from two communities in a study to collect population demographic data and to teach local people about turtle monitoring techniques. Our data demonstrated to local people the migratory links, site fidelity and reproductive biology of green turtles and participation in the project has boosted the ability of the communities to increase on-ground efforts to protect and conserve natural heritage.

"AMAZING GRACE", LETTING THE WILD GO WILD

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Five sea turtle species have been recorded in Sierra Leone. They include the loggerhead (*Caretta caretta*), green turtle (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), hawksbills (*Eretmochelys imbricata*), and the leatherback (*Dermochelys coriacea*). The exploitation of these species and habitat modification through human activities such as accidental fisheries bycatch using nets, long line hooks (morel), etc. for subsistence and the trade for both meat and shell; collection of eggs; pollution and debris including lost and discarded fishing gears, plastic/nylons; the loss of nesting beaches to construction and erosion, and the non conformity to the wildlife laws are among the many threats faced by sea turtles in Sierra Leone. Several efforts have been made by the Conservation Society of Sierra Leone (CSSL) and the Sierra Leone's Wildlife Conservation Branch (WCB) to address the problems facing sea turtles in Sierra Leone. A number of education and sensitization programs involving local communities and various types of media (radio/TV stations and brochure distribution) have been part of CSSL's strategies in campaigning for the protection of endangered species including sea turtles. The Sea Turtle Conservation Programme in Sierra Leone (STCP-SL) has largely been carrying out campaigns for saving sea turtles in Sierra Leone through public campaigns including releasing captured turtles which is mostly covered by TV crews, distribution of STCP's brochures and sea turtle identification posters, workshops, surveys and monitoring by-catches at landing site/ports. Due to these efforts the STCP-SL is making headway in letting these wild species go wild.

DEAD SEA TURTLE STRANDINGS ON THE OUTER BANKS, WHAT WE CAN LEARN, WHO WE CAN TEACH

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The location and management of nesting sea turtles on the Outer Banks of North Carolina has been monitored for 30 years through efforts by state and federal agencies, as well as non-profit organizations. Along the northern beaches extending from Oregon Inlet to the North Carolina/Virginia State line, limited resources have led to a collection of minimal data on dead strandings. Only 6.22% of potentially eligible turtles are necropsied annually. In 2007, The NC Aquarium at Roanoke Island (NCARI), the North Carolina Wildlife Resources Commission (NCWRC), and the Network for Endangered Sea Turtles (NEST), began pooling their efforts with a common goal of increasing necropsies on eligible dead sea turtle strandings to 100% in the Northern Outer Banks of North Carolina. The study area encompasses 57 miles. These increased efforts are to provide managers with more accurate data to better evaluate sea turtle populations in this geographically unique region. Sex ratios, gut contents, and potential causes of death are possible sources of information gathered from the necropsies. To date, 32 strandings occurred within the response area, 18 of which could be and were necropsied. While working towards this common goal, the combined resources of NEST, NCARI and NCWRC created additional educational opportunities. Each organization also benefited directly from the research. First, having a nonprofit such as NEST work with two educational institutions gave NEST volunteers access to additional teaching techniques and educational resources. Support and training from educators provided them with up to date information on research and current issues. Secondly, the necropsies provide the NCARI and the NCWRC with greater access to current and local data that is shared with their diverse audiences. Finally, the actual collection and necropsy of the turtles brought all three organizations into direct contact with the public. Through response to various turtle activity in the study area, project partners were able to reach a total of 646 members of the public during turtle activity as well as provide trainings for 89 NEST volunteers. The educational opportunities provided by these experiences have provided a valuable means of promoting the issues surrounding sea turtle management and conservation.

FROM JAIYARIYÚ TO NANÚ: 10 YEARS OF SEA TURTLE CONSERVATION IN THE GULF OF VENEZUELA, NEW ACHIEVEMENTS-NEW GOALS

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Sea turtles are considered endangered species worldwide due to different natural and anthropogenic threats that attempt against their survival. Because of this, governments have adopted legislative and juridic tools in order to protect these reptiles as well as their habitats (nesting beaches, feeding grounds and migratory routes). However, the strategies must be handled altogether with the diverse institutions, with the common goal of preservation and care of life, sea turtles among them. Therefore, the active participation of civil associations, such as the Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV), has a transcendental importance in the watch, education, investigation and extension of truly effective management and conservation plans, focused in the survival of these species. Therefore, in October 1997, the GTTM-GV started working (with the academic leadership of La

Universidad del Zulia), with the aim of exploring and evaluating unknown information and scientific data about the sea turtle situation in the zone. The lack of knowledge led to the necessity of responses to the newly discovered issues. The first aim was to obtain financial support (BP Conservation Program and Corpozulia), to study some aspects that could affect the survival of sea turtles at the Venezuelan Guajira. Our results showed a great socio-cultural and magical-religious root regarding the poaching and use of sea turtles as a living resource in the area. For this reason the principal tool to solve this problem was and still is, the environmental education of the population. Through speeches, workshops and interviews with the Caciques (high commanders) of the different communities and by GTTM-GV's members testimonies, the rescue of turtles began all along the coastline. In 2000, a group of fishermen was convinced not to sacrifice a subadult green turtle, which was named Jaiyariyú (after the native group), and turned out to be the first marked and released turtle, initiating thus the culture of "every turtle counts". The commitment of the people to the GTTM-GV grew more and more every year, as has the number of rescued turtles, that in other situation would have been consumed. Actually, there are 6 fishing fleets following this mission, in which sea turtles are no longer sacrificed. More than 60 animals between 2000 and 2006 have been returned successfully to their natural environment. This might be considered a small number, but as we analyze the mortality rate before GTTM-GV took action, there are 60 live turtles that still swim free in the Caribbean Sea and Atlantic Ocean. Nanú, a loggerhead turtle found stranded and seriously ill, opened new situations that represented new challenges, a crucial point for the evaluation of activities, achievements, inter-institutional strategic plans, projects, researches and new questions that require new answers. 10 years from now, there will be many elucidated doubts and even more new undiscovered issues, all of them leading to the common goal of preservation of such incredible species: sea turtles.

KARUMBÉ EDUCATIONAL PROGRAM: INVOLVING COMMUNITIES IN TURTLE CONSERVATION

Antonia Bauzá

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Since the creation of Karumbé, our team has been committed to the development of local communities in interaction with marine turtles that arrive to Uruguayan coasts. Our educational program has evolved since 1999. In the first years we visited and met several coastal communities, focusing on establishing contact with fishermen and their families. The extractive use of marine turtles was then a common practice within the communities. Although there was no specific hunting of turtles, there was incidental capture. They would eat their meat and trade their shells, in such a way that was a threat for the species *C. mydas*, *C. caretta* and *D. coriacea*. Since 2001 we have been working in San Luis, Canelones, providing information to fishermen working in the port, who used to bring us incidentally captured turtles. Their children immediately became our allies, so we started to focus on them. The social context and low income of these families led us to implement a school follow-up program, handcraft activities, movies, games and other activities in order to counteract the problems and violence of their environment. We carried out these activities during 2004 and 2005, with excellent results. We started an economic development pilot program in order to promote the non-extractive use of marine turtles, producing and trading t-shirts and handcrafts. At the same time, while working in Cerro Verde, an important refuge and feeding area for the *C. mydas*, we got close to two nearby communities, Punta del Diablo and La Coronilla. These two communities are very different regarding their population and culture. Traditionally, Punta del Diablo was a small town made up of shark fishermen, where individuals consumed shark meat and sold crafts made of shark's jaw bones and vertebrae as alternative income sources. In this community we are now having workshops with craftsmen in order to make crafts using the image of several flagships species. The idea behind this is to revalorize the identity of the town with its rich biodiversity. The other town nearby Cerro Verde is La Coronilla. Our work there started in 2004 and at the begining we met with several difficulties, because people in this town are very reluctant to new local development proposals. Karumbé has developed an education program for the whole community, but focusing on children and teenagers. The first Centre of Interpretation of Marine Turtles was opened to the public in 2004, with the first Festival of the Marine Turtle, which was a complete success. Since January 2007 we have been developing a course aimed at teenagers with the objective of informing them about biodiversity and the history of the area. We are trying to get them involved in these subjects, and make them feel proud and committed to the natural heritage of the area. They are going to be in charge of the organization in that area, and we require their participation in each stage of the process.

TWENTY YEARS OF SEA TURTLE SIGHTINGS DATA FROM NORTH CAROLINA, USA

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Because of their wide-ranging movements within an immense, oceanic habitat, the migratory patterns and abundance of sea turtles are difficult to depict accurately. Methods used to discern this information include aerial surveys, mark-recapture, satellite telemetry, and ship board surveys. Another method used by a number of organizations is the collection of sea turtle sightings by the public. The National Marine Fisheries Service in Beaufort, North Carolina has had an established sea turtle sighting system since 1987. For the past 20 years, we have used this system to collect seasonal distribution and relative abundance data of sea turtles inhabiting the inshore and nearshore waters of North Carolina. These data have been used by local, regional, and national resource managers in making decisions regarding fisheries, dredging operations, beach renourishment, establishment and monitoring of protected areas, and other activities with the potential to impact sea turtles. In addition, this and other sighting programs provide an excellent opportunity to educate and involve the public in the plight of sea turtles and their recovery efforts. In North Carolina participants are asked to record the date and location of the sighting, identify the sea turtle species, and describe any other pertinent behavioral and oceanographic information. To date over 7,600 sightings have been reported by the public. Currently our sightings data also resides in the International Sea Turtle Observation Repository (iSTOR), allowing us to take advantage of the management and visualization tools, generate summary maps and statistics, and continue our interest in educating the public and encouraging interest in sea turtle issues.

WHO IS JUAN CANO? COMMUNITY PARTICIPATION IN THE PROGRAM OF PROTECTION OF THE MARINE TURTLE IN PLAYA CEUTA, SINALOA, MEXICO

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The conservation and protection of the marine turtle was born in the decade of the sixties as an answer to the overexplotaition of these organisms, causing an unusual drop in their populations. The Universidad Autónoma de Sinaloa (UAS) since 1976 has a main function of cooperating in the conservation and investigation of these animals in their habitat and ecosystem in Playa Ceuta; also, it has established environmental education programs focused on the coastal communities and students in kindergarten through professional levels. This continuous work has allowed the population to be involved and committed with the protection and conservation programs, with such positive results that in the recent years government and non-governmental organizations have shown in supporting those individuals involved in the program. CONANP (Comision Nacional de Areas Naturales Protegidas) is a federal agency that has a program named "PET" (Temporal Job Program) to provide temporary salaryies to individuals from the nearby communities to allow them to participate in the protection and conservation program of the marine turtle; this form of support encourages individuals away from the looting and illegal use of this marine resource. In this

report the experiences of Juan Cano, a key member of the the community Ceuta and a new member of the PET program, are presented. Thanks to this program, he has moved away from illegal fishing and has become a community example.

ENVIRONMENTAL EDUCATION IN THE CAMP TORTUGUERO LA GLORIA (SANTUARIO PLAYÓN DE MISMALOYA, JALISCO, MÉXICO)

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As part of the activities for the Protection and Conservation Program of the Sea Turtles in Jalisco State, México, carried out by the Departamento de Estudios para el Desarrollo Sustentable de Zonas Costeras (Centro Universitario de la Costa Sur-U de G, México), there are Environmental Education projects done as an important strategy that allows the community to be involved directly in the protection of these marine species. These activities take place in the Camp La Gloria (Sanctuary Playón of Mismaloya, Jalisco, México). After ten years of carrying out these activities, it has been verified that the community and the volunteers participate more spontaneously. Every year "The Week of the Sea Turtle" is held, a workshop for groups of approximately 60 3rd to 6th grade children from nearby schools, teaching an established Environmental Education program. To date, approximately 4,383 children have taken part in this workshop. In addition, each season we receive from 250 to 300 volunteers coming from high schools and Universities from around the country, from Cihuatlán, Tomatlán, Ameca Mascota and La Huerta, and Guadalajara city, as well as from other countries such as Moscow, Russia and Idaho, USA. About 1,691 volunteers have received information sessions explaining to them the protection work carried out in the camp, and include games and dynamics. This way, children and youth learn about the importance of preserving nature and specifically this species, because it has been observed that when children touch and feel hatchlings in their hands a sense of belonging is provided to them. For these activities there are qualified high school students, teachers and different individuals interested in taking part in the program.

SEPTEMBER 15TH, THE SEATURTLE DAY IN ZAPARA ISLAND

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On Saturday September 15th, we celebrated in Zapara Island, Zulia State in Venezuela THE SEA TURTLE DAY. This day was put together by the volunteers of the Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV) for the education and recreation of the native community, continuing a complete program of environmental education for the development of this community. This program was composed of educational chats for children, teenagers, mothers and fishermen of the island; chat topics included the basic notions of the four species reported in the island, including green (*Chelonia mydas*), hawksbill or carey (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) turtles. Constructive elements were utilized to optimize learning of the know-how they give such as play, group dynamics, photographs and the direct contact with bones and carapaces. In the chats directed to the adults the social and economic specifications of the commerce and consumption of the sea turtles as well as the importance of their care were included, besides these formative events the day was accompanied by the design of an environmental mural on behalf of the sea turtles. At night we developed a session of videos and documentaries allusive to the day along with the community. For the conclusion

of the event, I carried out a trip through the beach where the assistants had the opportunity to be trained in the development of first aid for sea turtle rescue to be applied in the future with stranded turtles.

INTERNATIONAL SEA TURTLE OBSERVATION REGISTRY (ISTOR)

Michael S. Coyne[1], Joanne Braun-McNeill[2], Nicole Saladin[3], and Matthew Godfrey[4]

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Although information on sea turtle sightings is collected by a number of organizations in the United States and around the world, limited efforts have been established to standardize data collection or compare results. Involving the general public in the collection of these data provides a singular opportunity to educate people about sea turtles and their conservation status. Furthermore, sightings data can inform resource managers at all levels when planning for the conservation and recovery of threatened and endangered sea turtle populations. However, accurate and timely delivery of data is crucial to making effective management decisions. In order to streamline and improve the accuracy of the reporting process while making it more accessible to those that wish to report sea turtle sightings, the International Sea Turtle Observation Registry (iSTOR) was created. Through the use of online reporting forms and a centralized database, iSTOR allows data to be submitted and managed by authorized persons from any location around the world, providing a one-stop, global sea turtle sighting database. Participation in the global network is encouraged by the availability of value-added management and visualization tools to data managers and owners. Similarly, summary maps and statistics can be generated and displayed on the world-wide web for interested parties and to educate the public and encourage interest in sea turtle issues.

COMMUNICATION, CULTURE AND CONSERVATION

Fay Crevoshay and Aida Navarro

WiLDCOAST / COSTASALVAjE

Sea turtles of the world are threatened by consumption, over fishing, and coastal development, there is a lack of mainstream constituency that can advocate for their long-term protection. This presentation will discuss some communication strategies and framing designed to build support for Sea Turtle conservation and a sustainable way of life. It uses concepts from communications theory to illustrate why framing and cultural relevance are the building blocks for any strategic initiative designed to preserve the Sea Turtle in the long term. Over the past five years, WiLDCOAST has carried out internationally successful “Don’t Eat Sea Turtle” media campaigns, as well as other campaigns in support of Marine Protected Areas, against coastal development (Escalera Nautica, energy development,) border pollution, and gray whale conservation. By using spokespeople such as fishermen, celebrity models, priests and wrestlers like iconic El Hijo del Santo, as well as Grammy award winning musical acts, Los Tigres del Norte and Maná, WiLDCOAST campaigns have reached more than 500 million people. Randy Olson of Shifting Baselines (a co-production of Jeremy Jackson) called the recent WILDCOAST sea turtle campaign, “The best ocean campaign in human history”. Communication itself comes with a frame. The elements of the communication frame include: A message, an audience, a messenger, a medium, images, a context, and especially, higher-level moral and conceptual frames. Framing is an art, but one that needs to be done systematically. Framing is about moral values and systems of ideas.

