NOAA Technical Memorandum NMFS-SEFSC-582

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

18 to 22 January 2005
Savannah, Georgia, USA

Compiled by:
Heather Kalb, Alexandra S. Rohde, Kacie Gayheart and Kartik Shanker

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

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U.S. DEPARTMENT OF COMMERCE
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PRESIDENT'S REPORT

The 25th Annual Symposium on Sea Turtle Biology and Conservation, Our Silver Anniversary Symposium. Savannah, Georgia, USA, January 18th-22nd, 2005

Thane Wibbels

ISTS President, University of Alabama at Birmingham, 1300 University Blvd., Birmingham, Alabama, AL 35294-1170, USA (E-mail: twibbels@uab.edu)

With registrants from over 70 nations, a crowd of almost one thousand sea turtle biologists, conservationists, and enthusiasts attended the "Silver Anniversary Sea Turtle Symposium" in Savannah, Georgia. The schedule included an initial two days of regional meetings followed by three days of the main symposium, and a final day that included the Marine Turtle Specialist Group (MTSG) meeting. The venue for the symposium proved to be very functional. The meeting facilities included a Harborside Center that served as the location for the opening social, the poster sessions, and the coffee breaks. Thanks to the efforts of Janet Hochella (the Vendor Chair) and other volunteers, an excellent "Turtle Square" area was set up in the Harborside Center that included kiosks for vendors and many sea turtle organizations. The location of the hotel on River Street in the historic district of Savannah also proved to be very functional since there were numerous restaurants, pubs, shops, and historic landmarks within walking distance.

The main portion of the symposium started on Tuesday evening with the opening socials that drew a capacity crowd. The congregating of this many sea turtle biologists/conservationists generated a synergistic atmosphere for scientific discussions and development of collaborations that exemplify the significance of the annual symposium. The symposium had a full schedule of events and state-of-the-art presentations regarding the biology and conservation of sea turtles including over 125 oral presentations, 260 poster presentations, and a series of workshops regarding education and conservation. Fortunately, with that many presentations, as well as numerous other events, attendees were kept aware of all schedules by an excellent printed program produced by the efforts of Kristy Long and Barbara Schroeder. The Program Chair, David Owens, the Program Committee Coordinator, Kartik Shanker, and the entire Program Committee should be commended for the exhaustive efforts in putting together a great program for the 25th Symposium.

The meeting's theme "A Quarter Century of Advancements that Propel Us into the Future" was highlighted by the first day of invited talks in front of the entire assemblage. The symposium was initiated by a keynote address by John Avise, a world-renowned geneticist whose laboratory has been at the forefront of genetic studies in sea turtles. Dr. Avise provided a world-class presentation that focused on the role of genetics and evolutionary biology in the 21st Century. The first oral presentation session of the symposium (organized by Karen Bjorndal) highlighted this year's theme by focusing on "Insights from Long-Term Research Programs". The session included an international slate of speakers that described the lessons learned from a variety of long-term sea turtle programs conducted throughout the world. The session covered a variety of subjects regarding the biology and conservation of sea turtles, including topics that are currently receiving much interest, such as the effect of longline fisheries on the pelagic stages of some sea turtle populations. The initial afternoon session highlighted the fact that the long-term implementation of effective management strategies can halt downward trends and enhance the recovery of sea turtle populations. The initial talk of the session by Graeme Hays discussed the theoretical dynamics of extinction and recovery in sea turtle populations. The next series of talks provided long-term examples that show "conservation is working", including the history and current status of populations such at the Kemp's ridley, the olive ridley on the Pacific coast of Mexico, and the Atlantic leatherback in St. Croix. The historical trends and current status of nesting of greens and leatherbacks on the Atlantic coast of central Florida were also described. The afternoon session also discussed "populations of concern". In particular, data regarding the Pacific leatherback was presented. Additionally, the nesting trends and current status of loggerhead nesting in central Florida was discussed, as well as the nesting of olive ridleys in India, and leatherbacks in Atlantic Africa. The afternoon session also included an overview of the Marine Turtle Conservation Act, which has the potential of significantly enhancing sea turtle conservation through the funding of international collaborations. Collectively, the first day's sessions included an impressive group of speakers that provided an overview of lessons learned over the past quarter century and highlighted areas of concern and emphasis for the future.

Days two and three of the symposium included a wide variety of oral presentation sessions that addressed a full range of topics including population biology, ecology, behavior, genetics, nesting beaches, pathology and disease, fisheries, management, public education, and social and cultural issues. Special sessions were also held that focused on the sensory biology of sea turtles, and on the design, methods, and analysis of tagging studies. A major goal of this year's symposium was to significantly increase the emphasis on the poster presentations. Poster presentations represent a major avenue for conveying information at scientific meetings, and posters are more appropriate and effective than oral presentations in many situations. To enhance this year's poster sessions, two specific time periods per day, with no conflicting events, were scheduled for the poster sessions. Additionally, the poster sessions were held in the Harborside Center, which proved to be an ideal setting for viewing and discussing posters. Over 260 posters were presented at this year's symposium, which represented a phenomenal amount of information. The overall scientific quality of the posters was impressive.

Throughout the symposium, a series of workshops were held over the noon hour. The WWF sponsored a workshop on longline fisheries, and an "Operation Migration" workshop was presented that discussed the potential use of ultralight aircraft in sea turtle research. On Wednesday evening, a full schedule of sea turtle videos were presented that covered topics ranging from loggerhead lost years to specific conservation techniques for sea turtles. A major benefit of the annual sea turtle symposium is that it provides a forum for regional meeting for sea turtle organizations. Regional meetings were held on Monday and Tuesday prior to start of the main symposium. These regional meetings included RETOMALA Latin American Reunion, WIDECAST, African, Mediterranean, and the IOSEA (Indian and South East Asia). A wide variety of regional and international topics were discussed at these meetings, which will help coordinate current and future sea turtle conservation efforts in these regions.

Due to the generous donations from sponsors and fund raising from last year's auction, the ISTS was able to provide travel grants in the amount of approximately $60,000 to students and specialists from countries throughout the world. Travel grants were awarded to 131 recipients, and these awards were distributed through the various travel chairs to recipients in Latin America, Africa, Asia/Pacific, Europe, the Caribbean, and the USA. The ISTS would particularly like to thank Disney's Animal Kingdom for their continued support of the Disney Fellowships in Sea Turtle Conservation. The Disney Fellowships are an excellent method of acknowledging the contributions of individuals by helping cover their travel expenses to attend the symposium and present their research.

The ISTS would like to acknowledge the generous support of all the donors. Their support ensures the success of the symposium, thus enhancing the communication and education of sea turtle biologists and conservationists world-wide. This year we were again fortunate to have many generous donors. We would particularly like to thank the Western Pacific Fisheries Management Council, NOAA Fisheries Office of Protected Resources, NOAA Fisheries Southeast Fisheries Science Center, Disney's Animal Kingdom, the National Fish and Wildlife Foundation, Florida Power and Light, and an anonymous donor for being major sponsors of the 25th Annual Symposium on Sea Turtle Biology and Conservation. We would also like to acknowledge the generous donations from Turtle Time, Inc. (in Honor of Flo Vetter), Chelonian Research Foundation, Wildlife Computers, Ecological Associates, Grays Reef National Marine Sanctuary, Service Argos, Paul Norman of the Amelia Island Sea Turtle Watch, Inc., Erode Kuppuswami, and SEATURTLE. ORG. Furthermore, we would also like to acknowledge the large number of people who provided individual donations to help sponsor travel grants or rooms for travel grant recipients. Collectively, these donations ensure that the symposium will have an optimal impact on sea turtle conservation.

The 25th Annual Symposium would not have been possible without the tireless support of hundreds of individuals. Heather Kalb, the Volunteer Chair, acknowledged many of these individuals at the banquet and they should all be commended for their dedicated efforts. The tireless efforts of the volunteers are exemplified by people such as Sandy McPherson (the symposium's Registrar), as well as Jaime Peña and Carlos de León (who coordinated all of the audiovisuals and assisted in registration). The ability to efficiently organize such a large international symposium was due to the organizational skills of our Meeting Coordinator, Donna Broadbent, and the ISTS Information Technology Specialist, Michael Coyne. Finally, it has been a great pleasure to help organize the 25th Annual Symposium on Sea Turtle Biology and Conservation. After working with the many volunteers who were instrumental to the success of the symposium, I can truly say that the ISTS represents a large family of enthusiastic and altruistic individuals who are dedicated toward a noble goal, the recovery of sea turtle populations world-wide.

SYMPOSIUM COMMITTEE CHAIRS AND KEY ORGANISERS

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Mediterranean Meeting	Dimitris Margaritoulis
African Meeting	Jacques Fretey
IOSEA Meeting	Douglas Hykle
Marine Turtle Specialist Group	Roderic Mast and Nicolas Pilcher
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Parliamentarian	Frank Paladino

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STUDENTS AWARDS - Archie Carr Student Paper Competition, 25th STS 2005

Lisa Campbell & Jeanette Wyneken- Co-chairs, ISTS Student Awards

A total of 111 student competed in one of 4 categories: Biology Orals, Biology Posters, Conservation Orals, and Conservation Posters. Students are defined as either those currently enrolled in school or have received their degrees within the previous 6 months. For the 2nd consecutive year, we had almost equal entries in the conservation and biology categories.

Student paper/poster entries (by category)

Category	**Orals**	**Posters**	**Total**
Conservation	12	44	56
Biology	20	35	55
Total	32	79	111

Fifteen volunteer judges (both academic and nonacademic professionals) participated this year with 3-5 judges serving each category. All judges were supplied with general guidelines for judging. Each judge ranked the presentations in their category and brought their top candidates in for discussion at the judges meeting.

Judges by Category

Category	**Judges**
Biology Orals	Bill Irwin, Ed Standora, Roldan Valverde, David Rostal
Biology Posters	Blair Witherington, Bill Irwin, Ray Carthy, Michael Coyne
Conservation Orals	Cynthia Lagueux, Kartik Shanker, Jeanette Wyneken
Conservation Posters	Larry Crowder, Anders Rhodin, Ana Barragán, Marydele Donnelly

The committee awarded 4 winners and 4 runners-up. Winners each received $500 and runners up each received $250. In total there were 8 awards amounting to $3000. Both winners and runners-up received a subscription to *Chelonian Conservation and Biology* and were recognized with a certificate.

Award Recipients and presentation titles, 2005.

Category		Presentation Title
Biology Orals	Winner: Louise B. Brooks	From Turtles to the moon: The importance of tides for movements. Home range and marine protected areas.
	Runner-up: Lucy A. Hawkes	Understanding the spatial ecology of one of the most important loggerhead nesting populations in the Atlantic Ocean.
Biology Posters	Winner: Kimberly J. Reich	Diet-tissue discrimination and isotopic turnover of stable carbon and nitrogen in loggerheads.
	Runner-up: Michael P. Jensen	The mating system of the Ostional (Costa Rica) olive ridley rookery studied through microsatellites.
Conservation Orals	Winner: Catherine McClellan	Sea Turtle Interactions with an inshore gill net fishery: a novel approach
	No runner-up was awarded	
Conservation Posters	Winner: Kristine Halager	Assessment of turtle friendly lights: a method and underlying principles.
	Runner-up: Katherine Mansfield	Sea turtle surfacing behavior and aerial census: how seasonal turtle sightability effects juvenile density estimates in Virginia.
	Runner-up: Rodrigo C. Almeida Santos	Involvement of artisanal fishermen in green turtle management for research and conservation in southern Brazil.

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THE INCUBATOR: HOW BEACHES WORK

Ralph A. Ackerman

Iowa State University, Ames, Iowa, USA

Sea turtle eggs are oviposited into large nest chambers excavated deep in marine beaches where the eggs are incubated for 50-70 days. The beach is the egg incubator and provides the thermal, hydric and respiratory environments appropriate for successful embryonic development. How the beach operates as an incubator is not especially well understood and our knowledge of the incubation environment provided by the beach is limited to a relatively sparse phenomenological data set collected from a few beaches, chiefly describing temperature in the nest chamber. Marine beaches are chiefly composed of granular materials such as sand of various origins and size distributions, water and gas and are bounded on one side by liquid water and on the other by the atmospheric boundary layer. The beach exchanges energy, water and gases with the overlying atmospheric boundary layer and thus is strongly influenced both by climate and weather. It is the interaction of beach and boundary layer heat and water exchange and transport of heat and water within the beach that determines the developmental environment of the eggs. I will present a model (Chung and Horton, 1987) which calculates the temperature and water content within the beach as a function of depth and time as well as energy and water exchange at the beach surface. The model allows us to ask a variety of what- if questions which provide testable predictions as well as insight into how beaches work as incubators.