CONVICTION AND WILLINGNESS FOR MARINE TURTLE CONSERVATION IN THE SOUTH OF SINALOA, MÉXICO

Angeles Cruz-Morelos, Eliezer Zúñiga-Guajardo, Brisa Hernández-Rendón, and Andrea Toledo-Pineda

Acuario Mazatlán, Mazatlán, Sinaloa, México

As time goes, there are more of us living in cities and loosing every real contact with plants and animals. So now, zoos and aquariums around the world have the commitment of teaching their personel to begin activities for biodiversity and habitat conservation. Also there is the process of creating social conscience through information about the living collection, the protection programs on endangered species and educational work. In the last century, the social and historic perceptions about the role played by zoos and aquariums have changed around the world. Since the 1960s conservation has been incorporated as a fundamental piece in communication, information sharing and specialization processes of the personel that manage the many areas of a zoo, to work looking for a mission and focused goals as are established at the Zoos and Aquariums Worldwide Strategy for Conservation. In the northwest region of Mexico is Mazatlan, the Entrance Harbor to the Gulf of California World Heritage site. In 1987 the Children's Conference for Sea turtle Conservation committed to support the first governmental program for sea turtle conservation in the state of Sinaloa. 100 children in 6th grade attended from 23 rural coastal fisher communities from the south of the state located in foraging and nesting areas of olive ridley sea turtles (*Lepidochelys olivacea*). During 21 uninterrupted years, efforts and willingness from institutions and individuals have coincided to gain an attitude change and civil participation in order to benefit resource conservation. Our program coincides with many recommendations of the Zoos and Aquariums Worldwide Strategy for Conservation, even before it was developed. This integral program is oriented to prevent the extinction of species, and promotes the recovery and sustainability of healthy populations of wild fauna. It allows us to utilize formal and informal education; establishing partnerships with institutions and workgroups and encouraging the regional cooperation in the communities; management and education politics with methodology and actions congruent with the need and resources, and with principles and institutional linings that update according to the conservation standards. The most remarkable results: 1) 2100 children from Sinaloa, Mexico, have attended the conference and had a change in perception about the resource, with theoretic-practical tools and reflection elements for better analysis of the olive ridley turtle problems in their communities; 2) This educational model has been implemented in the states of Baja California Sur, Jalisco, Nayarit and the northern region of Sinaloa; 3) Some of the now grown-up attendants work on sea turtle conservation and monitoring governmental programs; 4) At the institutional level, using the same methodology, two new thematic tracks have been implemented for Bird Conservation and Gulf of California Biodiversity.

OLIVE RIDLEY SEA TURTLE OUTREACH AND HATCHERY MANAGEMENT METHODS ADOPTED IN COMMUNITY BASED CONSERVATION – CHENNAI COAST, INDIA

Supraja Dharini

Tree Foundation, Chennai, India

This paper illustrates our efforts for conservation of olive ridley sea turtles by involving the fishermen dwelling in the coastal fishing villages in Chennai, India. The coast of Chennai is the nesting site of the endangered olive ridley sea turtle. The nesting beaches of the fishing villages such as Periya Neelangarai, Injambakkam, Panaiyur, Nainarkuppam (Uthandi) and Reddy Kuppam – Kanathur are patrolled by the youth of the fishing community of respective villages. They have been initiated by the Tree Foundation in the year 2002 to protect, relocate the eggs and release all hatchlings in the sea on a volunteer basis. These volunteers are known as the "KADAL AAMAI PADHUKAVALRGAL" (SEA TURTLE PROTECTION FORCE). This initiation of community conservation of the olive ridley sea turtle has successfully progressed in the last five years from the protection of 27 nests to 107 nests and releasing of 2022 hatchlings to 27,588 hatchlings and there was no illegal poaching of eggs from 2006 onwards. This paper also elucidates the methods of motivation adopted for outreach programs used for the fishing community, to spread the awareness of the role and importance of the sea turtles in the coastal bio-diversity. The main programs conducted for educating the uneducated fishing community are: one day environmental education workshops for the youth and children at zoos, sanctuaries, etc., slide shows, sand modeling competitions, street plays, puppet shows, peace rallies, the Pungamiya plantation for bio-diesel project, youth workshops for men to form self-help groups, temperature maintenance in hatchery management and sea turtle awareness programs for the trawl boat and mechanized fishing community.

THREATS TO AN URBAN NESTING COLONY: 10 YEARS OF CONSERVATION WORK IN CAYENNE, FRENCH GUIANA

Guillaume Feuillet, Charlotte Briand, Matthieu Delfault , Tabournel Patricia, Typhaine Le Nours, and Benoit de Thoisy

Kwata, Cayenne, French Guiana

Nesting beaches of the Eastern part of French Guiana are located in urbanized areas. For the past ten years Kwata NGO works for monitoring of turtle populations, preservation of sites, and public welcoming and education. Indeed, unlike many other sites of the region, these beaches are considered major places for recreation and hobby, long before being recognized for their importance for leatherbacks and olive ridleys. Beaches then face numerous pressures related to urbanization and high human densities. Threats include the presence of stray dogs, disrespectful behaviour, and inadequate installations. Kwata acts at different levels. First, the public is welcome on beaches every night during the nesting season. The natural hatchery, on the Montjoly beach, also became a popular meeting point where information is shared on turtles, and didactic games and other kinds of pedagogic supports can be found. Kwata's animators meet regularly in classrooms and organized conferences. Lastly, an important lobbying activity is developed towards politics, for better consideration of the sites in the urban development. After several years of activities, positive trends are recorded, with significant increase of public awareness and decrease of some direct threats. Nevertheless an insufficient attention of decision-makers can be deplored, and better compromises between policy, urbanization and maintenance of nesting sites have still to be reached.

"KNOWING THE MARINE TURTLES" - AN INFORMATION AND AWARENESS CAMPAIGN IN THE PERUVIAN PORT FISHING COMMUNITY OF PAITA RELATED TO THE USE AND CONSERVATION OF MARINE TURTLES*

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This work was carried out in the port of Paita (05º02'S, 81º07'W) department of Piura, north Peruvian coast. Paita is one of the main Peruvian ports, displays one of the greater longline fleets of the country, and it is precisely there where a considerable bycatch of marine turtles takes place. Our objective is to sensitize the longline fishery community creating conscience of conservation of marine turtles and their habitat, besides achieving the understanding of why they should protect these species, their identification with them and finally be in the disposition to change or eliminate cultural myths that lead to the consumption and illegal use of marine turtles. We also aim to demonstrate the benefits that a healthy and environmentally friendly fishery can bring to their economy and life status, with all we try to reduce the bycatch of marine turtles. The methodology used was the identification of longline fishery communities and their leaders, and working with them to define the best way of approaching the rest of the community with accurate information about the biology, management and conservation of marine turtles and other interest topics. The objective public: 1. High School Students of Paita Port. Mainly children of the fishermen of the area, who from early age form part of the fishing activity, it is necessary to inform them and to train them in conservation topics and sustainable use of resources since they will be the fishermen of the future. 2. Fishermen Inlets of the Area. La Islilla (05º10'S, 81º11'W), Yacila (05º08'S, 81º1'W), Colan (05º00'S, 81º04'W), Parachique (05º46'S, 80º10'W) and La Tortuga (06º13'S, 81º10'W); where close to 90% of the longline fleet of the port is located. The message was directed to the most experienced fishermen, who have ingrained customs and cultural myths; the message highlighted the experience of the fishermen and emphasized the necessity of implementing alternatives that improve their fishing tasks and maintain the resource that sustains it. 3. Authorities of the Area. With whom support was sought for the control of the illegal use of the species, with the appropriate application of the often ineffective legislation. 4. Students of Superior Institutes and Technical Centers. Those who act as observers on board vessels, being useful when cohabiting with the fishermen in their fishing tasks and having reinforced the theoretical information transmitted previously on land with the practice on the ocean. In total we reached 763 persons: High School Students, 62%; Inlets of the Area, 25%; Authorities, 1%; Students of Superior Institutes, 12%. Our preliminary results were encouraging, showing the disposition of the fishermen to collaborate and to modify their behavior, customs and fishing tasks. Additionally, the conscience of conservation and commitment of the young students towards the preservation of marine turtles was appreciated. We have concluded that the fishery community of Paita is ready for the following phase: Exchange of circular hooks, data collection or other activities for the conservation of the marine turtles.

TURNING LOCAL ANGER INTO MOTIVATION FOR TURTLE CONSERVATION IN NICARAGUA*

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This work is focused on communities along the Pacific coast of Nicaragua's southwestern region. The communities are situated near La Flor Reserve, an important marine protected area for the olive ridley and leatherback sea turtles. Over the past two years, we have conducted interviews and workshops in local communities and determined that there was a high degree of resentment towards government authorities and conservation organizations. However, our studies have demonstrated a local interest in developing tourism activities focused on sea turtles. Also, we saw that local people understood the potential for sea turtles to bring economic benefits to the community. We concluded that a change in attitudes was necessary and an increased participation and ownership of conservation and eco-tourism activities was warranted. Using the SWOT report I and II as key tools, we carried out a series of educational workshops in local communities. These meeting were focused on increasing knowledge and understanding of sea turtle life history and providing community members with examples of community-based eco-tourism. We also carried out classes with school children. We propose a series of activities with local communities to increase their involvement. These include a sea turtle egg nursery for the purpose of promoting stewardship, mandatory local guides at turtle reserve, and direct payment for endangered turtle conservation. While communities continue to express frustration over sea turtle conservation, they feel strengthened and have a positive outlook about the potential for them to benefit from sea turtle conservation. We also discuss some of the strengths and weaknesses of our sea turtle education efforts to date.

CREATIVE NEW FUNDING SOURCE AIDS TURTLE CONSERVATION ACTIVITIES AND COMMUNITY PROJECTS IN TORTUGUERO, COSTA RICA*

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Since 2004, a new turtle tour system has been in operation in Tortuguero National Park, Costa Rica. The ‘Turtle Spotter Program’ was implemented with the aim of reducing impacts of tourism on nesting sea turtles and improving the service offered to tourists. Both these objectives have been realized within three years but, since its inception, the Program has struggled with financial instabilities that have threatened its existence. Initially, funding was sought via donations from the lodges and ‘cabinas’ in Tortuguero; the amount requested from each was proportional to its capacity. Unfortunately, this voluntary contribution system resulted in substantial non-payment, leading to the curtailment of Program activities in 2005 and 2006 due to lack of resources. After the 2006 nesting season, the committee responsible for the Turtle Spotter Program, comprised of representatives from the Ministry of Environment and Energy, the Caribbean Conservation Corporation and the community of Tortuguero, determined that a more creative and reliable source of funding was urgently required for the Program to continue. With assistance from the non-governmental organization ProParques, a novel scheme was devised to generate sustainable revenue for the Program. An information brochure was created for tourists to purchase, with each brochure containing a sticker that visitors would be encouraged to wear during their tour. The concept was to generate a sense of pride among tourists that they were supporting not only turtle conservation efforts, but also the community of Tortuguero. A price of $4 for international tourists and $2 for Costa Rican nationals was approved. Calculations of revenue potential, based on tourism figures from previous years, showed that brochure sales could cover all the Turtle Spotter Program running costs, with excess funds remaining. This additional money would be used to support

health and education initiatives in Tortuguero. In May 2007, Tortuguero hoteliers and tour operators were invited to a meeting where the new brochure was unveiled. There was unanimous support for the idea; support echoed by local tour guides in Tortuguero when they were presented with the proposal. In the first two months of the project (July – August, 2007), 76% of tourists participating in turtle tours purchased a brochure, raising $80,000; enough to pay the Program expenses for the entire season. All subsequent sales will generate money for community projects that will be selected by the Program committee and the Tortuguero Development Association. The undisputed success of the project, in such a short time period, far exceeds the committee's expectations and hopefully will ensure the continued development of the Turtle Spotter Program in coming years. This new initiative offers a sustainable source of funding for the Turtle Spotter Program, with obvious benefits for nesting turtles. It also has the potential to greatly assist the wider community by supporting vital projects within the village. It is also hoped that additional merchandise, such as badges or t-shirts, will generate supplementary funds for the Program in the future. The authors believe this program could be implemented successfully at other turtle nesting beaches where guided turtle tours are conducted.

TURTLE ISLAND CONSERVATION PARTNERSHIP: A COLLABORATIVE EFFORT BETWEEN THE TORONTO ZOO AND FIRST NATION COMMUNITIES

Amanda P. Karch, Benny T. Michaud, and Bob R. Johnson

Toronto Zoo, Toronto, Ontario, Canada

The Toronto Zoo is a world leader in animal care, conservation, public education, and outreach programming. As part of the commitment to each of these goals, the Zoo has recently established a new program called "Ways of Knowing: Turtle Island Conservation Partnership". The program is a collaborative effort between the Toronto Zoo and First Nation (replaces the word "Indian" and refers to Indian peoples in Canada) communities across Ontario. The goal of this unique partnership is to improve upon existing turtle conservation efforts by bridging the gap that exists between conventional western scientific understanding and indigenous traditional knowledge and beliefs. Among First Nations people, the turtle symbolizes many important teachings. For example, the lesson of sacrifice is conveyed in the creation story of Earth as it is the turtle that lends it back for the foundation of all life. In reverence to this belief, many First Nations people refer to North America as Turtle Island. To compliment the First Nations people's intrinsic value of turtles, a primary objective of the partnership is to provide these communities with culturally relevant species at risk (Canadian designation for species that are at risk of becoming extinct) conservation resources and outreach presentations. Resources include the Toronto Zoo's turtle identification guide which has been translated into Aboriginal languages. These guides facilitate and promote local monitoring initiatives on First Nation lands. In addition, there is "Turtle in Aboriginal Contexts", an educational unit that has been incorporated into an existing wetland curriculum made available through the Zoo. Integrating an Aboriginal perspective into the curriculum provides a more holistic approach to turtle conservation and gives non-native Canadians an appreciation of First Nation cultures and teachings. Outreach presentations review turtle biology and ecology and encourage a sharing of how turtles are represented in different First Nation cultures. Presentations are held at Friendship Centres, schools, day camps, and powwows and have already proven to be very successful in generating interest in the partnership. Further sharing of turtle conservation and awareness among First Nation communities was brought about at the first Annual National Aboriginal Day held at the Toronto Zoo on June 21st, 2007. The overwhelming success of the event suggests that it will continue to attract more presenters, sponsors, and most importantly, guests who will learn about the importance of conserving turtles and their habitat through First Nation teachings, as well as the cultural significance of turtles to Aboriginal peoples. At a time when six of Ontario's eight native turtle species are at risk, it becomes critical to enlist the knowledge and participation of First Nation communities to aid in devising and executing recovery plans. The partnership forged between the Toronto Zoo and First Nation communities provides a model for other organizations striving to cooperate with local indigenous communities on turtle conservation projects. Protecting turtles does not only conserve biodiversity, but also ensures that they do not become extinct creatures of the past known only through stories.

INDIGENOUS MANAGEMENT OF MARINE TURTLES IN NORTHERN AUSTRALIA: EXPERIENCES FROM THE NAILSMA DUGONG AND MARINE TURTLE PROJECT*

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The NAILSMA Dugong and Marine Turtle Project (DMTP) is about Indigenous communities across northern Australia working together to protect threatened sea turtles and dugongs and their coastal habitats. Indigenous rangers and community members from the Kimberley, Northern Territory, Gulf of Carpentaria, Cape York and Torres Strait are working with government organisations, scientists, industry and other stakeholders to map and protect sea grass beds and other habitat; clean beaches and rescue stranded wildlife, tag turtles and monitor turtle nests; record and share traditional knowledge; and educate and raise awareness about the need to look after turtles and dugongs. Building local capacity and sustainable partnerships to support ongoing community activities are essential to the NAILSMA DMTP. Northern Australia is one of the last great strongholds for marine turtles and dugongs on the planet. With home ranges that cross borders and seas, these migratory species face a diverse range of threats and impacts that, collectively, have decimated populations elsewhere around the world. Maintaining Australia's great herds of dugong and marine turtle requires effective partnerships, networks and collaborations that span northern Australia and indeed the South East Asian region. Northern Australia is also home to some of the longest running, intact land and sea management regimes in the world. Indigenous communities of northern Australia maintain long-held rights and responsibilities for land and sea management and continue to enjoy dugong and marine turtles as a significant natural and cultural resource. There are numerous examples demonstrating the skill of Indigenous Australians in combining traditional and contemporary skills, knowledge and expertise for better resource management, and for north Australia Indigenous land and sea managers are the only management presence. The NAILSMA DMTP represents a recognition by Australian national and state governments that effective and sustainable management of dugong and marine turtle requires a community-based approach that builds on the strengths, skills and expertise of Indigenous people and is driven by the concerns and issues identified by Indigenous people. The collective expertise of the Indigenous participants in the project coupled with the networks facilitated through NAILSMA and the partnerships being forged with government and other stakeholders, is making significant contribution to the sustainable management of dugong and marine turtle.

MAKING WAVES AT OCEAN CONSERVANCY: THREE DECADES OF SEA TURTLE ADVOCACY, OUTREACH AND CONSERVATION

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Ocean Conservancy is a science-based ocean advocacy organization based in Washington D.C. that has worked to protect sea turtle and other ocean wildlife for three decades. The primary goal of the organization has been to eliminate the major threats facing sea turtles, especially in North American waters. Issues ranging from bycatch in shrimp trawls and the use of TEDs, bycatch on longlines and in gillnets, nesting beach lighting and development, marine debris, stronger domestic ocean policies, environmental education and marine protected areas are among the areas where Ocean Conservancy has worked and collaborated with countless organizations and individuals through the years. This year we have added several new projects to our sea turtle program. These include co-hosting the 2008 International Sea Turtle Symposium in Loreto, BCS, Mexico, collaborating around the world on bringing conservation tourism to sea turtle hotspots (www.seeturtles.org), reaching out to millions of turtle-lovers through print, TV and film projects, helping to advance important sea turtle reserves, and partnering in the creation of a Global Sea Turtle Bycatch Fund. In addition, the 22 years of the International Coastal Cleanup (www.coastalcleanup.org) held in virtually every coastal country around the world has made an impact in awareness of marine debris and will continue to describe the link between ocean pollution and sea turtles. The common theme with all of these projects is that they focus on sea turtles, involve collaboration, and utilize the best information and tools available to us.