FATTY ACID COMPOSITION IN THE YOLK OF GREEN SEA TURTLES, *CHELONIA MYDAS*

Kathryn S. Craven[1], Joe Parsons[2], Stephen Taylor[3] and David W. Owens[4]

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[2] Cayman Turtle Farm, Ltd., British West Indies
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Egg yolks are packaged by female amniotes for use by their offspring during development and through the immediate post-hatching period. Yolk lipids and their component fatty acids can be traced to dietary sources and are important for normal embryonic growth and survival. Previous studies have shown that in green sea turtles, embryonic death during incubation was a more serious threat to nest success than egg infertility. This study focused on the identification of yolk fatty acids and their implications on the success of green turtle eggs. On average, wild green turtles have better hatch success than captive animals. Eggs were sampled from turtles in captivity and the wild. Food and yolk samples were analyzed using gas-liquid chromatography. Different levels of several fatty acids were found in the yolks. Compared to levels of fatty acids in their respective food sources, green sea turtles packaged lipids in their yolks in proportions different than those found in their diets. Lipid composition of sea turtle diets and the possible consequence on their reproductive success merit further investigation. Egg lipid composition may become an indicator of sea turtle habitat quality.

FIELD ANESTHESIA OF LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*)

Craig A. Harms[1], Scott A. Eckert[2], Stacy A. Kubis[2], Mervyn Campbell[3], David H. Levenson[4] and Michael A. Crognale[5]

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[3] *The University of the West Indies, Faculty of Medical Sciences, School of Veterinary Medicine, St. Augustine, Trinidad and Tobago*
[4] *Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, California, USA*
[5] *University of Nevada, Reno, Nevada, USA*

Nesting leatherback sea turtles on Matura Beach, Trinidad were anesthetized for electroretinogram (ERG) measurements using a combination of ketamine and medetomidine, reversed with atipamezole. Immediately after laying eggs, turtles were weighed using a tripod and pulley system. Ten turtles weighing 242 - 323 kg were anesthetized using initial dosages of 3 - 8 mg/kg ketamine combined with 30 - 80 µg/kg medetomidine and administered IV in the external jugular vein using a 9 cm 18 ga spinal needle that was left in place through the procedure as a rigid catheter. Six turtles received supplemental doses of 2.6 - 3.9 mg/kg ketamine combined with 0 – 39 µg/kg medetomidine. Lower dosages were employed initially to ensure against overdoses and to reduce chances of residual effects following a return to the water, but the degree of immobilization required for successful ERGs required step-wise dose increases to the required level of anesthesia. Respiratory rate, heart rate, electrocardiogram (ECG), cloacal temperature and venous blood gases were monitored and blood was collected for hematology and plasma biochemistries. At the end of the ERG procedure, atipamezole was administered at 150 - 420 µg/kg (5x the dose of medetomidine), 1/2 IM and 1/2 IV. The turtles were monitored and prevented from re-entering the water until normal behavior had returned. Surf entry was judged subjectively. No apparent mortalities or serious anesthetic complications occurred. The observed within-season return nesting rate of anesthetized turtles was comparable to turtles weighed but not anesthetized in the same time span.

FEMALE-BIASED SEX RATIOS OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) NESTING ON TWO GEORGIA BARRIER ISLANDS: NATURAL PIVOTAL TEMPERATURE AND SEX RATIOS

Anne M. LeBlanc[1], David C. Rostal[2], Thane Wibbels[1], Kristina Drake[2], John Robinette[3], Kristina Williams[4], Michael G. Frick[4] and Debra Barnard-Keinath[3]

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[3] *U. S. Fish & Wildlife Service, USA*
[4] *Caretta Research Project, USA*

Temperature-dependent sex determination was studied in loggerhead sea turtles (*Caretta caretta*) nesting on two Georgia barrier islands during the 2000-2003 nesting seasons. Both in situ (n = 60) and relocated (n = 78) nests were studied on Blackbeard Island and Wassaw National Wildlife Refuges. Nest temperatures were monitored to estimate pivotal temperature and to predict hatchling sex ratios. These predicted sex ratios were compared to the histologically determined sex ratios of ten hatchlings sampled from each of ten nests in order to estimate pivotal temperature and transitional range of temperatures. The estimated pivotal temperature based on temperature regimes in natural nests was similar to previously published pivotal temperature for Atlantic loggerheads based on constant incubation temperatures. These data were then used to predict sex ratios produced in other nests to examine seasonal changes in sex ratios. Our results show a seasonal trend in sex ratios: nests laid during the first third of the nesting season (May 1 - June 4) produced the highest percentage of males; whereas, nests laid during the remainder of the season (June 5 - August 10) produced predominantly females. The results indicate that both male and female hatchlings were produced on these Georgia barrier islands, but overall a significant female bias was predicted.

TISSUE VARIATION AND TURNOVER RATE OF C AND N ISOTOPIC SIGNATURE IN THE LOGGERHEAD SEA TURTLE *CARETTA CARETTA*

Mónica Revelles[1], Lluís Cardona[1], Alex Aguilar[1], Gloria Fernandez[2], Manu San Felix[3] and Assumpció Borrell[1]

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Isotope ratio analysis for C and N from tiny tissue samples collected either from alive or dead individuals allow insight into the feeding habits of a given species or population. However, interpretation of analytical results requires accurate information on the fractionation between tissues. This information is not currently available for marine turtles, hence limiting the applicability of the technique to this group of animals. The aim of this study is to fill this gap. Samples of carapace, skin, muscle and blood from loggerhead sea turtles (*Caretta caretta*) were collected in the Balearic Islands (Western Mediterranean). MANOVA revealed significant differences in the isotopic signatures of the considered tissues. Muscle (mean±std; delta 15N=8.9±0.91 0/00 and delta 13C=-18.4±0.2 0/00) was depleted in 13C but enriched in 15N when compared with skin (delta 15N=8.1±1.3 0/00 and delta 13C=-16.9±0.6 0/00), a pattern consistent with the higher turnover rate of the muscle. Blood was more depleted than the former tissues in 15N (delta 15N=7.4±0.6 0/00), as previously reported from other vertebrates and it was also more depleted in 13C (delta 13C=-18.8±0.2 0/00), an unexpected result. Finally, the carapace was also more depleted than the muscle and the skin (delta 15N=6.1±0.8 0/00 and delta 13C=-18.5±0.4 0/00) in both heavy isotopes, although it's isotopic signature was expected to be similar to that of the skin. It is concluded that results from different tissues cannot be combined to investigate diet but, rather, a single tissue should be selected and used as a model. This study was funded by EU-LIFE project 00NAT/E/7303.