CAPACITY BUILDING THROUGH ENVIRONMENTAL EDUCATION IN GUATEMALAN COASTAL COMMUNITIES

Sarah Lucas and Scott Handy

ARCAS / Project Parlama, Guatemala City, Guatemala, Central America

Sea turtle conservation in Guatemala is distinctive due to the unique legalisation of the collection and sale of sea turtle eggs. Conservation relies upon a ‘donation system’ whereby local collectors 'donate' one dozen eggs from each nest to a local hatchery for conservation purposes. The whole success of this system relies entirely upon the active involvement of hatchery staff with local communities. Increasing understanding for the need of conservation is instrumental in securing a future for Guatemala’s sea turtles. Environmental education therefore plays an essential role in the success of sea turtle conservation efforts. Levels of education in rural areas of Guatemala are often poor (Guatemala holds the second highest illiteracy rate in the western hemisphere). Schools across coastal regions are usually located within every village, with up to 70 students. Classes usually only consist of four hours a day. Many children do not attend school due to economic reasons. Due to high teacher to pupil ratios, teaching time restrictions and shortness of terms, environmental education is not an integral part of the learning process for most local children. In the past, the only form of environmental education has been conducted ad-hoc by various volunteers in local schools. As a result of these circumstances, Project Parlama has designed a comprehensive modulated environmental education program. The goal of this project is to teach young people the importance of resource management and conservation, while also providing them with the necessary understanding, skills and capacity to continue raising awareness by educating others. In the Hawaii area, Project Parlama has established a Youth Group for Environmental Education, with 20 participants aged between 14-20. Members are guided through the extensive

program, developing an enriched understanding for sea turtle conservation as well as covering other local and universal environmental issues (such as mangrove conservation and pollution). Unlike conventional formal teaching in the area, the group holds sessions outside of school time and uses a range of diverse subjects uncommon in local schools to teach new skills and to bring environmental education to life through art, science, music and the performing arts. Basic teaching skills are also taught and developed. Once the youth group has completed each educational theme, they are then asked to use their new knowledge to organise and carry out their own educational activities within their local school and community. Participants are encouraged to input their own ideas and experiences into the educational activities they conduct. Alongside the exisiting donation system, Project Parlama aims to improve levels of sea turtle conservation in Guatemala by providing a comprehensive educational package for local youth groups. This program endeavours to equip participants with fundamental knowledge and skills, allowing them to actively educate their wider community, encouraging local people to take responsibility and pride over their natural environment and resources.

SUN, SAND AND SEA TURTLES: INSPIRING CARIBBEAN YOUTH THROUGH NONFORMAL EDUCATION*

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While cooperative and collaborative action between Caribbean islands is crucial to the survival of 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, it is important to educate those who will be accountable for the resolution of this problem in the future: our youth. In 2006, during a 3-month internship on the Caribbean island of Nevis, I developed a summer camp for local children called “Sun, Sand and Sea Turtles”. The internship was sponsored and supervised by the Department of Fisheries, a local non-profit organization (Nevis Turtle Group, NTG), and the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). The camp was initiated as collaboration between the Four Seasons Resort in Nevis and NTG. The success of the summer camp program became the inspiration for my master’s project. The specific objective was to produce a detailed (and ultimately multilingual: English, Spanish, French) curriculum guide for the “Sun, Sand and Sea Turtles” program, including all necessary resources to successfully implement a week-long summer camp focused on the basic biology, contemporary threats (both man-made and natural), and conservation issues that relate to sea turtles in the Caribbean Sea. “Sun, Sand and Sea Turtles” has been designed as a 15-hour camp organized over five consecutive days with an intended age range of 9-15 years. At the end of the five days, the students receive Course Completion Certificates stating that they have successfully completed the camp and are now Junior Members of a local natural resource agency or conservation group, with whom a partnership had been established by the instructor beforehand. As a result of educating Nevisian youth, the Nevis Turtle Group saw an elevated island-wide interest in sea turtle conservation, including increased participation of local adults in nighttime beach monitoring. Another significant accomplishment of this project was that it was a unique collaborative effort between businesses, Government, NGOs and local communities, and as such it provides a model for similar collaborations in the future, both in Nevis and elsewhere. During the summer of 2007, the “Sun, Sand and Sea Turtles” summer camp curriculum was field-tested in 18 countries. It has also been incorporated into the education programs offered at the Georgia Sea Turtle Center. Based on comments and suggestions, the Guide will be reviewed, revised, and ultimately published. Upon completion, the Guide will be repatriated to Nevis where it was conceived, and also distributed throughout the Caribbean region and the United States through the efforts of WIDECAST and the Georgia Sea Turtle Center. As a result, sea turtles and the communities that interact with them will benefit. With this in mind, I anticipate that “Sun, Sand and Sea Turtles” will enhance conservation programs throughout the Caribbean region and beyond.

SEA TURTLE CONSERVATION BONAIRE: A MODEL FOR SMALL-ISLAND CONSERVATION GROUPS IN THE CARIBBEAN

Mabel Nava, Bruce Brabec, Funchi Egbreghts, Marlene Robinson, and Andy Uhr

Sea Turtle Conservation Bonaire - Bonaire - N.A

Sea Turtle Conservation Bonaire (STCB) has progressed since 1991, from a small volunteer group, with little experience or knowledge of our sea turtle populations, to a small but professional organization that uses strategic programming to ensure the protection and recovery of Bonaire's sea turtle populations. As STCB's capacity grows, we are putting increasing emphasis on sharing our model with other small-island conservation groups in an effort to extend the reach of protection into the wider region. Bonaire is home to three of the world's six endangered or critically endangered species of marine turtles: the hawksbill, green, and loggerhead turtle. Despite the excellent natural conditions for sea turtles on our island, threats to survival are real and ongoing. Bonaire is attracting rapidly increasing tourism and development that threatens our sea turtle populations. Nesting beaches are being lost or degraded through sand-mining and construction along the coast; waste-water runoff pollutes reefs and foraging areas; human activity drives nesting females away from the beaches, light from near-shore buildings can disorient hatchlings, and tourism activities are causing encroachment into turtle foraging areas. Turtle by-catch, poaching and entanglements in fishing line and debris have declined under STCB's watch, but ongoing education and awareness programs are necessary to keep these threats minimized. Green turtles, especially in the foraging areas at Lac Bay, are suffering from fibropapillomatosis, a serious, tumor-forming disease about which little is known. STCB uses programs in science; conservation; education and public awareness; and training and collaboration to systematically confront and reduce the threats to sea turtles. In-water surveys and tagging help us determine the size and composition of the turtle population in Bonaire's foraging areas. We use satellite transmitter technology to track where nesting turtles go when they leave Bonaire's waters. During the nesting season (from April to January), staff and volunteers patrol the beaches most used by turtles, recording signs of nesting and hatching. We are conducting a DNA study to help reveal just where our turtles began their lives—which is important information for conservation planning. We monitor and protect nests from poachers and predators, relocate nests that are in danger of erosion, conduct annual beach clean-ups, place vehicle barriers at nesting sites, lead beach restorations after natural and manmade events such as hurricanes and sand-mining activity, and rescue turtles from threats such as entanglements. STCB is a member of Aliansa (the Bonaire Nature Alliance), the local conservation advocacy network. We work closely with the Bonaire National Marine Park to provide elementary and high school education programs. We share information about our work via our website at www.bonairertutle.org, conduct regular slide presentations and use local print media, radio and television to publicize important conservation issues. STCB shares findings and expertise with others, and partners with range states to take conservation efforts beyond Bonaire's borders. STCB is affiliated with WIDECAST (Wider Caribbean Sea Turtle Conservation Network) and DCNA (Dutch Caribbean Nature Alliance).

PUBLIC AWARENESS CAMPAIGN FOR THE CONSERVATION OF SEA TURTLES IN CUBA*

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Cuba is an important place for the nesting, forage and migration of hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*), as a consequence of the availability of numerous beaches with fine grain sand, extensive areas of coral reefs and sea grasses, and of the location between two continental land masses (North and South America) influenced by the passing of the marine currents. These species are fishing resources, for that reason they have been exploited for the consumption of meat, fat and eggs, as well as for the use of the shell in the special case of the hawksbill. Several investigations have been realized in order to achieve a sustainable fishery in Cuba. Paradoxically, recent studies have demonstrated that the coastal settlement that resided in the island ignore the conservation status of the sea turtles, as well as the threats that attempt against the survival of these species and their habitats. Consequently, we intended to design a Public Awareness Campaign oriented to the sustainable management and conservation of the sea turtles that nest in Cuba starting from: 1) to structure the campaign defining the public goal, objectives to obtain, promise, limitations, motivations, restrains, psychological axis, evocation concept and stages of the campaign; 2) to define contents that will be presented on messages; 3) to develop designed solutions that communicate effectively the messages of the campaign. We developed meetings with researchers, fishermen and their families, workmen of the fishing industry, artisans and consumers from 2005 up to 2006. All that propitiated the recognition of the actors, their qualifications and their activities as well as the consequences caused by them. In function of the subjects (sea turtle, habitat, and generic man) revealed in the problem and their characters, qualitative and quantitative variables were applied, defined to the authors' convenience inside the conceptual mark of the campaign in question. We identified the decline factors: the ecology of sea turtles it self, their overexploitation as fishing resource, the modification and habitat loss, and the ignorance of the species' biology among those who make use of them; and the public goal: solicitors (meat consumers, consumers of derived articles of the hawksbill shell, artisans, fishermen and illegal hunters), modifiers of the habitat (touristic companies, state companies, residents of coastal settlements, tripulants who don't carry out fishery of sea turtles, and passengers of boats); and under age. Then, communication objectives were planned: 1) to sensitize the public with the problem of the decline of sea turtle populations, 2) to clarify the role in which each one of the public acts inside the problem of the decline of sea turtle populations, 3) to change the attitude of the public that intervene in the factors of sea turtle population decline. All that allowed to define the message, creative, and means strategies. Finally, in the project phase a logo, a pet and a web site were designed, and some supports were made: collectable cards, posters, calendars, wallpaper, and television spots.

SEA TURTLES: A CONSERVATION SYMBOL AND COMMUNAL DEVELOPMENT IN THE NORTHERN CARIBBEAN COLOMBIAN COAST

Carlos Pinzon

FUNDACION TORTUGAS MARINAS DE SANTA MARTA - Colombia

Along 112.5 Km of coastal beaches in the states [departments] of Magdalena and Guajira, four species of sea turtles find these areas suitable for nesting; a fifth species has been found foraging in the nearby waters along the coast. During the past ten years, the Fundación Tortugas Marinas de Santa Marta has been active in the area. What began

as protection of nesting beaches, nesting sea turtles, nest relocation, education and involvement of local fishermen has now transcend to the different levels of societal community in Magdalena and Guajira. Presently, the universities in the two states, environmental and academic identities, NGOs, and the private sector contribute financial, legal, and technical know-how to the protection efforts. The most salient result is found in the local fishing communities. These fishing villages have developed technical workshops, personal experiences, environmental education, monitoring and identification of nesting beaches. In addition, these villages have opted to develop alternative solutions to save the remaining nesting sea turtles in their areas. The synergy generated by the above efforts, have resulted in the protection of over 33,000 eggs and the release of over 21,000 hatchlings. These communal efforts have strengthened the relationships of over 25 organizations, which encompass fishermen, peasants, squatters and indigenous communities around the Sierra Nevada de Santa Marta. The main focal point of the interrelationship of these communities is based on the protection of the sea turtles. The network of communities and organizations in the Northern Colombian Caribbean region is the way to success. Different interests are now set aside. The conservation, assistance given by different identities and the support of local communities found in these territories, each one with its different socioeconomic and cultural interests have found a main goal: the survival of sea turtles.

ARE MAJOR RETAILERS WILLING TO HELP SEA TURTLES? AN ATTEMPT TO ENCOURAGE ENVIRONMENTAL SUSTAINABILITY IN GAINESVILLE, FLORIDA, USA USING A SEA TURTLE AS AN ADVOCATE

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Sea turtles have many threats to their survival including mortality related to ingestion of plastic bags. Aside from this damage, the production of petroleum-based, disposable, plastic bags is increasingly targeted as a contributor to global warming. With renewed interest in reducing the consumption of fossil fuels to prevent further carbon emissions that contribute to global warming, timely efforts to inform consumers of the additional risks plastic bags present to both the environment and wildlife may motivate more sustainable practices. As such, there is an opportunity to encourage consumers to use cloth bags by informing them of how their actions can prevent mortality of sea turtles, a popular, charismatic animal. I attempted to distribute posters featuring information of the threat that plastic bags pose to sea turtles to major grocery, pet supply, and discount stores in Gainesville, Florida. One major discount store declined hanging the poster as they deemed it solicitation which is against corporate policy. A different major discount store, two grocery stores, and a major pet supply store said they needed to consult with their corporate managers before they could hang the posters, but would do so since they thought the message conveyed by the poster was important. The managers of these stores accepted the posters in anticipation of a positive response from their corporate managers. Two branches of one major grocery store and one locally-owned grocery store hung the posters on the community announcement boards. Another major grocery store placed the poster on the employee lounge board. Though none of the areas in which the posters were displayed were ideal, the interest in hanging the posters was encouraging. Further efforts to encourage sustainability using sea turtles as a flagship species are suggested both in and out of Gainesville, Florida, USA.

SEA TURTLES AND THE TROPICS: LEVERAGING THE NEW ENGLAND CONNECTION THROUGH BI-DIRECTIONAL EDUCATION AND COMMUNICATION

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Pubic awareness projects regarding sea turtles are usually limited to areas where sea turtles nest. Nesting occurs in tropical and subtropical areas, 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. The Center for Tropical Ecology and Conservation (CTEC) at Antioch New England Graduate School, New Hampshire, promotes education and research in tropical biology, conservation, and the sustainable use of tropical ecosystems. New England and tropical coastal systems are intimately connected through commerce, migratory species, local, and global threats such as pollution and rising sea levels. CTEC is actively involved in developing ways to bring together students and professionals from a variety of disciplines to address the complex problem of sustainable use issues. On November 3, 2007, CTEC sponsored its 5th annual symposium, “Coastal Connections: Linking Research and Education in Tropical Systems.” The objective was to bring together students and professionals from a variety of disciplines to find creative, long-term solutions to the rapid loss of biodiversity in the tropics, and to act as an educational resource for the New England Community. Threats that sea turtles face in New England are similar to threats that sea turtles face around the world. I presented an abstract at CTEC’s symposium with the purpose of teaching educators about how to bring sea turtle ecology and conservation into the New England classroom through real world projects in art, science, and cultural appreciation of indigenous communities. The focus of this abstract was to generate a greater understanding of the importance of conserving marine turtles and their habitats in New England. As a member of The Center for Tropical Ecology and Conservation in New Hampshire, I plan to present the abstract materials that I delivered at CTEC’s symposium at the 28th annual Sea Turtle International Symposium. This abstract will provide information about CTEC, its participants, their concerns, and issues. I also intend to facilitate a linkage between CTEC participants and the International Sea Turtle Society to further educate and unite organizations with a common goal of preserving biodiversity in the tropics. I would like to thank Antioch University New England, and The Center for Tropical Ecology and Conservation (CTEC) for travel support, and the sea turtle symposium for providing me with a travel grant making it possible for me to attend the 28 Annual Symposium on Sea Turtle Biology & Conservation. I am appreciative of the funds made available through donations by the following organizations: Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, as well as Carlos Peralta Quintero and Robert N. Allen, Jr.

EFFORTS TO INCREASE THE PARTICIPATION OF LOCAL COMMUNITIES ON THE CONSERVATION OF THE ENDANGERED LOGGERHEAD POPULATION OF CAPE VERDE

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The loggerhead population of Cape Verde is one of the most important in the world. Several islands from this archipelago capture nesting females for human consumption. This a widespread practice in the local population that can be killing more than 25% of nesting females every year. This activity is not relevant for the general economy of the country but can be important for some families. Moreover, the capture, sale and consumption of turtle meat are a traditional activity very widespread in the local population. The capture of sea-turtles is prohibited by the caboverdian law but the protection measures are not efficient and actual capture rates of nesting females are unsustainable and are significantly contributing to the quick decline of this important loggerhead population. Uncontrolled development of touristic resorts is also threatening some important nesting beaches. Some Spanish organizations coordinated by the NGO Cabo Verde Natura 2000, in collaboration with the Government of Cape Verde, are implementing some actions to inform and educate the population about the importance of conserving sea turtles as an important natural resource than can offer more benefits to their life and economy if they remain alive. Moreover, several developmental and sustainable projects are being implemented to improve the economy of individuals who are killing turtles. Finally, several professional development programs for caboverdian young people from the local communities have been started in order to develop activities related to sea turtle conservation such as turtle watching ecoturism, beach vigilance or turtle monitoring.