REPRODUCTIVE PHYSIOLOGY OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) NESTING ON TWO GEORGIA BARRIER ISLANDS: UNDERSTANDING POPULATION PATTERNS AND FECUNDITY

David Rostal[1], Anne Marie LeBlanc[2], Kristina Drake[1], Michael Frick[3], Kris Williams[3], Debra Barnard-Keinath[4], John Robinette[4] and Valentine Lance[5]

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[3] *Caretta Research Project, USA*
[4] *US Fish and Wildlife Service, USA*
[5] *San Diego State University, USA*

The nesting physiology of the loggerhead sea turtle (*Caretta caretta*) was studied on two Georgia barrier islands from 2000-2003. Nesting activity was monitored from early May until early August on Blackbeard Island and on Wassaw Island. All nesting females observed were measured, double flipper tagged and given a PIT tag in the right flipper. Blood samples were collected from nesting females for hormone analysis each season and the reproductive status of a subset was determined by ultrasound. Nesting chronology based on tag information was correlated with hormone and ultrasound results. Testosterone and estradiol levels showed a gradual decline across the course of the nesting season. Progesterone levels fluctuated as observed in other species. Corticosterone levels increased towards the end of the nesting season. Females nesting in Georgia have been documented to lay up to 6 clutches of eggs during the nesting season. Yearly variations in nesting and movements between barrier islands have made accurate determination of fecundity difficult. Seasonal nesting patterns and fecundity measures will be discussed.

BEHAVIOR AND MOVEMENTS

SEASONAL HABITAT UTILIZATION PATTERNS OF JUVENILE LOGGERHEAD SEA TURTLES COLLECTED NEAR THE CHARLESTON HARBOR ENTRANCE CHANNEL, CHARLESTON, SC USA

Michael D. Arendt[1], Philip P. Maier[1], Al L. Segars[1], Julia I. Byrd[2] and J. David Whitaker[1]

[1] *South Carolina Department of Natural Resources, Marine Resources Division, USA*
[2] *College of Charleston, Masters in Environmental Studies, USA*

Conclusive data regarding the seasonal foraging patterns of juvenile loggerheads, based on intensive telemetry monitoring of individual turtles, is sparse for coastal waters south of Cape Lookout, NC. Consequently, it is difficult to determine whether low tag-recapture rates during a 2000-2003 in-water trawl survey represent high emigration rates out of the area or a dilution of tagged turtles in a sea of unmarked turtles. To help address these issues, six juvenile (57.4 to 65.8 cm SCL min) loggerheads were outfitted with Telonics ST-20, Model A2010 satellite transmitters during summer 2004. Two loggerheads were tagged and released in June and four loggerheads were tagged and released in August. All loggerheads were collected during 15 min trawl tows within the confines of the Charleston Harbor shipping channel. As of the time of this abstract submission, all six loggerheads have remained within the general vicinity of Charleston, SC. Behavioral data from telemetry sensors will also be discussed.

FROM TURTLES TO THE MOON: THE IMPORTANCE OF TIDES FOR MOVEMENTS, HOME RANGE AND MARINE PROTECTED AREAS

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Although it has been recognized that tidally influenced lagoons or bays are important habitats for sea turtles, few studies on turtle movement in foraging areas have considered the effect of tides on movements. The purpose of this study was to test the affects of physical oceanographic features, specifically tidal currents, on green sea turtle movements in a foraging area in Baja California Sur, Mexico. We used GPS-VHF telemetry to track fourteen turtles for 6.3 to 59.5 hours each during July and August, 2003. Over 10,000 location positions were recorded and tracks ranged from 3.4 to 47.8 km in length. Tracks were analyzed to determine mean speed and direction of the turtle for half-hour intervals throughout the duration of the track. At the same time, an Acoustic Doppler Profiler (ADP) measured tidal current direction and magnitude throughout the study area. Analysis of ADP data allowed us to quantitatively predict the tidal speed and direction that a turtle encountered during its movements in the study area. Results indicate that turtle movement is highly influenced by tidal currents with respect to both speed and direction. Diel patterns of turtles in Estero Banderitas are markedly different than those described in non-tidal foraging areas. Similar interactions between turtles and tides probably exist in tidally influenced turtle foraging areas throughout the world. Because many of these areas are established or proposed marine protected areas, an understanding of the how turtles interact with tides can be invaluable in designing biologically accurate and effective sanctuaries.

UNDERSTANDING THE SPATIAL ECOLOGY OF ONE OF THE MOST IMPORTANT LOGGERHEAD NESTING POPULATIONS IN THE ATLANTIC OCEAN

Lucy A. Hawkes[1], Annette C. Broderick[1], Michael S. Coyne[2], Matthew H. Godfrey[3], Pedro Lopez[4], Luis-Felipe Lopez Jurado[4], Nuria Varo Cruz[4] and Brendan J. Godley[1]

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The previously understudied Cape Verde Archipelago, West Africa is thought to host the largest known population of nesting loggerhead turtles in the eastern Atlantic. The population is of such magnitude that it is one of the largest in the Atlantic Ocean and is of global significance. The population is known to be subject to directed and incidental take in the nesting grounds and the foraging grounds are as yet unknown. To help underpin conservation of the population, a project was designed to gain insights into the movements in the internesting habitat, define migratory corridors and highlight potential important foraging habitats. In conjunction with a beach survey project carried out by Project Natura 2000 since 1998, 10 satellite transmitters were deployed on adult turtles in 2004. This included eight post nesting females which were released from the beaches of Boavista and one adult male turtle captured at sea. Turtles demonstrated a high degree of site fidelity during the nesting season before undertaking an exciting range of pelagic movements towards Africa, demonstrating marked diversity in movement patterns influenced by dynamic oceanographic features. We outline how movement patterns are being integrated with geospatial analyses and remote sensing technologies to allow a deeper understanding of the ecology of the species. In addition, one turtle ceased to send messages 4 weeks after deployment and local information and satellite data suggest an illegal terminal interaction with a fishing vessel. The implications for international conservation measures to protect these turtles from Cape Verde are discussed.