ECOTOURISM, TOURISTS, AND GREEN SEA TURTLES AT KAHALU'U BAY, KONA, HAWAI'I

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The Hawai'i Community College, with support from the Hawai'i Tourism Authority, Big Island Reef Fund, and the Kula Nai'a Foundation, sponsored a Marine Educator Certificate Program during Spring 2007. The program was taught by professors from University of Hawai'i, Hilo. The object was to train students in marine biology and conservation, with the ultimate aim of training them on how to effectively communicate accurate marine science concepts to the general public and promote conservation, including reducing the harassment of resting turtles, monk seals, and dolphins. A core requirement of the course was to prepare an educational program that could be given in an outdoor beach setting to groups of visitors. The ReefTeach program presently in place at Kahalu'u Bay addressed the issues of coral reef preservation. However, it was observed that the majority of questions from visitors were on the green sea turtles that frequent the Bay to graze on the algae and bask on the beach, and the ReefTeach volunteers were not trained to answer those questions or to know the law on protecting the turtles. The authors prepared a training course that would be given to the ReefTeach educators, and materials that would become a permanent part of the ReefTeach education booth. The training course was given in two sessions, one designed for the adult volunteers, the other for the school-age volunteers. The trainings were conducted on a busy day at the popular beach park, and, as a part of the training, the ReefTeach volunteers practiced their new knowledge by talking to visitors at

the beach. The training session was videotaped and is now on YouTube, and is also shown on the public access channels of Hawaii television. The poster describes the materials used to teach the ReefTeach educators, the materials the ReefTeach volunteers use to educate visitors, and charts showing the number of visitors, number of cruise ships present, and the number of turtles present at various times of the day and how long they stay. There are now more than 30 volunteers at Kahalu'u Bay able to educate visitors how to behave around the turtles, and counts are made of turtles present each day, in addition to the visitor and reef data collected by ReefTeach. The count study will be used to help evaluate future conservation plans for Kahalu'u Bay, which hopefully will include a permanent Marine Education Center along the lines of the Nature Preserve established at Hanauma Bay on Oahu.

THE GREAT TURTLE RACE: A MULTIMEDIA CAMPAIGN FOR SEA TURTLE EDUCATION AND CONSERVATION*

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Scientists often use satellite telemetry to study movements and behaviors of sea turtles. Although there have been some attempts to present results to school children and the general public through academic and non-profit websites, relatively few people beyond the scientists themselves learn about sea turtles through this technology. The Great Turtle Race was a campaign to educate the public about the plight of Pacific leatherback turtles and to raise funds for conservation. Taking advantage of ongoing research, the website followed 11 leatherbacks as they “raced” from the starting point at Parque Nacional Marino Las Baulas in Costa Rica to the Galapagos Islands. The 14-day event was hosted online by Yahoo! and targeted youth, their parents and the general public in the U.S and Costa Rica. Coverage of the Great Turtle Race reached over 28 million individuals in North America and over 90 million internationally. Value of U.S. media coverage was over $2 million. A key action occurred when student researchers at Las Baulas dedicated the eleventh turtle to popular U.S. comedian Stephen Colbert. When notified of this tribute Colbert introduced “Stephanie Colburtle” on his hit Comedy Central television show. After this initial four-minute exposure, Colbert updated his one million viewers on Stephanie’s progress three more times during the race boosting attendance at the website, www.GreatTurtleRace.com. Over 670,000 unique visitors viewed the site over 2.9 million times and 42,871 people adopted a turtle for the Race. Media coverage included national and international print and online articles, television news broadcasts, radio interviews and blogs. Leatherback World, Sea Turtle School and Turtle Champions website pages attracted educators and students and a Race curriculum was very effective. Many educators contacted organizers, shared stories about their classes and commented on positive effects on their classes. National television and print media coverage in Costa Rica bolstered public and governmental support for protection of nesting beaches at Las Baulas. The Race raised more than $250,000 for research and conservation- $225,000 from sponsors and $26,589 from individual donors through the website. Transmitters cost $110,000, Race operations cost $10,000 and remaining funds went to conservation at Las Baulas Park. A coalition of two non-profit organizations (The Leatherback Trust and Conservation International), an academic institution (Stanford’s Hopkins Marine Station – TOPP program), and a government agency (Costa Rica Ministry of Environment and Energy- MINAE) organized the Race. Ten corporate and non-profit organizations

sponsored turtles. These included Yahoo!, Plantronics, Dreyer's Ice Cream, GITI Tire, West Marine, Bullis Charter School in Los Altos CA, Drexel University, Travelocity, Offield Center for Billfish Studies, and Life Sciences Secondary School of New York. Additional organizations contributed expertise in web design, marketing, imagery, law, and education so that the web site was an exciting, state of the art product. These groups included McCann Erickson of Salt Lake City, Civic Actions, BeaconFire Consulting, GCA Law Partners LLP, Delapa Consulting, Schireson and Associates, Educational Information and Resource Center of New Jersey and Alexander Atkins Design. Effective coalitions require excellent leadership, extensive coordination and forbearance by all.

THE SEA TURTLE AS A FLAGSHIP SPECIES FOR COMMUNITY BASED CONSERVATION AND PROTECTION OF NATURAL RESOURCES IN MAGDALENA BAY, MEXICO

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Magdalena Bay is one of the largest and most important wetland ecosystems on the west coast of North America. Magdalena Bay is a critical calving area for gray whales and home to numerous marine mammals, migratory bird species, three species of mangrove, and provides vital feeding grounds for loggerhead, leatherback, olive ridley, hawksbill, and black sea turtles. Unfortunately, this once pristine bay faces a range of threats. Contamination by industrial and residential runoff has turned beaches once popular for clamming into urban health hazards. In the bay, destructive fishing practices including poaching of endangered species, threaten local sea turtle populations. The fragile dune and mangrove systems are threatened by new mega-tourism development, the type of which has irreparably scarred the coast of the Baja California peninsula. Meanwhile, the population of Magdalena Bay lacks the awareness and concern at the community level necessary to combat these and other threats, and public agencies have been unwilling or unable to rise to the challenge. Sea turtle protection presents a unique opportunity to create a culture of conservation and engender stewardship of natural resources in the communities of Magdalena Bay. Ongoing sea turtle population monitoring, local sea turtle festivals, conservation tourism, and sea turtle-focused environmental education in schools has opened the door for engaging the local community in conservation issues and raising awareness locally, nationally and internationally of the serious threats facing this unique ecosystem. Vigilantes de Bahía Magdalena (Magdalena Baykeeper) has taken the lead in addressing these issues from within the community. Continuing a decade of work of the Grupo Tortuguero, the School for Field Studies, and in partnership with national and international academic institutions, partner NGOs, and the International Waterkeeper Alliance, Vigilantes carries out sea turtle population monitoring, water quality monitoring, environmental education, and natural resources defense to preserve this unique habitat for future generations.

ENGAGING LOCAL SCHOOLS IN PUBLIC AWARENESS CAMPAIGNS: A CASE STUDY

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St. Kitts is located in the Eastern Caribbean at 17° 20'N, 62° 45'W and has a population of around 39,000. Fishing communities in St. Kitts have a cultural and subsistence dependence on sea turtles; however, outside of these communities few members of the general public are aware of the nesting and foraging populations of sea turtles in their country. The St. Kitts Sea Turtle Monitoring Network (SKSTMN) was founded in January 2003 with 2 major goals in mind, to implement, under the direction of the St. Kitts Fisheries department, a long standing sea turtle conservation management program and to promote community awareness of the plight of sea turtles. In August 2006 the decision was made to implement a National Sea Turtle Hotline for St. Kitts that would serve as an outlet for local citizens and visitors to report any sea turtle related activity. As we function on a low volunteer base, this hotline would help to increase our monitoring efforts to include all beaches on the island while involving local communities in sea turtle conservation efforts. The initial campaign and launch for the hotline involved a poster competition with local participants at every level – governmental authorities, special interest groups, local businesses, educators, and local schools. The poster competition was a collaborative effort between the SKSTMN (www.stkittsturtles.com) and UNESCO Small Islands Voice (http://www.unesco.org/csi/smis/siv/Caribbean/caractiv.htm). Following approval by the Board of Education, children were asked to submit artwork following the theme of the competition which was "Promoting Awareness of Sea Turtles in St Kitts". One hundred ninety entries were received from 14 different schools. Entries were judged on November 11th, 2006 at RUSVM by 7 local judges. The Awards Ceremony was held at Basseterre High School December 9th, 2006 and over 200 individuals were in attendance. The winners and runners up in each age division received prize packages along with their corresponding teacher from 15 local and international sponsors. Each participating teacher and child received a participation package which included a free leatherback nightwalk voucher for themselves and guests during leatherback nesting season. Each school also received Sea Turtles: An Ecological Guide along with the teacher's manual and a WIDECAST Sea Turtles of the Wider Caribbean Poster for their library. The winning designs are featured on three posters advertising the St. Kitts Sea Turtle Hotline. As a direct result of the leatherback nightwalk voucher distribution and awareness campaign surrounding the poster competition, around 70 local school children and adults accompanied members of the SKSTMN team on leatherback nightwalks this season. Hotline posters were distributed island-wide and calls reporting varying types of sea turtle activity are received regularly. Artwork submitted as a result of the competition has also been used in various other outreach programs throughout the year.

A NEW SUPPORT ALTERNATIVE: VOLUNTEERS - PARTICIPATIVE TOURISM - NATURE TURISM

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Since its origins, the historical incorporation of volunteers in sea turtle protection camps around the world has been a great support for La Gloria Turtle Camp (Playon de Mismaloya Sanctuary, Jalisco, México). Thanks to the support of some researches in the tourism area from the CUCSur, La Gloria started a new stage in its volunteer history through the implementation of new activities, facilities and services in order to provide better and more comfortable attention to the hundred of volunteers that, as a tradition, visit the camp every year. This work offers an analysis of different groups that visit this camp: national and international NGO groups, university and high school students, and other groups. These groups offer volunteer services to the camp to be provided at all the facilities and services on it. It is estimated that from 1996 to 2006 there were 2942 visitors; not all of them were able to give a donation, but all of them were given the same attention. At the same time, in coordination with different associations including the Fishing Cooperative La Cruz de Loreto, la Gloria, La Gloria land ejidos and Duna Blanca, A.C. (Civil Association), the volunteres were offered different activities, such as horseback riding, boat trips, visits to palm plantations, etc, as well as home cooked meals. Thanks to this integration, it has been possible to create new jobs based on the everyday activities of the town and the sea turtle camp.

THE STORY OF CAPTAIN SCOUT OF THE BLACK TURTLE: THE EFFECTS OF FEATURING A SEA TURTLE MASCOT ON GENERAL ENVIRONMENTAL EDUCATION AND OUTREACH PROGRAMS

Dominique Vissenberg

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The three Conservation Foundations of the Dutch Windward Islands of Saba, St. Eustatius and St. Maarten have developed different environmental education and outreach campaigns throughout the last three years targeting the communities of the islands with an emphasis on primary schools. This year's campaign 'The story of Captain Scout of the Black Turtle' received the 'Island Vision Award' for 'Outstanding Environmental Education' for its innovative way of generating environmental awareness. The pilot project to implement environmental education was the sea turtle awareness project entitled "Help out or sea turtles miss out". This project featured "Scout" the cartoon styled sea turtle mascot and was presented at the 2006 ISTS. It showed much positive feedback from the community and the improved interest in sea turtles offered encouragement to continue. The mascot itself developed into a well-known personage and became the main character in the two succeeding campaigns, entitled 'The Waste Watchers' and 'The story of Captain Scout of the Black Turtle'. Using the popular turtle mascot explaining other environmental problems helped fetching the students' interest, since they already started to care for turtles. Scout's connection to pollution and water lowered the threshold for the young target group to understand the relevance of these difficult topics and created eagerness amongst the students for a better environment on land and ocean. Next to that, all projects used educational tools that related the students' interest: comic book, film, a rap-contest and a voice recorded adventure story, illustrated by an animation slideshow with Playmobile pirates. As the title 'The story of Captain Scout of the Black Turtle' already implies, the water-topic is fitted into a pirate theme. The major awareness goals of this project are to elevate students' interest in marine life, coastal vegetation and the importance of water in general. This time, Scout is cursed by the spell of greed. He becomes the wicked captain of the pirate ship "The Black Turtle" and he and his crew sail out to find a hidden treasure. Each of their five adventures during this journey

is the introduction to one new lesson on water: 'scary underwater life?'; 'fun facts on the different eating habits of underwater life'; 'the water cycle'; 'mangroves' and 'physical characteristics of water'. In the end, Scout is freed from the curse and returns to the sea as the friendly turtle he always was. The set up of the program makes the topics fitting for students in the age range from 6-11. The stories and animations helped the students remembering the lessons and they were eager to learn about each next story. Therefore it's anticipated that the lessons help acquiring the loss of fear of what occurs in the ocean and an increased respect for marine and coastal ecosystems. The assistance of a sea turtle mascot after getting the students' feelings of care for the animal facilitates accomplishing this result.

2006 YEAR OF SEA TURTLE (YOT), CHINA---A PUBLIC AWARENESS OF SEA TURTLE CONSERVATION

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2006 is the Year of Turtle of IOSEA, UNEP. As a country of this region, and have month propaganda. Five species of sea turtle are found in China. Most are documented from the South China Sea. The major factors imposing threats to our sea turtle population are the following: fisheries by-catch, the killing of nesting females, the collection of eggs for sale and consumption, and a general lack of sense of preservation. So increasing public awareness of sea turtles and conservation is very necessary in China. China launches 2006 Year of Sea Turtle (YOT), China, on Oct 23, 2006 the opening ceremony takes place in Huidong Gangkou National Sea Turtle Refuge, Guangdong Province, China. Delegates include, Mr. Du Qingling, minister of Ministry of Agriculture, Mr. Huang Huahua, Nomarch of Guangdong Province, China and around 300 individuals from The National People's Congress (NPC), related ministry and students, NGOs, fishermen, and corporations. At the ceremony, 999 sea turtles that were injured and captured by fishermen, and kept in the Sea Turtle House, were released back into the water, including 500 tagged turtles. One sea turtle, named Gangkou 8, using satellite telemetry, was released to the South China Sea for tracking. Some educational brochures were printed, also t-Shirts were distributed to public and students from the local community. Several mass media were used, such as television, radio, and print, to publicize the activity for the purpose of environmental awareness and fundraising for further studies of sea turtle. A science symposium was held on the celebration day of the turtle release to discuss policy to protect sea turtles in China. At the same time, Beijing, Hainan, Shanghai and Guangzhou have similar ceremonies and activities for public awareness of sea turtle conservation. In Beijing, about 200 individuals, representing related organizations, students, NGOs, fishermen, and corporations present at the ceremony. “A knowledge competition on wildlife conservation” was organized. In Guangzhou, 6 sea turtles that come from illegal catch and trade were released back into the water.

Sea Turtles of the Californias Mini Symposium

FORAGING IN THE SHADOWS: ECOLOGY OF LEATHERBACK TURTLES OFF CALIFORNIA, USA*

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Western Pacific leatherbacks have diverse foraging destinations in temperate and tropical regions of the Indo-Pacific region. A subset of leatherbacks from the largest remaining nesting population, in West Papua, Indonesia, migrates across the North Pacific to forage off the West Coast of North America. Opportunistic leatherback sightings have been reported during summer and fall off Oregon, Washington and California, but until recently no systematic surveys or targeted ecological studies had been conducted in this region. Since 2000, aerial line-transect surveys, telemetry studies, and leatherback habitat characterizations have yielded significant new information on the migratory and foraging behavior of leatherbacks off California. The California Current Ecosystem is a dynamic and productive marine habitat, in which wind-driven upwelling supports a great diversity and abundance of marine life. Leatherback abundance off California has been linked to positive anomalies of the Northern Oscillation Index, corresponding to years in which there is greater upwelling. This in turn allows for the development of large blooms of scyphomedusae, which are important leatherback prey. Aerial surveys conducted in nearshore waters off central and northern California between 1990 and 2003 provided the first abundance estimates for a Pacific foraging population of leatherbacks. Abundance estimates, derived using line-transect methods and including a correction factor for missed diving animals, ranged from 12 leatherbacks (CV=0.75) during 1995 to 379 individuals (CV=0.23) in 1990. The shelf region off San Francisco supported the greatest density and total abundance of leatherbacks, but sightings were also common in Monterey Bay and north of San Francisco. Based on these preliminary coastwide findings, targeted habitat studies were conducted during 2002-2006 off San Francisco and Monterey Bay to characterize potential leatherback foraging habitats and identify key trophic linkages. Fine-scale aerial surveys were coupled with remotely sensed oceanographic data, shipboard in-situ sampling, and telemetry studies documenting leatherback movements and diving behavior. Scyphomedusae recorded visually during aerial surveys and sampled from vessels included sea nettles (*Chrysaora fuscescens*), moon jellies (*Aurelia* spp.), purple-striped jellies (*Chrysaora colorata*), and egg-yolk jellies (*Phacellophora camtschatica*); however, leatherbacks were not associated equally with all jellyfish species. Leatherback turtles were found to aggregate primarily in shallow waters (30-60m) characterized by visible phytoplankton blooms, elevated surface temperatures of 14-16 degrees C, and moderate to dense concentrations of large *Chrysaora fuscescens*. These conditions appear to arise from a complex sequence of physical and biological processes, driven by upwelling and relaxation events and possibly influenced by low-salinity waters flowing from San Francisco Bay. The greatest leatherback concentrations were reliably found in retention areas and upwelling shadows along the California coast. The results of longterm deployments of satellite-linked transmitters on leatherbacks foraging off California suggest there may also be important offshore foraging regions, located approximately 30-100km from shore in oceanographic frontal areas. These offshore habitats remain poorly understood, but appear to have been particularly important for leatherbacks during 2004-2006, when nearshore jellyfish abundance was greatly reduced. Combined, neritic and offshore waters off California represent a critical foraging region for one of the largest remaining nesting populations of leatherback turtles in the Pacific.