MOVEMENTS OF HAWSKBILL TURTLES (*ERETMOCHELYS IMBRICATA*) MONITORED BY SATELLITE TELEMETRY FROM THE CUBAN SHELF

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The movements of 14 hawksbill turtles (*Eretmochelys imbricata*) were tracked via satellite telemetry from three sites from the Cuban shelf. This paper presents the results of these tracking studies.

INTERNESTING DIVING BEHAVIOR OF LEATHERBACK TURTLES IN COSTA RICA

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We examined the diving behavior of 28 leatherback turtles during internesting intervals in Costa Rica. Using Lotek LTD tags, we obtained 12,701 hours of diving data, which translated into 72,090 dives. We analyzed these data by dividing the internesting interval into three phases. The first three days after nesting was considered the beginning phase, while the last three days before the turtle nested again was the end phase. All days in between were considered the middle phase. We also examined diel and nocturnal differences in diving behavior. Dives were significantly deeper and longer during the day than at night in each phase. Surface intervals were significantly longer during the day than at night for the beginning and middle phases, but not the end phase. We recorded 250 post-dive surface events that were in excess of 30 minutes. Of these extended surface intervals, 132 were diurnal and 118 were nocturnal. Dives preceding nocturnal extended surface intervals were much shallower and shorter than dives preceding diurnal extended surface intervals. Seventy-seven percent of nocturnal extended surface intervals occurred during the end phase, whereas 66% of diurnal extended surface intervals occurred in the beginning phase.

We also attached satellite transmitters to and tracked 12 turtles from the nesting beaches during internesting intervals. During the first phase, turtles began to move away from the nesting beach. In the middle phase, most turtles headed north toward or into the Gulf of Papagayo. Four turtles went south, heading towards the Gulf of Nicoya. During the last phase, almost all turtle locations were concentrated right at the nesting beaches for the three days before the turtles nested again.

During the day in the first phase, extended surface intervals may represent leatherbacks swimming for extended periods just under the surface as they move away from the nesting beaches. Satellite data indicates that leatherbacks appear to move quickly away from Las Baulas after nesting, frequently heading north toward the Gulf of Papagayo. The extended surface intervals are punctuated with occasional deep dives, which may be a means of dissipating heat created by the nesting process and/or extended activity near the surface. Leatherbacks then resort to shallow diving during the night. During the middle phase, different diurnal and nocturnal diving patterns may be explained by foraging or, alternatively, thermoregulation. By the end phase, several days before they nest again, almost all turtles have already returned to the nesting beaches. The nocturnal extended surface intervals and shallow diving observed at night during this phase likely represent unsuccessful nesting attempts.

OLD HABITS ARE HARD TO BREAK: NEST PLACEMENT BY THREE SPECIES OF MARINE TURTLES IN NORTHERN PALM BEACH COUNTY, FLORIDA, USA

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The positioning of sea turtle nests on a beaches dune-water axis has important implications for offspring survival. This study examines the nest placement behavior of loggerhead, green and leatherback sea turtles in Juno Beach, Florida, USA, which hosts approximately 1000 nests per mile annually. Multi-year nesting surveys provided distance to water line/dune and subsequent emergence success data for a randomly selected subset of nests, while sub-meter GPS data were collected at all nest sites and at the apex of aborted crawls. Nest positions were correlated to elevation and slope within the framework of a Geographic Information System. Though the proximal cue(s) that trigger nesting behavior remain unknown, patterns of nest placement were observed that suggest a consistent, non-random adaptive strategy that was demonstrated on both pre-existing and artificially-widened beaches within the study area. On the non-widened portions of beach, loggerhead and leatherback turtles clumped their nests near mid-beach, while green turtles clumped nests nearer the dune, corresponding to areas where low survivorship was at its minimum for each species. Though the widened beach seemingly provided additional nesting habitat, the range of distances each species nested from the high water line remained consistent with those observed on the pre-existing beaches; however, green turtles more often crawled to landward sites. The crawl length consistencies across beach types for each species suggest that either the requirements for site choice were met in the seaward portion of the widened beach, or there are preferred species-specific ranges for crawl distance.

CONSERVATION WORKING

RECOVERY STATUS OF THE OLIVE RIDLEY IN MEXICO

F. Alberto Abreu-Grobois

Unidad Academica Mazatlan, Instituto de Ciencias del Mar y Limnologia, Mazatlan, Sinaloa, Mexico

Invited lecture – no abstract available

THE BINATIONAL KEMP'S RIDLEY PROJECT: A HISTORICAL PERSPECTIVE

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Over 60% of the nesting of the Kemp’s ridley sea turtle occurs in a 30 km stretch of beach near the small town of Rancho Nuevo in the municipality of Aldama, Tamaulipas. It is the most endangered species of sea turtle and is considered to be a conservation dependant species.

In 1947 Andres Herrera shot a 16 mm film of an estimated 40,000 turtles coming ashore during a massive nesting aggregation. In 1961 Dr. Henry Hildebrand screened the film at a conference of ichthyologists and herpetologists, once and for all solving the “riddle” of where the Kemp’s ridley came ashore to nest. In 1963, after Mr. Ford Lockett showed the film at a Brownsville Sportsman Club's meeting, Mr. Grover Singer and Dearl Adams began their efforts to save this turtle. This represented the first time this turtle received help from outside of the agencies and non-governmental groups devoted to conservation efforts in its struggle to survive. Ila Loetscher joined this effort in 1965. On April 15, 1966, Mexico established the first sea turtle camp in Barra Calabazas, near Rancho Nuevo. By 1978 the Mexico and US governments agreed that if drastic measures were not undertaken, the Kemp’s ridley was on its way to extinction and that perhaps indeed it was already too late. The binational Mexico/US Project then began, spearheaded by Dr. René Marquez and Dr. Peter Pritchard. In 1981, the US Fish and Wildlife Service asked the Gladys Porter Zoo of Brownsville, Texas to administer the United States' field portion of the joint effort. In charge of the project for the US is Patrick Burchfield, who had been involved with conservation of the Kemp’s ridley since 1973.

Since 1978, there have been over 60k registered nests and almost 4 million hatchlings have been released. These numbers have to be considered very carefully. The project has had success, but we’re still a long way from the species’ recovery. Current population models don’t suggest that the Kemp's population has recovered - in fact, they make it clear that recovery has not been reached and that the projected recovery dates will only hold if conservation efforts continue. The very thing that makes the species ideal for modeling (majority of nesting occurring in a small area) also makes it extremely vulnerable. Future recovery programs for the Kemp’s ridley should not only include the three main nesting areas - Rancho Nuevo, Tepehuajes and Playa Dos - but also consider a year-round residency of adult males and copulating pairs in the waters directly in front of these areas.