GREEN TURTLES OF SAN DIEGO BAY*

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Our research since 1990 has shown that San Diego Bay is home to a relatively sizeable population of green turtles that are long-term, year-round residents in the Bay. Our genetic and telemetry work shows that this foraging population is part of the Mexican breeding stock, and San Diego Bay is northernmost year-round foraging area for green turtles off the Baja/California region and the long-term research undertaken there has enabled insights into the biology of green turtles in the region. Planned urban development poses new threats to this population.

THE EASTERN PACIFIC HAWKSBILL INITIATIVE*

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One of the most imperiled sea turtle populations worldwide; the Eastern Pacific (EP) hawksbill (*Eretmochelys imbricata*) is also one of the most enigmatic. Despite the species' presence throughout the EP and Critically Endangered status, virtually nothing is known about the population. It has received essentially no attention from the conservation community and directed efforts to evaluate abundance and conservation needs are all but non-existent. The data gaps regarding the population have been recognized by the World Conservation Union's (IUCN) Marine Turtle Specialist Group (MTSG) as a serious obstacle for developing appropriate and effective management strategies for the species. Studies to generate information have been identified as a critical conservation need. Beginning in October 2007, The Eastern Pacific Hawksbill Initiative represents the first in-field directed effort to study the population. The first stage of the initiative takes place within the Gulf of California (Gulf), or Sea of Cortez, Mexico, a foraging site known to historically contain substantial numbers of juvenile and, to a lesser extent, adult hawksbill turtles (SCL cm: min=27, max=74.2, avg=42.41, n=48). Considering the critical status of the population, our limited knowledge of its biology, and the low number of individuals reported to date, a holistic approach involving many groups (local fishermen, conservation organizations, government entities, etc.) and methods (interviews, literature reviews, in-water monitoring, genetic sampling, etc.) is being utilized to simultaneously gather information on the species and initiate conservation efforts. The project is being undertaken in conjunction with the Grupo Tortuguero, the premiere grassroots conservation organization in the Gulf, with more than ten years experience in sea turtle conservation and activism, and more than 500 members in over 30 coastal communities in the region. Objectives of the first phase of the initiative include the generation of information and raising awareness on the species in the Gulf. To evaluate hawksbill populations in other areas of the EP, this initial effort will be duplicated in foraging habitats throughout the region. In the process, we aim to satisfy the long-term objective of the initiative, a regional hawksbill network. By shedding light on the biology and conservation status of EP Hawksbills, we hope to provide critical information that will be integrated into local and regional conservation

management plans and which will ultimately determine the feasibility of recovery of hawksbill sea turtles in the EP. We present preliminary results of the initiative and summarize the current knowledge of EP hawksbills, including history of exploitation, confirmed sightings, mark recapture efforts, by-catch concerns and new conservation actions. Future research and conservation forecast will also be presented.

A COMPARISON OF TWO EX SITU INCUBATION METHODS (GREENHOUSE AND INCUBATION CHAMBER) TO PRODUCE LEATHERBACK HATCHLINGS IN AGUA BLANCA, MEXICO*

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The most important nesting beaches of the critically endangered Eastern Pacific leatherback population are located on mainland Mexico and Costa Rica. The northernmost nesting colony is found on the Pacific side of Baja California Sur at Agua Blanca (23º39’N 110º31’W), with 23-127 nests per season. However, low temperatures in the sand of 20-23°C from November to March prevent hatching, as embryos die in early stages of development. Since 2000, an incubation chamber with temperature control has been used to produce hatchlings ex situ, where nests are incubated in Styrofoam boxes with sand. However, hatching success has been relatively low (9-40%), sex ratio was strongly skewed towards females, and the artificial environment may have decreased hatchling fitness. Therefore the objective of this study was to compare the quality of hatchlings incubated in two different methods: the incubation chamber, and a greenhouse built on the beach. In fall and winter 2005, 12 nests were divided in half and incubated simultaneously using both methods. The greenhouse raised temperatures in the sand at 80cm depth by 5-7°C, temperature fluctuated between 26-32ºC (average: 28.7±1.3) In the incubation chamber temperature varied between 25-33ºC (average: 29±1.9), variations were much lower in the greenhouse than in the chamber. Incubation period was 71 and 64 days in greenhouse and chamber, respectively. Hatching success was high with 81-83%, no significant differences were found between the two methods. Hatchling size was similar as well (5.7 cm carapace length), but significantly smaller than at Cahuitán (6.0 cm), one of the major nesting beaches in Oaxaca. Hematology (Hemoglobin, and hematocrit) and plasma chemistry (total protein, and glucose) showed no significant differences among methods. However, a trend towards higher glucose and hematocrit was apparent in the incubation chamber, indicating stress and low humidity, respectively. Hatchlings from the incubation chamber were more vigorous and moved faster when released on the beach. However, it must be taken into account that they did not have to dig through over 50 cm of sand, as the greenhouse hatchlings did. When comparing production costs per hatchling, both methods were similar with 20 and 23 USD in the greenhouse and incubation chamber, respectively. Compared to Cahuitán however, each leatherback hatchling costs ten times more in Agua Blanca. As temperatures in the Greenhouse were below 29°C from November to February, it is likely that a high percentage of males was produced, which is important, given that temperatures on nesting beaches in mainland Mexico are so high, that apparently almost 100% females are produced. Our results indicate that the greenhouse is the best method to incubate Leatherback nests on beaches where temperatures are too low for natural hatching. Nests are kept in a more natural environment, they are less exposed, and the quality of hatchlings seems to be similar or better than those produced in the incubation chamber. Also, the incubation chamber is rather impractical in rural environments without electricity and plenty of mechanical failures due to corrosion from sea breeze.

GRUPO TORTUGUERO COMCÅAC: CULTURAL AND ENVIRONMENTAL PRESERVATION AND REJUVENATION FOR THE 21ST CENTURY

Gabriel Hoeffer[1] and Timothy R. Dykman[2]

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The Comcáac, more widely known as the Seri, Indians of the Sonora coast and midriff islands of the Gulf of California have long been stewards to their shockingly harsh and incredibly diverse environment. They retain ownership of, and exclusive rights to the natural resources of much of their historical homelands. Having resisted westernization for centuries, they still seek to preserve their traditional lifestyle within the context of the seas' dwindling resources and increasing economic, political, cultural and environmental pressures. Over the last four decades, sea turtle populations in this region have experienced tremendous declines. Leatherbacks and hawksbills are critically endangered, loggerheads and green turtles are endangered, and the olive ridley is listed as vulnerable. This decline taken together with the impact of the irresponsible and illegal fishing practices of outside groups and the heavy hand of neighboring coastal development presents a cascade of environmental wrongs that may irreversibly change the seascape within this once pristine area. In response, there has been increased resolve by the Seri to protect and manage the natural resources within their ecosystem and to preserve the traditional knowledge that has provided the strength to defend the tribe's territorial, cultural and environmental integrity in the past.

ENDANGERED SPECIES OR LOCAL DELICACY? THREATS TO SEA TURTLES ON THEIR FEEDING GROUNDS OFF BAJA CALIFORNIA*

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Despite strict legal protection in Mexico since 1990 and widespread, grassroots educational efforts, illegal hunting and incidental by-catch remain serious threats to sea turtle populations in Northwest Mexico, where turtle meat is still considered a delicacy and is often served at festive occasions. As a consequence, recovery of the depleted sea turtle populations in the Northeast Pacific remains unsure for the black turtle, and becomes increasingly difficult for hawksbill, leatherback and loggerhead turtles. Our aim is to provide a comprehensive review of the threats to sea turtles in Northwest Mexico, including information on the black market trade of sea turtle products in the region. In 2006, total reported sea turtle mortality was 1,542 individuals in BCS, and a total of 6,230 carcasses has been reported since 1994 in the state. However, these values are most likely severe underestimates. Principal mortality causes in 2006 were consumption and stranding (47% each), the latter probably mostly due to incidental by-catch in artisanal gillnet and long-line gear. Black and loggerhead turtles were the most affected species. The total ban on sea turtle harvest in 1990 favoured the creation of a lucrative black market. Prices for live turtle or turtle meat vary substantially from 2.2 to 50 USD per kg depending on the species, the demand and supply, and on the distance of the market to the capture location. We can distinguish between familiar consumption, a local market and a regional/international market. The latter is well organized and operates throughout the peninsula. Main traffic routes originate in Todos Santos and Magdalena Bay, which supply turtle meat to the southern half of the peninsula, while San Ignacio Lagoon, Guerrero Negro and Bahía de los Angeles, BC, supply Ensenada, Tijuana and sometimes U.S. border cities. In other communities like Santa Rosalia, San Bruno and Santo Domingo, sea turtle hunting is also very common, but mostly for local consumption. The risk of getting caught is low, and profits are high, especially for

intermediaries and vendors. Fishermen run the highest risk of getting caught, and usually earn the least. Lack of stewardship, appropriate fisheries regulations and insufficient law enforcement are among the major problems that need to be addressed to protect sea turtles more effectively. Additional threats come from a boom in coastal development that may threaten olive ridley and leatherback nesting beaches in the southern region of the peninsula. Migrants from mainland Mexico arrive in increasing numbers, bringing with them the custom of eating sea turtle eggs. Consequently, egg poaching has increased significantly in the past years, especially in the municipality of Los Cabos and La Paz. Overall, sea turtle mortality from anthropogenic causes remains very high in the region and continues to threaten population persistence of several sea turtle species in the North Pacific, a seemingly local problem that has consequences for the entire North Pacific basin and distant nesting beaches.

SEA TURTLE HUNTING BY NATIVE GROUPS IN THE GULF OF CALIFORNIA*

Jonathan B. Mabry and Richard C. Brusca

Arizona-Sonora Desert Museum

Sea turtles have been important in the subsistence and mythology of native peoples of the Gulf of California for millennia. Archaeological evidence includes burned bones and carapace fragments in shell midden sites on the eastern, western, and northern shores, and pictographs and petroglyphs on the Baja California Peninsula. Historic documents, ethnographic accounts, and native oral histories show that sea turtle hunting for subsistence continued to be important for native peoples between the 16th and late 20th centuries. This presentation summarizes these records of sea turtle hunting and its significance for native peoples of the Gulf, including new archaeological evidence from the northern coast.

COMMUNITY-BASED TOURISM AS A STRATEGY FOR SEA TURTLE CONSERVATION ALONG THE BAJA CALIFORNIA PENINSULA*

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The Baja California peninsula provides vital nesting and foraging habitat to five species of sea turtle including loggerhead, leatherback, olive ridley, hawksbill, and black sea turtles. These sea turtles face a range of threats including poaching, entanglement in fishing gear, and coastal development, among others. Conservation activities along the Baja California peninsula have typically focused on research, establishment of protected areas, environmental education, and more recently, building enforcement capacity within MPAs. These strategies must be accompanied by active participation from local communities, as their activities will directly affect protection of sea turtle species and habitat. Development of sustainable economic activities focused on sea turtles is essential to the preservation of the species as well as the fisher communities with which they interact. Sea turtle focused tourism on the Baja California peninsula offers a viable and attractive opportunity to provide economic alternatives to dwindling fisheries and destructive activities such as poaching and non-sustainable fishing practices, while strengthening local sea turtle conservation efforts. The foundation of 10 years of sea turtle research and conservation work of the Grupo Tortuguero in a region with a solid history of naturalism focused tourism presents a unique opportunity to involve local communities in the long-term conservation of sea turtle species. Over the years, fishermen and community members throughout the peninsula have played a crucial role in sea turtle conservation and research activities, carrying out monthly monitorings and championing efforts at raising awareness. This in itself justifies investment in the development of locally based, conservation focused tourism. Declining fisheries, limited

enforcement of environmental regulations, and pressures from demographic movement and hotel and tourism development, only make the case stronger. As part of our Conservation Tourism effort, Pro Peninsula and the Grupo Tortuguero recognize the vital role of fishermen and inhabitants in fisher communities in conserving sea turtles and other natural resources. Based on relationships built over the course of a decade, this program also remains sensitive to the socioeconomic realities in communities throughout the peninsula. As such, our effort partners with communities, NGO's, academic institutions, private vendors and technical experts to: assess the needs and potential of participating communities; facilitate training for guides and small business operators; locally apply globally recognized standards and guidelines for sea turtle tourism; locate and facilitate small businesses financing; assist with permitting process; link various individuals, groups, communities and service providers to achieve a diverse and attractive regional offering of turtle tourism; facilitate promotion and market penetration. Based on initial, exploratory efforts in 2006, our work switched into high gear in 2007, encompassing site identification, introductory training, partnering with non-governmental, governmental, and private sector entities, development of first ever sea turtle watching permits in Mexico, and the operating of test trips in several peninsular sites. Based on initial evaluations, the willingness to participate of community members, government agencies, NGOs and the private sector, we believe that sea turtle focused Conservation Tourism is an essential strategy towards conservation of sea turtles along the Baja California peninsula.

BYCATCH OR DIRECTED HARVEST? – SEA TURTLE MORTALITY IN BAJA CALIFORNIA SUR, MEXICO*

Agnese Mancini and Volker Koch

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Five species of sea turtles are found in the coastal waters of Baja California Sur (BCS): black (*Chelonia mydas*), loggerhead (*Caretta caretta*), olive ridley (*Lepidochelys olivacea*), hawksbill (*Eretmochelys imbricata*) and leatherback turtle (*Dermochelys coriacea*). Although a total ban on sea turtle harvest was declared by presidential decree in 1990, and much effort has been put into grassroots conservation, large numbers of turtles are still killed each year. BCS is considered an important feeding and developmental area for North Pacific sea turtle populations, but there is still little information on rates and causes of mortality for most of the region. Therefore, we tried to determine minimum annual mortality rates of sea turtles, identify main mortality causes and pinpoint high-risk areas and seasons to inform sound conservation measures. Mortality censuses were conducted at 13 index sites, covering 280 km of beach and 22 villages and their dump-yards. Each specimen was identified, measured, marked, its geographic position taken and cause of death was determined when possible. Mortality distribution was mapped and compared with fishing effort of the artisanal fleet. From 03/2006-08/2007, we found 945 carcasses, mostly black (57.0%) and loggerhead (33.7%) turtles: 58% had stranded on beaches, 42% were found in villages and dump-yards, 79% of the carcasses were juveniles. Most of the stranded carcasses were found on the Pacific coast of Magdalena Bay (9.7 turtles km/year, 52% of total strandings, >90% loggerhead turtles), and in San Ignacio lagoon (15.7 turtles km/year, 36% of total strandings, all black turtles). Stranding peaks coincided strongly with halibut fishing in Magdalena Bay (July-September) and the guitarfish season in San Ignacio (June-July). While it was impossible to determine cause of death for most stranded turtles due to advanced decomposition, the connection with bottom-set gillnet fisheries is clear, and was independently validated through interviews with fishermen. All carcasses found in villages and dump-sites had been consumed, most of them were black turtles (73%), which is the most sought after species for human consumption. Turtles are eaten year-round at all sites, at some locations consumption increases around Easter week or other festive days (e.g. Father's Day in Santa Rosalia). Both our stranding and consumption estimates are very conservative, because: 1) we only monitored 12% of the total coastline and less than 15% of all coastal communities and fishcamps in BCS, 2) poachers have become more cautious recently and burn carcasses or throw them into the sea to avoid detection, 3) the percentage of turtles found on the beach is much lower than the actual number of turtles dying at sea, as stranding depends largely on prevailing oceanographic conditions, and 4) censuses were done bimonthly and carcasses may have been buried, eaten by scavengers or taken out to the sea in the meantime. Sea turtle mortality in the state may easily be more than an order of magnitude higher than what our

actual data show, and the high death rates from by-catch and hunting remain a serious threat to the recovery of sea turtles in the Eastern Pacific basin.

LONG TERM MONITORING OF EAST PACIFIC GREEN TURTLES (*CHELONIA MYDAS*) AT COASTAL FORAGING AREAS OF THE BAJA CALIFORNIA PENINSULA, MEXICO*

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The Baja California Peninsula is considered a key area for sea turtles, providing a great number of protected coastal foraging and nursery sites. But incidental bycatch and illegal hunting still threaten population persistence. Few long term studies have been done on the foraging areas to complement the information collected at nesting beaches. The Grupo Tortuguero has been working on a conservation program since 1999 and began a community-based monitoring study of East Pacific green turtles, *Chelonia mydas*, in 2001 at four different foraging areas located on the pacific side of the Baja California Peninsula and from September 2005 an additional site located in the Gulf of California has been monitored. Between August 2001 and November 2006, a total of 1243 turtles were captured from all monitoring sites including 155 recaptures, almost 100% *Chelonia mydas* (N = 1243: 1238 Cm; 3 Ei; 2 Cc). More than 94% of them were juveniles between 52.7 and 59.7 cm of average SCL. The average SCL of the turtles caught in the Gulf of California was significantly larger than the average SCL of Pacific coast turtles. The CPUE trend in Punta Abreojos from year to year indicates a population increase. The growth rate of Bahía Magdalena was the lowest and significantly different from other sites, with a difference of almost 2 cm; no recaptures between monitoring sites were reported, suggesting high site fidelity of the turtles. The low number of recaptures suggests a high number of turtles at the foraging areas or high mortality. Either way, the protection of turtles at these locations is important to the continued recovery of the East Pacific green turtle. This work is the result of the participation of all the people working in the monitoring sites and we want to thank their valuable participation. I also wish to thank the generous donations by the following organizations: Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, as well as two generous individuals: Carlos Peralta Quintero and Robert N. Allen Jr,. who made possible my participation in this meeting.

"A SEA TURTLE PROTECTION NETWORK IN LOS CABOS, BCS, MEXICO": AN INDICATOR OF ENVIRONMENTAL AND TOURISM SUSTAINABILITY OF THE DESTINATION

Mario Martínez-Díaz[1], Marco Murillo[1], Graciela Tiburcio-Pintos[2], and Raquel Briseño-Dueñas[3]

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The potential for tourism in a locality and its environmental sustainability are connected with the individual participation and the collective one of the community in its natural, cultural, and economic environment. On the other hand, an effective administration of the cultural and natural heritage is fundamental to give support and long-term viability for the tourist destination. Under this premise we need to fortify the appraisal of the singular attributes, of our identity and the regional culture of tourism. In 2003, the municipal government of the H. IX Los Cabos City Council through the Sea Turtle Protection Program and the local tourism sector developed the "SEA TURTLE PROTECTION NETWORK". The planned activities for the undertaking of such an initiative are: 1) training of administrative, safety and security staff of interested hotels, 2) linked patrolling of the private sector, of the three levels of governmental offices, and of the academic sector, and 3) exchanging of knowledge with emphasis on environmental law, in the biological processes, and in the good practices with national and international standards for the management and conservation of sea turtles at beaches with touristic infrastructure. Five annual training workshops have been given, where 570 people have participated, and a total of 25 hotels have been integrated to the network. Using the sea turtle as a conservation symbol, the objectives of the training are: i)to promote an appraisal of the natural heritage of our region, ii)to develop new habits and a conduct of respect towards the environment and its biodiversity, iii)to participate in the identification of problems and in the mitigation of environmental ones, and iv)to contribute to the social, economic, and environmental sustainability of the region. In sum, this effort has resulted in the conservation of 393 nests with a successful management of 349 clutches that produced 25,566 olive ridley hatchlings and 12 leatherback hatchlings. Four sea turtles were rescued and four people were arrested for illegal use of sea turtle eggs. Additionally, the document "Norms of behavior for nesting beaches with tourist use" and a base map with the location of nesting beaches of the Los Cabos Sea Turtle Protection Network were developed thanks to the group dynamics and the participation of the members of the network.

ECOLOGY AND BYCATCH OF ENDANGERED NORTH PACIFIC LOGGERHEAD TURTLES AT BAJA CALIFORNIA SUR, MEXICO: BIOLOGICAL JUSTIFICATION FOR A FEDERAL LOGGERHEAD REFUGE*

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New telemetry research confirms that migratory megafauna including sharks, cetaceans, sea birds, and sea turtles can frequent coastal habitats during vulnerable life history stages, exposing them to intense coastal fisheries. Because bycatch can be particularly severe in nearshore fisheries, identifying such habitats and the ecology that underlies them may yield important conservation gains in the form of protected areas for vulnerable migratory

populations. We investigated the habitat use, foraging ecology, and mortality of loggerheads at Baja California Sur, Mexico and evaluated the demographic implications of their local bycatch in order to evaluate the biological utility of a coastal refuge. 2137 loggerhead carcasses stranded along the 43km Playa San Lazaro from 2003-7 Stranding rates were high during summer, when local small-scale fisheries were intense, supporting previous estimates of a minimum annual bycatch mortality exceeding 1000 loggerheads off BCS. Preliminary modeling results suggest that observed levels of small-scale fisheries bycatch (1000+ loggerheads per year) at BCS preclude the recovery of the North Pacific loggerhead population. Stomach contents collected from 109 turtles stranded in fresh-dead condition from 2003-2007 included pelagic red crabs, several demersal crab species, and assorted molluscs but were dominated unexpectedly by various demersal fish species. Observations suggest that certain loggerheads are scavenging fish from nets, greatly exacerbating their bycatch. We identified a high use area of loggerheads at BCS by analyzing the movement of 43 turtles tracked with satellite transmitters from 1996-2007. The 60% utilization distribution of observed loggerheads consisted of an area of ~12,000km^2 centered well within the range of small-scale fishing fleets. The location of this high use area fluctuated seasonally, ostensibly matching the seasonal inshore/offshore migration of pelagic red crabs. The persistence of this coastal loggerhead high use area over the decade of our study and linkage to red crab abundance suggests that it is geographically stable. The biological evidence is clear: protecting juvenile loggerheads at BCS could contribute more than any other measure to the recovery of the North Pacific population. The social implications of establishing a Mexican federal loggerhead refuge of course are distinct. Ruiz *et al* will detail the process of partnering with local fishermen and local, state, and federal authorities to establish a refuge co-managed by local fishing cooperatives in this symposium. Maldonado *et al* will present alternatives to high bycatch fishing including sea turtle focused tourism. Delgado *et al* will report on the results of our strategy to raise awareness and mitigate bycatch from 2003-2007.

COMMUNITY-BASED CONSERVATION AT SAN JUANICO, BAJA CALIFORNIA SUR

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In 2001, the community of San Juanico, Baja California Sur, Mexico joined the Grupo Tortuguero. Since then, our community has participated in different activities such as monitoring the loggerhead feeding areas and attaching satellite transmitters to the turtles to identify the areas of major abundance. Through this participatory research we learned that bycatch at Baja California Sur is a major obstacle to the recovery of endangered loggerhead turtles. To address bycatch and poaching in our community we organized festivals, contests, and school outreach programs. We have also attended the annual meetings of Grupo Tortuguero to share our conservation work. In November of 2006 we traveled to Japan as part of the trinational fishermen's exchange and in August of 2007 hosted fishermen from Japan and Hawaii in our community to protect loggerhead turtles. We learned of the Japanese and Hawaiian peoples' efforts to protect loggerhead turtles and were able to show them our work, and shared this all with our community. We plan to involve our community in sea turtle conservation even more and to give the conservation message to other communities. In 2006, we launched an ecotourism program based on sea turtle watching. Tourists were greatly interested with this new recreational activity that we also combine with sport fishing. We will report on the socioeconomic results of this new initiative. For sea turtle conservation this turns out to be a great accomplishment, with a well structured ecotourism plan we can reduce the number of nets and decrease sea turtle bycatch, as well as increase the knowledge of sea turtle biology not only in our community but in other regions and strengthen conservation.

PROPOSED LOGGERHEAD REFUGE AT BAJA CALIFORNIA SUR: AN UNPRECEDENTED CONSERVATION OPPORTUNITY*

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The dramatic drop of between 80 and 90 percent of nesting activity over the past 50 years recorded on Japanese beaches for the Pacific loggerhead sea turtle indicates the need for urgent measures to be taken throughout its range to prevent the extinction of this endangered population. The trans-Pacific connection between nesting turtles in Japan and juvenile/subadult turtles foraging off the coast of Baja Californa Sur, Mexico have been established by Nichols *et al*. The technical ecological justification for a wildlife refuge for this species in a "hotspot" off Baja California Sur, Mexico, with the highest aggregation of juveniles of this subspecies yet known, has been presented by Peckham *et al*. as a strategy to mitigate the mortality by incidental capture by coastal fisheries. This paper describes the steps taken and the progress thus far to present a proposal to the Mexican government requesting the declaration of a wildlife refuge for the loggerhead sea turtle in waters off of the BCS coast. It also presents a vision for the co-management of such a refuge, incorporating the participation of local fishermen, academics, Mexican and international conservation organizations as well as private enterprise in addition to government involvement. The obstacles encountered in the refuge designation process are analyzed and the strategies proposed to overcome them are presented. We also present the results of efforts focused on awareness building and empowerment amongst the local fishermen, those directly responsible for sea turtle by-catch and therefore the most important sector involved. We honor and recognize the value of a highly responsible commitment made through the personal conviction of Efrain de la Paz Regalado, a local fisherman who voluntarily sacrificed the use of his fishing gear so that he is no longer responsible for sea turtle mortality.

APPLICATION OF LOOP ANALYSIS TO EXAMINE FISHING EFFECTS ON THE COMMUNITY STRUCTURE OF THE BLACK TURTLE (*CHELONIA MYDAS AGASSIZII*) IN THE BAHIA DE LOS ANGELES BIOSFERE RESERVE*

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Bahia de Los Angeles (BLA) in the Gulf of California is one of the most important regions for the feeding and protection of marine turtles in México. The objectives of this project were to a) characterize the black turtle (*Chelonia mydas agassizii*) population in BLA, b) determine the effects of artisanal fisheries on this and other marine species in the region, and c) model the biological responses by different taxonomic groups within this system based on different conservation tactics and management scenarios. A qualitative means of modelling was used called "Loop Analysis"; this technique allows the construction of ecological models to analyze the direct and indirect effects of a disturbance in the community. Models were built with published dietary and ecological information about the primary marine taxa within the BLA biotic community, with particular emphasis on those groups of commercial interest. Local knowledge from fishermen and key individuals within BLA was also

incorporated. Two qualitative models were considered: a) biological-fishery community models that include fisheries as a system variable, and b) biological community models in which fisheries were considered as an intermittent disturbance that does not permanently take part in the system (i.e. no-take zone). Inside each group, alternative models were used to represent the system variability. Model-derived prediction tables were then used to understand the effect of fishing and the other system variables on black turtles. Other natural disturbances such as the recuperation of protected species (marine turtles and sharks) and the impacts of harvest of primary producers within the system (commercial algae harvesting) were also considered. The qualitative analysis was very useful in understanding the direct and indirect effects of anthropogenic disturbance on black turtles. Results show that it is important to consider both types of impacts when developing conservation and management strategies.

THE GRUPO TORTUGUERO NETWORK: STRENGTHENING SEA TURTLE CONSERVATION IN THE CALIFORNIAS*

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Since its creation in 1999, the Grupo Tortuguero de Las Californias A.C., a community based network made up of local fishermen and community members, has developed and employed the Conservation Mosaic model to protect and recover the sea turtle populations of the Baja California peninsula. By combining the three major aspects of the Conservation Mosaic (generating knowledge, building a network and communicating strategically), scientists, fishermen, conservation organizations, women's groups, youth, government agencies and others work together to reduce threats and create long-term solutions for sea turtle conservation. The most important results of this open network include research, including the continuous monitoring of several sea turtle nursery and foraging areas in Baja California Sur, the creation of marine protected areas and social change. This program has led to the creation of more specific monitoring efforts that address the mortality of loggerhead turtles due to bycatch in the eastern Pacific (ProCaguama), the assessment of the Eastern Pacific hawksbill turtle populations (CAREY!), the development of alternative economic activities such as turtle watching, environmental education programs, annual sea turtle festivals, public sea turtle art and a wide array of national and international outreach/media. The work done over the last ten years has provided useful biological and ecological information for the 5 species of sea turtles found in this region, has empowered a new generation of conservation leaders, has engaged individuals and communities in the long-term conservation of these species and has shifted the emphasis on sea turtles as simply traditional food to that of cultural icon.

INFORMATIVE CAMPAIGN FOR THE TOURIST TO PROTECT SEA TURTLES IN LOS CABOS, B.C.S., MEXICO "DO NOT DISTURB"…

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Conservation and resource management programs in the state of Baja California Sur generate an interest from society for actions aimed to protect such resources. The coastal communities' lack of understanding and interest in sea turtle conservation is partly due to a deficiency in the inclusion of the different stakeholders in environmental programs with a coordinated and efficient approach, which are considered to be only available to scientists. A way to alleviate this and to engage the local communities in the solution of environmental issues is to have them comprehend the origin, dimensions, and consequences of such problems, including the actions each individual could take to ameliorate, stop, or remedy some of the negative impacts that deteriorate the environment, particularly that of the sea turtle. For such reasons, the Sea Turtle Protection Program of the H. IX Los Cabos City Council, in conjunction with the PROFEPA and the Sea Turtle Protection Network, integrated by different hotels of the region, have initiated a new awareness campaign aimed at the tourists that visit Los Cabos Municipality. In many cases, tourists have found turtles nesting or hatchlings just being born while strolling on the beach, without knowing what to do or who to contact. The campaign consists of the placement of 'door handles' (the ones that say "do not disturb" on hotel doors) to accomplish two tasks: the first, and best known, to use them in the hotel door for not being disturbed, and the second to provide to the guests all the necessary information about how to behave in the case of encountering sea turtles. This 'door handle' will also have contact information and phone numbers where tourists can call to receive recommendations and give notice of the encounter. Some recommendations are: do not touch the turtles, do not drive motorized vehicles on the beach, minimize use of lights for hotel rooms oriented towards the beach. The 'door handles' have been produced both in Spanish and English. The first edition of 10,000 door handles is being distributed during the 2007 nesting season among the hotels that are members of the network. This network is made up of 24 hotels of Los Cabos, in connection with local authorities to protect the sea turtle.

OCEANOGRAPHIC INFLUENCES ON THE SEASONAL DISTRIBUTION OF JUVENILE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) OFF BAJA CALIFORNIA SUR, MEXICO*

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The Pacific coast of the Baja California peninsula is one of the most dynamic oceanographic regions of the Pacific Ocean (Espinosa-Carreon *et al*. 2006, Thomas and Leggard 2006). At this southern end of the California Current, biologically-rich marine hotspots are formed by persistent physical features (i.e. upwelling, fronts, and eddies) that drive high primary productivity and provide important habitat for many pelagic predators, including five species of sea turtles: hawksbills (*Eretmochelys imbricata*), loggerheads (*Caretta caretta*), green turtles (*Chelonia mydas*), olive ridleys (*Lepidochelys olivacea*), and leatherbacks (*Dermochelys coriacea*) (Marquez 1990, Koch *et al*. 2006). Understanding the processes that establish and maintain these foraging areas requires knowledge of the spatial and temporal lags associated with physical processes, primary and secondary production, and top predator movement. The endangered loggerhead sea turtle (*Caretta caretta*) is an example of a highly migratory species that utilizes biologically productive areas off Baja California Sur, as it spends decades foraging year-round off the coast before returning to its natal beaches in Japan to reproduce (Nichols 2000, Peckham and Nichols 2002). Peckham *et al*. (2007) have shown that where intense small-scale fisheries overlap with these loggerhead foraging areas, high levels of incidental mortality occur, contributing to population declines. Using a combination of remotely sensed satellite products, bio-logged sea turtle movement funded by National Marine Fisheries Service (NMFS) and Tagging of Pacific Pelagics (TOPP), and ship-based prey distribution, we analyzed the physical and biological oceanographic features that influence the spatial and temporal distribution of foraging loggerhead sea turtles and their prey, the red crab (*Pleuroncodes planipes*), off of Baja California Sur, Mexico. Preliminary results suggest that juvenile loggerhead and red crab distribution can be correlated with environmental variables including chlorophyll-a concentrations and sea surface temperature frontal gradients. In working with Grupo Tortuguero, our results will contribute to a greater understanding of the seasonal movement of juvenile loggerhead sea turtles and management efforts for fisheries off Baja California Sur.