Clearly we are going in the right direction but we cannot diminish our present effort if we are to ultimately succeed. Governmental agencies, the fishing industry, the private sector and environmentalists in both Mexico and the United States working together is a big step in the right direction and hopefully this project will serve as a model for other endangered species programs where difficult economic and socioeconomic issues exist.

LONG-TERM RECOVERY EFFORTS PAY OFF FOR LEATHERBACKS ON ST. CROIX, U.S. VIRGIN ISLANDS

Peter Dutton[1], Donna Dutton[2], Rafe Boulon[3], Jeanne Alexander[4] and Milani Chaloupka[5]

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Invited lecture – no abstract available

LONG-TERM PATTERNS IN NEST PRODUCTION AND THE ABUNDANCE OF JUVENILES AT THE ARCHIE CARR AND PELICAN ISLAND NATIONAL WILDLIFE REFUGES AS INDICATORS OF SUCCESS IN MARINE TURTLE CONSERVATION

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Nesting surveys carried out over the past 23 years at what is now the Archie Carr NWR have revealed distinctive patterns and positive trends in nest production by loggerheads, green turtles and leatherbacks. Loggerhead nest numbers have risen from an average of 9,300 in the 1980's to a high of 17,629 in 1998. Green turtles have exhibited a biennial pattern of high and low nesting activity, progressing from fewer than 300 per year in the 1980's to 2,588 in 2002. Leatherback nest production was negligible in the 1980's and early 1990's but rose to 37 in 2003. Establishment of the Carr Refuge in 1990, protecting nesting habitats for these three species, was a significant advance for marine turtle conservation in the United States. Over the same 23 year span catch-per-unit-effort (CPUE) rates have shown a similar rising trend in juvenile green turtle abundance in a portion of the Indian River Lagoon encompassed by the adjacent Pelican Island NWR. Loggerhead CPUE rates were relatively unchanged during this period. These positive trends in the status of two disparate life history stages imply a degree of success for marine turtle conservation in the United States.

EXTINCTION AND RECOVERY OF SEA TURTLE POPULATIONS

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Following historical over exploitation of sea turtle populations, conservation measures are now in place in many areas. The overall impact of these measures is often unknown because there are few long time-series showing trends in population sizes. However, a review of recently published time-series of nesting numbers for both green turtles and leatherback turtles shows surprisingly quick population recovers over the last couple of decades. Importantly, even small populations have been shown to recover rapidly, suggesting that Allee effects do not impede turtle conservation efforts in operation worldwide.

ECOLOGY

FORAGING ECOLOGY OF BLACK SEA TURTLES (*CHELONIA AGASSIZII*) AT THE GORGONA ISLAND NATIONAL PARK IN THE COLOMBIAN PACIFIC

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The Gorgona National Park (2°50' - 3°00'N, 78°10' - 78°15' W) has been identified as a feeding ground for black sea turtles (*Chelonia agassizii*) in the Colombia Pacific (Rueda 1988, Amorocho et al. 1992). Foraging surveys conducted in the Gorgona National Park, shown that captured individuals of different size classes are primarily carnivorous. The preliminary results presented here represent a portion of a comprehensive three-year ongoing study designed to examine the diet, population structure and feeding ecology of black sea turtles in the Colombian Pacific.

Between October 10 2003 and July 2004, sandy bottoms and coral reefs of the Gorgona National Park were assessed for foraging black turtles. Animals were captured manually at night while resting during a two-hour survey-using snorkel, at a depth of approximately six meters. Weight and measurements of curved and straight carapace length were taken, as well as length and width of plastron, head and tail (Bolten 1999). Esophagic lavages were performed in 84 individuals to recover ingested food samples following Limpus & Forbes (1993). Sampled individuals were double tagged with Inconel 1005-681S tags (National Band & Tag Co.). All animals were released within six hours after obtaining stomach contents with a consecutive fluorescent number painted on the carapace. For better comprehension of the dynamics between food sources, their spatio- temporal abundance and turtle distribution, the dietary analysis was done comparing the two habitats within and between seasons, taking into account differences between sexes and individual size classes.

Individuals captured in shallow waters of coral reefs (n=66) and sandy bottoms (n = 18) at the Gorgona National Park showed an alimentary tendency biased towards tunicates and marine invertebrates followed by vegetal material. The 86 individuals captured were classified as immature animals. The straight carapace length of the assessed number ranged from 40 to 73 cm with a mean of 58.4 cm (s.d.= 7.8) and the average weight was 28.80 kg (s.d = 10.32; range: 11.50-50.0). The population of black sea turtles at Gorgona Island is biased towards animal food based on the occurrence of marine tunicates (*Salpa* sp) as the main dietary component. The use of variable food sources (such as terrestrial vegetative matter and tunicates) could be determining the development and productivity of this population. It is necessary to continue evaluating the spatio-temporal availability of the identified food sources and their level of use. The diet shifts from carnivorous to herbivorous of black sea turtles at Gorgona would appear to be governed by relative abundance of food types, the variation in digestive capability among individuals, or population structures between seasons year after year. Further research will focus on the relationship between food selection, nutritional value of the diet components and digestibility.

SPATIAL, TEMPORAL, AND DIETARY OVERLAP OF LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*) AND OCEAN SUNFISHES (FAMILY MOLIDAE)

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Leatherback sea turtles (*Dermochelys coriacea*) and ocean sunfishes (family Molidae) occur in tropical and temperate oceans around the globe. These wide-ranging species share a common diet (jellyfish and gelatinous zooplankton) and have similar distributions. In this study, we examined distributions of leatherbacks and ocean sunfishes along the North American coast from Nova Scotia to Cape Hatteras and in the Gulf of Mexico to determine the extent of spatial and temporal overlap. The data were collected from existing aerial surveys (NOAA Fisheries Service). Leatherbacks and sunfishes were attracted to similar oceanographic regions and features. Spatial and temporal distributions of leatherbacks and sunfishes in the Northeast have nearly identical occurrence patterns, with peak occurrence in summer. On average, leatherbacks and sunfishes were seen within 40 km of each other. In the Gulf of Mexico, the patterns of spatial and temporal distribution indicate that they co-occur in this region but differ in co-occurrence distances and in seasonal densities. Sunfishes were more abundant in winter while leatherbacks were more uniformly distributed across the year. The majority of leatherbacks and sunfishes were sighted within 80 km of each other. Similarities in diet, assessed from gastrointestinal contents of 12 leatherbacks and 2 sunfishes found stranded along the U.S. Atlantic coast, showed similar prey. Nematocysts reveal dietary overlap (all cnidarian classes). Whole prey items found in the specimens include pieces of mesoglea, *Libinia* spp and *Aplidium* spp. Plastic debris was found in 7 leatherback GI tracts, but not in the sunfish. Since these species share similarities in diet, distribution and spatial overlap, there is potential for food resource competition.

Acknowledgments: We thank the NOAA Fisheries Service for supplying aerial survey data and for assisting with spatial analysis. We are grateful to the stranding coordinators and volunteers who provided leatherback and sunfish GI tracts.

USING NET CAPTURES AND COLD STUN STRANDING DATA TO ASSESS POPULATION STRUCTURE, SEASONAL ABUNDANCE, GROWTH AND ACTIVITY LEVELS OF JUVENILE GREEN TURTLES IN THE NORTHEASTERN GULF OF MEXICO

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Little is also known regarding the seasonal abundance of juvenile populations in temperate developmental areas such as those in the Gulf of Mexico. It is likely that the Gulf of Mexico supports a year round population of juvenile sea turtles but further in-water research is needed to fully understand the structure and seasonal abundance of sea turtle populations utilizing near shore habitats during this important developmental stage.

From August 2001 through April 2004, we assessed population structure, residency patterns, activity levels, site fixity, growth and seasonal distribution of sea turtles in the northeastern Gulf of Mexico. Cold stunnings, a phenomenon in temperate and subtropical waters, occurred in the northern Gulf of Mexico in 2001 and 2003, stranding 389 juvenile green turtles. I combined and then compared data from net-captured green turtles vs. stranded green turtles during these cold stunning events to assess seasonal distribution, activity patterns and growth rates. A total of 154 individual turtles were captured 176 times (mean SCL = 40.2 cm, range 26.2-67.4 cm, SE= 0.6). A total of 264.7 net-set hours led to 149 captures at three set netting sites, whereas another 27 captures were made using strike-netting. Mean annual Catch Per Unit Effort was calculated as 4.02 turtles captured/ km net/ hour, with no turtles captured via net during the winter. However, multiple cold stunning episodes indicate that turtles may be present in this habitat throughout the year, most likely altering their activity levels according to temperature conditions.

We examined the short-term effects of decreased water temperatures and repeated cold stunning events on the growth of juvenile green turtles. Of the 154 green turtles captured during this study, 47 were recaptured a total of 51 times with recapture intervals greater than 10 months. Recapture intervals ranged from 311 to 1193 days (mean = 636 days, SD = 187). Mean SCL ranged from 30.9 to 60.8 cm (mean = 41.2 cm, SD = 6.62). Annual growth increments ranged from 1.17 to 8.38 cm/year (mean = 4.53 cm/year, SD = 1.24, N = 47). Although initial trends suggested growth rates decreased with increased number of cold stunning events, the lack of statistically significant results led us to conclude that number of cold stunning events and mean condition index were not good predictors of growth rates and that these factors did not play a key role in determining growth rates for recaptured turtles.

Severe cold stuns require assistance with rehabilitation and releasing turtles into warmer temperatures in which they can survive. However, the effects of this displacement are poorly understood. It is possible that juvenile green turtles overwinter in certain coastal habitats in which they show some degree of site philopatry to and utilize homing tendencies to return to these coastal areas. We documented homing behavior in 39 juvenile green turtles (mean SCL = 41.1 cm, range = 30.9 to 59.0 cm, SD = 1.0) in the northeastern Gulf of Mexico after stranding in the aforementioned cold stunnings. Despite being displaced by a minimum swim distance of 53 km from their original stranding locales, these turtles returned to St. Joseph Bay and were recaptured after 284 to 1193 days at large (mean = 652 days, SD = 29, N = 39. The homing movements documented here indicate small juvenile green turtles use specific foraging habitats and are capable of navigating to specific habitats if artificially displaced. This is the first study to assess population structure, growth, seasonal abundance and activity patterns of juvenile greens in the northeastern Gulf of Mexico using both in-water capture techniques and cold stun stranding data.

ECOLOGICAL IMPACT OF OLIVE RIDLEY NESTING AT OSTIONAL, COSTA RICA

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Relatively little is known about the ecological impact of sea turtle nesting in terms of the nutrient deposits associated with egg-laying. There may be a large net import of nutrients to the nesting beach and local ecosystem and this may take a variety of forms, such as eggshells, decomposition of unhatched eggs, hatchlings or eggs eaten by predators, etc. The contribution from decomposing eggs is likely to be greater on arribada beaches because the high density of turtle nesting often means that egg-laying by one female disturbs a nest previously laid by another. As a first step in analyzing the nutrient imports associated with arribada turtle nesting, we collected samples of beach sand from the main olive ridley arribada beach at Ostional, Costa Rica and analyzed them for ammonia, nitrate and phosphate content. For comparison, another set of samples was collected from a nearby beach at Nosara, selected because it does not receive any turtle nesting activity. Samples were collected at a depth of 40 cm and extracted with purified water, then analyzed with standard test kits on a Hach DR890 colorimeter. Sand pH and temperature were also measured. Analysis of the samples (n=20 for Ostional and n=16 for Nosara) indicates much higher nutrient content at Ostional: ammonia content averaged about 460 times greater, nitrate content about 16 times greater and phosphate content about 139 times greater. Sand temperature at nest depth was also higher at Ostional, averaging 35.4^{o}C versus 31.1^{o}C at Nosara.

MODELING THE EFFECTS OF ENVIRONMENTAL STOCHASTICITY ON THE REMIGRATION INTERVALS OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) NESTING AT PLAYA GRANDE, COSTA RICA

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The relationship between stochasticity in the marine environment and sea turtle ecology is a dynamic not completely understood. Our study examined the sensitivity of nesting Eastern Pacific leatherback turtles (*Dermochelys coriacea*) to environmental stochasticity at their potential foraging areas in the Eastern Tropical Pacific. We accomplished this by using sea surface temperature (SST), as measured by satellite, as an indicator of feeding conditions for leatherbacks nesting at Playa Grande, Las Baulas National Park, Costa Rica. We used 11 years of PIT tagging data to derive nesting remigration intervals for each nesting season up to 2003. We used SST anomalies from the National Oceanic and Atmospheric Administrations Climate Prediction Center comprising of 4 El Niño Southern Oscillation (ENSO) regions along the Equatorial Pacific Ocean. We analyzed mean SST data at various time periods prior to each nesting season as indicators of feeding conditions affecting each season's remigrants. We designed a log likelihood probability model to determine the relationship between the SST anomalies and leatherback remigration probabilities. A likelihood ratio (LR) test determined the significance level of the effect of the SST anomalies on the probabilities of leatherbacks remigrating to Playa Grande.