Social, Economic and Cultural Studies

USES OF THE SEA TURTLES BY WAYÚU PEOPLE IN THE GULF OF VENEZUELA: “NATIVE OCEANS” OF VENEZUELA

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Ethnic natives all around the world, ever since their beginnings have taken advantage of natural resources for their subsistence and as the root of their religious beliefs. Because of their wide distribution, sea turtles all around the world interact with many native communities, in which they play a crucial role in their ideals and customs. The Wayúu community is located in the approaches of the Gulf of Venezuela, identified as an important feeding ground for at least 4 sea turtle species. The high zone dryness is not good for the development of agriculture and cattle, which makes sea resources important for the economy and subsistence of the people. The constant interactions between the communities and the maritime environment lead to the incorporation of diverse species, such as sea turtles, to a great variety of magical-religious beliefs. The goal of this study is to get to know and understand how the presence of species such as sea turtles affect the daily activities of these communities, turning into part of their history, economy and culture. The data was obtained through non structured open interviews, in a comfortable atmosphere for the people and fishermen. This trust has been carefully built during 10 years of activities that allowed a progressive integration of the work team into the communities. The retro-alimentation product of these activities made possible a gradual decrease in the advantage of sea turtles. Also, it has allowed comprehending the importance of sea turtles in their beliefs, and the key of these reptiles in the representation of the communities. In the development of the endangered species environmental strategies it is necessary to know and study the native communities from the inside, allowing to understand the bond with the animal species, specially the sea turtles, with

their history and cultural ideals. In order to create viable strategies for sea turtle preservation, it is important to articulate the natives with specialists. This way, the communities that will take care of the natural resources are supported with the knowledge of the researchers.

MODELING PALEOECONOMICS OF HARVESTING SEA TURTLES AND SEA TURTLE EGGS IN A PRE-CONTACT INDIGENOUS SOCIETY ON THE GEORGIA COAST, USA

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Nesting loggerhead sea turtles (*Caretta caretta*) (Linnaeus, 1758) presented a significant seasonal nutritional resource to pre-contact and post-contact indigenous occupants of Georgia's barrier islands, including St. Catherines Island. St. Catherines Island has existed for over 40,000 years as a barrier island and has been occupied by indigenous Native Americans for over 5,000 years, a time when rising sea level once again separated the Georgia Golden Isles from the mainland and from one another. Although scant archaeological evidence presents itself for harvesting of sea turtles or eggs, it is logical to speculate that indigenous inhabitants harvested eggs and meat of loggerhead sea turtles that nest on the barrier island's beaches from May to August. Clutches of eggs (avg. 113 eggs/clutch) represent a significant high-protein food resource and were undoubtedly harvested in a hunter-gather society of early inhabitants. Eggs weighing ~30.2 g would contain considerable nutrition making clutches of eggs valuable seasonal food resources. Anecdotal evidence suggests the numbers of loggerhead turtles nesting on St. Catherines Island was significantly greater in the past. The hypothesized exploitation scenario includes reading of "sign" in crawlways and nest areas, digging for eggs with "found tools," and transportation of the eggs to temporary camp sites on the seaward side of the island. Tools of choice for digging have been tested experimentally and include abundant shells of hand-sized local mollusks such as the Knobbed Whelk (*Busycon carica* (Gmelin, 1791)), Channeled Whelk (*Busycotypus canaliculatus* (Linnaeus, 1758)), and the Giant Atlantic Cockle (*Dinocardium robustum* (Lightfoot, 1786), all found to be wanting in terms of manipulative ability. Broken branches have been tried and were more successful, especially in locating egg chambers by probing. The tool of choice, determined after two years of experimental "Native" digging, is the stem of Cabbage Palm (*Sabal palmetto* (Walt.) Lodd. ex J.A. & J.H. Schultes) fronds, a broadly concave stem with sharp keels. They form trowel-like hand tools (when broken into short pieces) that easily move sand and also are used to scrape the surface of the undisturbed laminated beach sand beneath the covering pit, exposing the egg chamber neck as a bulls-eye contrasting with the contour-like patterns of the undisturbed back beach sediment. Transportation from the beach to temporary summer campsites was probably in baskets woven of grasses, perhaps smooth cord grass (*Spartina alterniflora*). Hunting of loggerhead sea turtles for meat was also a likely seasonal economy, as nesting loggerheads could be easily "tipped" after nesting, prepared on the beach by roasting using flotsam wood, and distributed to tribal members. It is also speculated that a canoe-based harpoon or spear fishery may have existed exploiting migrating leatherback sea turtles, an industry that would provide oil for the economy and prestige and status for the hunter. Acid environments of coastal sand soils are not amenable to preservation of organic evidence (bone, shell, or grass fabric) of this sea turtle-based economy, therefore much of the nutritional story of sea turtle economics in indigenous societies of coastal Georgia remains speculative.

OSTIONAL, COSTA RICA, 10 YEARS LATER: CHANGING COMMUNITY PERCEPTIONS OF EGG HARVESTING AND TOURISM

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A survey of households in Ostional, Costa Rica, was designed to assess the socio-economic benefits of the legalized olive ridley egg harvesting project and of the tourism industry, and community perceptions of both activities. The survey was first administered in 1995 and then repeated in 2004, allowing us to examine how impacts and attitudes have evolved over a ten year interval. The 1995 research found high levels of support for both egg harvesting and tourism throughout the community, and that socio-economic benefits from egg harvesting were more important than those from tourism for the community as a whole. However, a small percentage of households earned more income from tourism. In 2004, economic dependence on the egg harvest had decreased for some households, due to increased employment opportunities in other sectors, including tourism. Although tourism in general had grown, local tourism ownership had not and outside investment accounted for most growth. Attitudes towards both egg harvesting and tourism remained positive, but there was increased concern about the interaction of these two activities, and the interests of government agencies in tourism development. Results are used to interrogate the concept of community based conservation, the compatibility of consumptive and non-consumptive use of wildlife resources, and Agrawal's (2005) theory of environmentality.

THE WOMAN BEHIND THE FISHERMAN OF SEA TURTLES: STUDY CASE ZAPARA ISLAND, GULF OF VENEZUELA

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The Zapara Island is characterized for its wealth of natural and exotic landscapes, and a community of native inhabitants belonging to the Añu and Wayuu ethnic groups, descending from the Arawacos Indians. This community develops through fishing and commerce and they have tried to maintain the essence of their culture before the urban demands, as this island is in direct contact with the Gulf of Venezuela. Historically sea turtles have been frequent characters in this island. By being a community characterized by a matriarchal family structure, the native women exercise the fundamental role inside family decisions. They are characterized as being dominant, eloquent, spontaneous and excellent cooks, and they are worried about the formation of their children and the development of family life. The man, on the other hand, complies with the role of providing the family with all that is required to cover its needs. This community maintains the faithful belief that sea turtles are animals that provide prosperity and fertility to the family and to the land. They consider sea turtles exotic, therefore their presence on the table is considered a festival and is the main plate of visitors to the island. They also utilize the blood and the oil of sea turtles as a medicinal beverage and aphrodisiac. This investigation was carried out with the objective of determining the influence of female dominance over the fishermen on sea turtles, utilizing the phenomenological method of analysis and interviews to collect data. This is a study developed through 10 years of work of the GTTM-GV as environmental educators. The sample contains native women, mothers, and wives of fishermen of the Island that were willing to offer the information. To triangulate these data, I carried out a historic analysis of events that confirmed the findings.

COSTA RICA CARIBBEAN PEOPLE AND THEIR SEA TURTLE PERCEPTIONS

Didiher Chacón

Latin American Program Coordinator, WIDECAST

This research was conducted in 8 coastal communities of the Caribbean coast of Costa Rica, between 2004-2006. A total of 1352 surveys were conducted, 37.6% of these in Limón city and 2.4% in Gandoca Community. In total during the study, 231 persons refused to participate, 49.9% of the persons interviewed were men and 50.1% were women. In the total sample, 58.3% were Latin or white people and 1.3% were indigenous people. The study included only people 18 years or older. 87% of the people recognize the presence of sea turtle around their communities, while 32.8% recognize the presence of leatherback, green, and hawksbill sea turtles. People from Gandoca show the highest knowledge about the species of sea turtles around their communities. 85% of Gandoca residents thought sea turtles shouldn't be consumed, while 86% of Barra del Colorado residents accepted consumption; both of these communities are inside Protected Areas and in extremes of the Costa Rica Caribbean coastline. In other communities, like Manzanillo, Cahuita, and Tortuguero, towns inside or with strong links to Protected Areas, 20% of people accepted consumption of sea turtle meat, and 65.5% of the people accepted consumption of sea turtle eggs. In Gandoca, only 28.6% accepted consumption of sea turtle eggs. The survey includes 49 questions about knowledge, use, perceptions and the study shows that Costa Rica Caribbean people use and protect sea turtles without any relationship with protected area presence.

THE TURTLES IN THE SHIPWRECKS

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Literary works exist where we can read true stories of incredible shipwrecks, in where novelesque marine turtles and in one occasion terrestrial turtles, have played determinant roles in the survival of shipwrecks. In this work we abstracted some paragraphs of those terrible experiences, from the tragedy of the whaling boat "Essex" when it was attacked by a gigantic sperm whale in 1829, to the misfortune of the fishing crew of "Cairo III" in 1988; passing through other stories at the moment of the encounter man-turtle in the middle of immense ocean and the ways in which turtles have helped them to mitigate starvation.

ILLEGAL TRADE OF SEA TURTLES AT THE SOUTH WESTERN COAST OF THE GULF OF VENEZUELA

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Sea turtles play an important role among several Caribbean cultures. These animals are widely used as relevant objects of tradition, culture and socio-economics in these communities. The use and trade of sea turtle products occurs across the tropical coastline. In The Gulf of Venezuela sea turtle illegal trade is a common activity, and only five species have been recorded for this area: *Chelonia mydas*, *Eretmochelys imbricata*, *Caretta caretta*, *Dermochelys coriacea* and *Lepidochelys olivacea*. Poaching affects many species of sea turtles; although hawksbill turtle might be the most endangered of all, because of its carcass trade, which has the highest demand at the south western coast of the Gulf of Venezuela. For this reason an analysis at small scale of poaching and trading of sea turtle on the coast of the Gulf of Venezuela was carried out. Between 2002 and 2007 open and not structured interviews were made to fishermen, craftsmen and owners of different restaurants in order to detect sale and use of sea turtle products and sub-products. There were two defined types of uses: food and decoration. Green sea turtle and hawksbill meat is the most frequent product commercialized in this region. Its prices vary between $5(green turtle) and $6 per kilo (hawksbill) with a cost of $163 – 21 for the whole turtle (adult or sub adult); restaurants sell the sea turtle plates between $8 and 9 each. There are other sub products of sea turtles, such as leatherback oil ($5 per littre) and dried penis, which is believed by the people in this area to give strength to men. Its prices vary between $14 for green turtle and $37 for hawksbill. The carcass of the hawksbill is generally trade for decoration. This kind of carcass is the most wanted for its commercial appeal. They are used world wide as material for jewelry. This region also uses its scutes for roosters spurs ($9 the pair). Despite of the existence of national laws that protect sea turtles, natives follow their specific laws. In their religion the sea turtles are the representation of gifts given by God and their uses (whatever they might be) and trade are seen as correct and even legal. This is a reason why illegal trade of sea turtle products at the Gulf of Venezuela is an important issue that needs to be handled mainly with environmental education and research and integrating the community of this region.

TORTOISESHELL TRADE IN SANTO DOMINGO, DOMINICAN REPUBLIC: DISCOURAGING NEWS FOR CARIBBEAN HAWKSBILLS

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Despite long-standing national legislation prohibiting the sale of hawksbills and their derived products, the Dominican Republic is well known for the conspicuous sale of tortoise shell items in tourist gift shops. To provide an update of this situation, we surveyed the majority of these shops (108) in the Colonial City of Santo Domingo,

and documented the presence, abundance, and variety of displayed merchandise. At the same time, a short survey questionnaire was administered to willing shop owners and/or sales people to learn about their knowledge of hawksbills, related laws and sales trends. Seventy-seven percent of the shops visited sold hawksbill items of great variety and abundance, even though most respondents knew about its illegality. This indicates that the lack of enforcement by the Dominican authorities is the main culprit for this widespread trade. We also recommend that an education campaign is carried out to sensitize the increasing number of tourists that visit the Dominican Republic every year.

ECOLOGICAL ANTHROPOLOGY IN CARIBBEAN NICARAGUA: A HISTORY OF THE CONNECTIONS BETWEEN MISKITU INDIANS AND *CHELONIA MYDAS*

Katy Garland

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The sea turtle fishery on Nicaragua's Caribbean coast is a prime example of the influence of natural resource use, dietary customs and market influence on environmental conditions. As early as the 19th century, Bernard Nietschmann reported that the Miskitu Indians made use of the largest sea turtle feeding grounds in the Western hemisphere, deriving 82% of their meat harvest from aquatic resources. Historically, 65% of Miskitu men devoted their meat-gathering time only to the harvesting of turtles and the protein obtained by these fishermen remained in their local communities. However, due to an increase in market demand for turtle meat (throughout Nicaragua) and shell (mostly in Asia), the Miskitu economy quickly became more dependent on cash in the mid 1900s. To meet rising market needs, the traditional Miskitu turtle men and other Nicaraguan fishermen altered their subsistence fishing strategy to one of mass exploitation. In 1972, Nietschmann observed that "Miskitu hunters and fishermen are focusing on animals with high market potential in the village populations of green turtles, white lipped peccary, and white-tailed deer are receiving additional pressure from human populations because of their taste preference and marketable potential." During the early 1970's, indigenous communities on Nicaragua's Caribbean coast began to notice a decline in meat sources, particularly green turtles. While there is a growing interest among coastal communities to pursue more sustainable uses of natural resources, such as sea turtles, local participation in conservation efforts is minimal. This lack of involvement likely results from a historical preference for turtle meat and the lack of cheap, alternative sources of protein. Currently, year-round unlimited legal harvests of *Chelonia mydas* take place along the Caribbean coast. The only times that people don't harvest turtles are when the weather is bad or when they are on holiday. The cultural system of Caribbean Nicaragua has its own 'cultural logic' that helps explain eating habits of indigenous communities that rely on and prefer the meat of sea turtles; a practice that cannot simply be explained by utilitarian theories. In his book, Good to Eat, Marvin Harris' (1985) main thesis is that there are practical reasons for what people eat. Nutritional costs and benefits form a fundamental part of the balance, yet there are ecological, economic and cultural factors that may override the nutritional value of food and make them good (or bad) to eat. Although sea turtle is one of the cheapest sources of protein that is easily accessible to the population along Nicaragua's Caribbean Coast, there are likely underlying factors that contribute to an individual's decision to eat (or to not eat) sea turtle meat. Since the 1600s the Miskitu Indians' reasoning for fishing turtle has changed many times as has the significance of this protein source for Caribbean Nicaraguans. This poster presentation will document the changes in this human-turtle relationship (dependence) through time, from A.O. Exquemelin (1686) and E.G. Squier (1855) to Carr and Nietschmann in the mid to late 1900s and theorize the implications of these changes for Caribbean populations of *Chelonia mydas*.

OPTIONS FOR THE SUSTAINABLE USE OF GREEN TURTLES BY HAMMOND ISLANDERS*

Jillian Grayson[1], Stephen Ambar[2], Helene Marsh[1], and Mark Hamann[1]

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Torres Strait and northern Queensland have the largest population of green turtles in the world. This population supplies a large, internationally-based, green turtle harvest, which is currently not managed. In Queensland, successful management will need the involvement of the Indigenous Torres Strait Islanders who use green turtles for cultural, social and economic purposes. This project investigated the existing opportunities and constraints for the sustainable use and management of dugongs and green turtles by the Hammond Islander community of Torres Strait. It also documented the aspirations of Hammond Islanders in relation to such use and management, particularly the use of various controls in their traditional sea country. Individual hunters from Hammond Island discussed their perceptions and aspirations about green turtle management during a semi-structured interview. An indigenous counterpart employed on the project assisted with the interviews. In general, hunters perceived there to be plenty of turtles around and they did not think the population was declining. However, the Islanders did think there were more people hunting now than in the past and that more turtles were being caught. Many hunters were concerned that if they did not do something to look after turtles there might not be enough for future generations of Islanders. These perceptions are consistent with scientific information that although it is difficult to tell whether the population is increasing or decreasing, there are some signs (e.g. poor nesting success at smaller sizes of the largest females nesting at Raine Island, the major rookery for this green turtle population) that the population might be declining. With respect to management options, most hunters favoured a permit system over other options, but were concerned about ensuring everyone cooperates (i.e. policing) and about ensuring that turtles are available for cultural ceremonies. Similar concerns were raised for area closures. Turtle fast season (the turtle mating season) is from about October to December in Torres Strait and a very large number of turtles pass through Torres Strait at that time. Turtle fast is a very important time for hunting and few hunters thought that it would be possible to get people to agree to restrict hunting during that time. Torres Strait Islanders generally prefer large, adult female turtles and most hunters thought it would be very difficult to get people to catch male turtles or smaller-sized turtles. The information collected in this study may assist Hammond Island in designing an effective community-based management strategy for green turtles. Acknowledgements: International Sea Turtle Symposium, Project GLOBAL, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service (Marine Turtle Conservation Fund), David and Lucille Packard Foundation, and the Sandler Family Foundation, Carlos Peralta Quintero and Robert N. Allen, Jr.

TOWARD REDUCING HUMAN-CAUSED IMPACTS ON GREEN TURTLE NESTING ACTIVITY IN OGASAWARA ISLANDS: RESULTS AND IMPLICATIONS FROM A RESIDENT SURVEY*

Asuka Ishizaki[1], Tara Teel[1], and Manami Yamaguchi[2]

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In Ogasawara Islands, the largest breeding ground for green turtles (*Chelonia mydas*) in Japan, one of the emerging concerns over the overall health of the species in the area is the interaction with humans on nesting beaches. During the busy tourist season, a female green turtle attempting to nest can easily attract more than 30 turtle watchers. Currently, there are no regulations or sufficient guidelines in place on the islands to limit access to important nesting

areas or to manage visitor behavior in these areas. In anticipation of future management actions to manage human impacts on nesting beaches, our project was designed to examine the social dimensions of sea turtle conservation in Ogasawara. METHODS: The study was conducted during the summer of 2007 to examine residents' attitudes and beliefs regarding sea turtles and levels of support for potential turtle management actions. Data were collected via a self-administered quantitative survey developed collaboratively by researchers of Colorado State University and the Ogasawara Marine Center. Survey questions were based on a preliminary issue-investigation phase conducted in Ogasawara during the summer of 2006. Question development was also guided by theories from social psychology, including the Value-Attitude-Behavior Hierarchy and the Theory of Reasoned Action, that have been adapted for use in understanding human behavior in a wildlife or natural resource-related context. The survey was hand-delivered to all resident households in Chichijima, the larger of the two inhabited islands of Ogasawara. Of the 915 surveys delivered, 553 usable surveys were returned, resulting in an overall response rate of 63%. RESULTS: A majority of survey respondents indicated a positive attitude toward sea turtles and turtle conservation efforts in Ogasawara. Over half agreed that the current efforts are effective in increasing the green turtle population in the area, and only 12% believed that the convenience of people's lives should take precedence over sea turtle conservation on the island. Two specific management actions were examined on the survey: (1) establishment of a regulation restricting certain human behaviors (e.g., approaching, touching, using flashlights or flash photography) on nesting beaches; and (2) restriction of access to nesting beaches. While 80% expressed support for action 1, respondents were more divided with respect to the acceptability of restricting beach access. Regression analysis was used to construct a model of factors forming the basis for support for the two actions. Significant contributors included attitudes toward sea turtles, beliefs about the importance of sea turtles to Ogasawara, and beliefs about outcomes of sea turtle conservation (e.g., the effectiveness of conservation action and impacts on local residents) as well as the specific management strategies. Our presentation will conclude with a discussion of how results may be used to inform future sea turtle conservation efforts in Ogasawara, ensuring these efforts account for social factors that could influence their success.

ILLEGAL SEA TURTLE FISHERY IN BAJA CALIFORNIA SUR, MEXICO: ORIGIN OF THE PROBLEM AND CONSEQUENCES

Agnese Mancini, Ricardo Borquez, and Volker Koch

Universidad Autónoma de Baja California Sur, La Paz, BCS, Mexico

The black market trade for sea turtle products in Northwest Mexico usually originates in communities where sea turtle fisheries were once very common; most of the people involved in this illegal activity do it for cultural and economic reasons. Eating sea turtle meat is still considered a normal habit and is not perceived as a crime by most people from coastal communities in BCS. The aim of this paper is to describe the profile of illegal sea turtle fishers in BCS, evaluate the factors that promote illegal fisheries and pinpoint some consequences of this activity. For this, structured interviews have been carried out among known and supposed turtle poachers selected through the "snow-ball" system in the communities where black market trade of sea turtle meat is known to occur. Here we present preliminary results of these interviews. In general, three different profiles of illegal fishers can be described: full time poachers, occasional fishermen that sometimes hunt turtles for profit, and regular fishermen that only occasionally catch sea turtles. Full time poachers are well equipped and organized in networks. Usually they have a regular job not tied to the fishery. Occasional poachers usually catch sea turtles for extra income, they mostly sell the product in the same community where they live. Some regular fishermen will catch sea turtles only rarely, for special familiar events, but don't sell the product. The percentage of these three types of illegal fishers varies greatly depending on the communities where the interviews were conducted. Different regions have been identified based on the distribution of this percentage. While the first two types are moved strictly by economic factors, the latter is mainly influenced by culture and tradition. Main factors promoting the illegal fishery are the low probability of being caught, the lack of law enforcement, the locally high abundance and ease of catching sea turtles in some locations, and the severe over-exploitation of many marine resources and the resulting high levels of unemployment in many coastal communities. Illegal fishers are usually protected from above, and earn good money, but they normally don't use it to improve their living conditions. Thus, the outlook is rather bleak, and no efficient

measurements have been implemented by the government to diminish illegal hunting. On the other hand, the creation of Grupo Tortuguero and other local NGOs shows that a growing sense of stewardship and responsibility towards sea turtle conservation is taking hold in the fishing communities in Baja. However, effective law enforcement is urgently needed, together with more education, and strategies to provide economic alternatives to fishermen who increasingly face resource depletion and consequently unemployment and poverty.

ADVANTAGES IN THE ADMINISTRATION OF OSTIONAL NATIONAL WILDLIFE REFUGE, COSTA RICA USING PARTICIPATORY ENVIRONMENTAL MANAGEMENT

Carlos Mario Orrego Vasquez

Director Refugio Nacional de Vida Silvestre Ostional, Costa Rica

The Ostional National Wildlife Refuge was established by the Ministry of Environment (MINAE) of Costa Rica in 1983 to protect marine turtle nesting conditions in Ostional. Our mission is to manage and achieve the sustainable use of this resource and gain community support through their participation in the conservation process, including the planning, investigation, protection, control, ecotourism, and environmental education. To provide benefit to the community of Ostional, the MINAE and Institute Fish and Aquaculture of Costa Rica (INCOPESCA) authorized use of olive ridley (*Lepidochelys olivacea*) turtle eggs as subsistence (consumption and selling) in an executive decree. The decision to allow the harvesting of olive ridley eggs is based on the results of social and biological studies performed by University of Costa Rica and other national and international universities demonstrating that the population is stable. Historically, governments in Latin America that created protected areas without completely incorporating local communities have caused conflict between different stakeholders. Conflicts between government and locals in Ostional occurred 20 years ago due to a number of contributing factors: 1) a lack of confidence in government officials, 2) the importance of economic profits from the sale of olive ridley eggs, 3) harsh living conditions (i.e deteriorated homes), 4) the possibility of being displaced and 5) lack of research and publications presenting sustainable use of natural resources. Other factors leading to disagreement included the lack of physical presence of MINAE personnel and infrastructure in the refuge, legal framework, management plan, territorial order, and a budget to implement the management strategies. Since 2003 MINAE and stakeholders (INCOPESCA, the Ostional community, and University of Costa Rica) have implemented the Participatory Environmental Management (PEM) to allow for an integrated approach to identify priority objectives, solve potential problems and reach the mission statement. This methodology included the use of knowledge from traditional, scientific, technical and administrative sources to provide more efficient, effective and longer lasting ecosystem management under social, environmental and economic terms. Under the new management practices, MINAE and the stakeholders reach important advances in the research, protection, control, environmental education, and eco-tourism of the Ostional National Wildlife Refuge together. Lessons learned through the implementation of the PEM and the authorized harvest of olive ridley turtle eggs are: 1) well being and quality of life of the locals have improved from increased profit from egg sales and ecotourism; 2) economic, social, and scientific benefits lead to stable and sustainable conservation; 3) Administer Protected Areas is not viable without the recognition, support and participation of local actors in the decision-making process; 4) objectives and goals of protected areas can become threatened without proper funding; and 5) environmental education leads to changes in attitudes and perceptions on sustainable resource use.

MARINE CHELONIAN ILLUSTRATION PART SIX: TURTLING

Chuck Schaffer[1] and Rick Schaffer[2]

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Far before they were considered charismatic animals, humans had a strong link with marine turtles, primarily due to their importance for food. Meat, eggs, and even oil have been of vital importance to coastal communities for thousands of years. Worldwide, the majority of marine turtle hunting has been subsistence related, but there has also been a ritualistic as well as a luxury goods aspect to the hunt. Ritual human burials have often been associated in a mortuary context with turtle shells. The earliest records of marine turtles as a delicacy date not from the Key West Turtle Kraals, but from China in the fifth century B.C. Although the majority of marine chelonians hunted are green turtles, for the reasons mentioned above, hawksbills have been collected for the "tortoiseshell" trade. This is not limited to Asia, by any means. Marine turtle shells have been utilized for decorative purposes since Greek and Roman times. The shells of several sea turtles, but primarily of the hawksbill, have been used in the construction of various objects and ornaments by the Greek and Roman upper classes. The Calusa of southwest Florida were also known for their use of this material for combs and pins. Agatharchides of Cnidus in Journey around the Red Sea (132 BC) describes the chelenophagi, or turtle eaters, their hunting methods, and utilization of marine turtles. The earliest depictions of these activities are seen on Dulum seals in 2000 B.C. But from the 1500s on, marine chelonian depictions increased and with them came illustrations of hunting practices and methods. This poster will provide a pictorial history of these activities from then until modern times.

SEA THE VALUE: QUANTIFYING THE VALUE OF MARINE LIFE TO DIVERS*

Lisa White[1], Lisa Campbell[1], Elizabeth Griffin[2], and Suzanne Garrett[2]

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Contemporary wildlife conservation is often promoted through market-mechanisms. The logic behind this approach is that wildlife must 'pay its way' if it is to be conserved. While this approach can be critiqued from a variety of perspectives, considerable investment has been made in finding ways to create markets for wildlife conservation (e.g. through ecotourism). From a methods perspective, assessments of willingness to pay (using contingent valuation) have become widely used to determine whether or not various values for wildlife (e.g. existence value, option value) can be translated into market values, and thus into economic arguments for conservation. The purpose of this research was to examine willingness to pay among U.S. recreational scuba divers for particular wildlife encounters while diving, including sea turtle encounters. We also assessed respondent views of the role of divers in marine conservation. We posted a web-based contingent valuation survey over the summer of 2007 on Oceana's—an international non-profit—website. In total, 492 US-based divers completed the survey. Results indicate that three-quarters of divers (n=487) are willing to pay an additional amount beyond normal diving costs to increase their likelihood of diving with sea turtles [as well as with other marine resources] in the wild. The majority of divers (82%, n=490) believe that they play an active role in conservation. While scuba divers make up a small proportion of the overall U.S. population, they enjoy unique and privileged access to marine environments. Our results suggest that the scuba diving industry can provide an economic argument for sea turtle conservation, and that divers and the dive industry can be important allies in conservation efforts.

SEA TURTLES: 3,000 YEARS OF REVERENCE AND CULTURAL SIGNIFICANCE*

Regina Woodrom-Rudrud

University of Hawaii at Manoa, Honolulu, Hawaii, USA

Pacific archeologists suggest that humans first appeared in the Pacific towards the end of the Pleistocene era, about 40,000 years BP, and argue that while the ecological attenuation of islands and their relative isolation renders island ecosystems stable over the long haul prior to human occupation, these same features make island ecosystems vulnerable to rapid environmental alterations after people arrive. Indeed, human colonization of the insular Pacific left concrete and archaeologically detectable evidence of the immediate decimation of easily exploitable species like reef and lagoon species such as sea turtles. Robert Johannes argued that some Pacific Island cultures used these initial impacts to learn that their marine resources were limited and furthermore such societies introduced marine conservation measures such as taboos (tapu, kapu) accordingly to ensure that such mistakes were not repeated. He suggested that a review of relevant literature would show that societies that developed taboos relied on natural resources that were circumscribed and thus easily depleted and theorized that such conditions were most likely to be found in small, non-nomadic societies whose natural resources were circumscribed by geography — such as living on small oceanic islands heavily dependent upon the resources of small water bodies. It is this hypothesis that was examined here. The data that exists on the cultural and traditional ideologies such as folklore, rituals and taboos regarding sea turtles that represent basic aspects of 'cultural and traditional use' – or human turtle interactions in the broader sense - representing the traditional societies of 34 separate Pacific island groups was collected and analyzed in order to determine if there were geographic, linguistic, regional or other patterns. A surprising lack of regional patterns emerged from this analysis revealing instead a pan-Pacific span for such cultural traits. Additionally, information on island type, maximum elevation and land area, as well as special indicators such as isolation index, natural protection index, natural catastrophic threat indicator, number of ecosystems, and species richness was examined. I expected to find that Johannes' theory applied and island groups which had these cultural traits would measure at the wrong end of each continuum and island groups which had not developed such traits would land at the opposite end. In contrast, I found that high islands, large islands, islands with high species richness and high numbers of ecosystems, high natural protection indicators, low isolation indexes and low catastrophic natural disaster indexes had no more and no less extraordinary cultural value placed on sea turtles then those with the opposite environmental conditions. These results do not support Johannes' theory but they are important for conservation and management efforts in the region. Determining the similarities and differences behind human-turtle cultural interactions will help to enhance our understanding of how best to develop culturally effective conservation and management programs.

Video Presentations

SEA TURTLES- OUR OCEAN AMBASSADORS- **IOSEA/ Karen Arthur**

WILD CHRONICLES- MORETON BAY

Karen Arthur/National Geographic

Impacts of toxic *Lyngbya* blooms on green turtle in Moreton Bay, Australia

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RESPUESTA DEL PRESIDENTE

Patricia Baum

A fifth grade class from Todos Santos, B.C.S., receive a response to their letters to the President of Mexico, about their concerns for the leatherback turtle.

FUTUROS BIOLOGOS DE TODOS SANTOS

Patricia Baum

Highlights ASUPMATOMA A.C.'s program in which students age 10- 13 work in conservation efforts along side biologists with the olive ridley turtle and her hatchlings.

FLIPPER FEST '07

Supraja Dharini

Marine biodiversity conservation, Awareness Mela (Mela means festival). This was an outreach program for school and college students involving them in various competitions, such as poetry, photography, painting, junk art model making, quiz, street play on marine bio diversity theme and cultural program on nature theme and various marine documentaries were screened for students and general public.

GROUPO TORTUGUERO COMAAC

Groupo Tortuguero Comaac/ Timothy Dykman

The struggle of a group of young conservationists in the Comaac Nation of Sonora, Mexico to conserve turtles and their cultural and spiritual importance in a community that had traditionally relied on them as a major source of protein in their diet.

MESSAGE DISK

NAILSMA/ Timothy Dykman, Mark Hamann

The efforts of the National Alliance of Indigenous Sea and Land Management (NAILSMA) to protect turtle and dugong across a vast stretch of Northwest Australia to the Torres Strait.

CARPENTERIA GHOST NET PROGRAM

Timothy Dykman, Mark Hamann

Saltwater People from over 20 indigenous communities rid the waters and beaches of the Gulf of Carpentaria, Australia of over 3400 abandoned killer nets that entangle turtles, sharks, dugong and other marine animals.

SEA TURTLE WAYUU TREASURE

Timothy Dykman

Biologists work in one of the poorest areas in Latin America, the Wayuu Peninsula of Venezuela where the sea turtle is most often the only meat available.

TRAILER FOR "11TH HOUR" PLUS TURTLE BITS-Holli Fajack

NEW SURGICAL TECHNIQUES TO REMOVE HOOKS AND FISHING LINES LOCATED IN THE GASTROINTESTINAL TRACT IN SEA TURTLES

Daniela Freggi and Antonio Di Bello

Sea Turtle Recue Center of Lampedusa, WWF, Italy

SONG OF THE OCEANS- **Colin Garland from Global Classroom**

HIGHER GROUND: THE BATTLE TO SAVE FLORIDA’S BEACHES- **David Godfrey**

SEA TURTLE ENRICHMENT DEVICES- **Lucy Guillen, Sea Turtle Inc.**

GREEN BELT RESTORATION IN SRI LANKA

Thushan Kapurusinghe

BBC film on marine turtles of Sri Lanka TBC.

Title not available

Nuno Loureiro

PHOTOVOICES

Ann McBride Norton

Photographs of indigenous people and their landscapes.

Tri National Fisherman Exchange- **Hoyt Peckham**

LOGGERHEADS OF THE PACIFIC: IN WHOSE HANDS- **Hoyt Peckham**

HIGHLIGHTS WORK IN PAPUA NEW GUINEA CONSERVING LEATHERBACKS-

Nick Pilcher

KEEP IT CLEAN

Marc Rice, and Alejandro Horowitz

This video highlights the observations made on a sea turtle cleaning station at Puako, Hawii. Puako, a 5 km stretch of submerged lava platform bordered by coral reef, is situated on the west coast of the Island of Hawaii. The reef platform has a substantial area of turf algae providing forage for juvenile and sub-adult green turtle. We show the various symbiotic cleaning behaviors between Honu and Hawaiian reef fishes at a well-defined cleaning station.

TURTLES IN TROUBLE

Peter Richardson, and Karen Arthur

An environmental education animation.

LAST JOURNEY OF THE LEATHERBACK- **Todd Steiner**

Presented in Spanish, then in English.

A COMPREHENSIVE APPROACH TO SEA TURTLE CONSERVATION AT THE SOUTH CAROLINA AQUARIUM-**Kelly Thorvalson**

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