Leatherback remigration intervals at Playa Grande ranged from 2 to 7 years. After enough time passed to allow the observation of all remigrants, the distribution of 2 to 7 year remigrants was not consistent from 2000 to 2003. When the SST anomalies were incorporated into the model, our estimate of the number of remigrants at Playa Grande from 1995 to 2003 fit the observed data at a significance level of $P \ll 0.0005$ when compared to the model's fit without the anomalies. We found that using the mean SST anomaly from ENSO 4 (150^{o} W to 160^{o} E) prior to each nesting season produced the best remigrant number fit (lambda = 89.81). Cooler SST anomaly values corresponded to higher probabilities of leatherbacks remigrating to Playa Grande. A shift from 1^{o}C to -1^{o}C in the ENSO 4 SST anomaly increased the leatherback remigration probabilities by 5 times. These cooler values of SST are indicative of highly productive La Niña events that follow warmer, less productive El Niño events in the Equatorial Pacific Ocean due to shifts in the depth of the thermocline. These shifts affect the upwelling magnitude of cold, nutrient rich water that may be regulating the biomass and distribution of gelatinous zooplankton, the primary food source for leatherbacks.

Our results suggest that the ENSO 4 SST anomaly is currently the best signal for the feeding conditions of nesting leatherbacks at Playa Grande. This does not imply that the turtles are feeding at the ENSO 4 region; it only suggests that ENSO 4 may be accounting for the lag time between the cooling of SST, the increase in primary productivity and the increase in gelatinous zooplankton at the majority of leatherback foraging areas. These results suggest that the remigration intervals of leatherbacks nesting at Playa Grande are highly dependent upon environmental conditions in the Equatorial Pacific Ocean.

LOGGERHEAD HATCHLING MORTALITY REFINING OUR UNDERSTANDING OF HATCHLING QUALITY AND SURVIVORSHIP

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We examined patterns of mortality within a subsample (n = 10 hatchlings/nests) of loggerhead (*Caretta caretta*) hatchlings from 103 nests deposited on beaches in southeastern and western Florida. Hatchlings were collected at emergence and held in a captive-rearing facility for other studies. Their mortality was tracked within clutches, across clutches, by beach and by subseason (early, middle and late) to identify mortality correlations. We found no significant relationship between mortality and sex, size or beach. There was a significant relationship between mortality and repeated or prolonged tidal inundation and higher than average rainfall. In 2002, rainfall during the early and middle subseason was 40% higher than the average monthly rainfall. This correlates with the higher than average mortality that we observed in the early and middle subseason hatchlings from 2002. During the late subseason of 2003, there were repeated tidal inundation events as a result of hurricane storm surges. Hatchlings from the affected nests experienced mortality that was four times greater than turtles collected from nests that were not inundated (40 % vs. 9%).

We conclude: (1) Wet nests produce hatchlings of lower quality. Therefore, emergence success may not be a true indicator of hatchling survivability. (2) Not every hatchling that makes it to the water is equal in terms of its probability of survival; many from wet nests are unlikely to survive more than a few weeks. (3) Hatchling production estimates (and contributions to the year 1 pelagic stage) must be modified to take into consideration incubation conditions. At sites that are managed to maximum hatchling production, nest conditions should be monitored closely to minimize inundation risk. Unfortunately, there is little one can do about rainfall. Finally, these results suggest that it may be desirable to maximize both hatchling production and quality at rookery sites suffering from nesting declines. That may be achieved by relocating nests in danger of inundation to safer sites.

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CLIMATE AND FISHERIES DELIVER A ONE-TWO PUNCH TO PACIFIC LEATHERBACK TURTLES

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Leatherback turtles, *Dermochelys coriacea*, are critically endangered and their unique physiological and life history traits make quantification of their energetic requirements crucial to conservation of the species. Pacific leatherbacks are generally smaller, have a lower reproductive output and are declining in numbers more precipitously than their Atlantic counterparts, despite similar incidental fishing pressures in the two oceans. However, the causes of these inter-population differences remain undetermined. We combined our measurements of field metabolic rates (FMRs) for adult female leatherbacks and information from the literature to calculate energy costs of reproduction, migration and foraging activities. Our energy budget estimations indicate that differential resource limitation might lengthen remigration intervals for Pacific leatherbacks as compared to Atlantic leatherbacks, thus decreasing the Pacific population's reproductive success and increasing its exposure to risk of pelagic fisheries mortality. Stochastic resource availability related to El Niño-Southern Oscillation (ENSO), combined with energetic constraints, is probably exacerbating the effects of a high incidental fisheries mortality rate currently responsible for plummeting Pacific leatherback populations. Therefore, management strategies for fisheries should be more conservative and allow little, if any, mortality of leatherbacks if there is to be any reasonable hope for recovery of this species.

FISHERIES

IMPROVING TED ACCEPTANCE AMONG COSTA RICAN SHRIMP TRAWL CAPTAINS AND CREWS

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Programa Restauración Tortugas Marinas PRETOMA, Costa Rica

Thanks to the collaborative efforts between the Puntarenas Fishing Chamber and local sea turtle conservation groups since 1995, Costa Rica became the first nation allowed to use a 6-inch deflector bar spacing TED as of July 2000. Unfortunately, in spite of this positive development, many captains still resist using TEDS, a reluctance which triggered an embargo of shrimp exports to the United States from August 2003 to January 2004. To improve TED acceptance, PRETOMA is carrying out a one year program to increase TED acceptance. Georgia shrimp fisherman and inventor of the TED, Sinkey Boone, was hired as a project consultant to foster direct fisherman to fisherman communication. Sinkey carried out several meetings with fishermen and government representatives, observations at sea to study TED performance and held a one day workshop with over 30 fishermen and netmakers, where he provided fishermen with tips to improve TED performance. Of special concern to the Costa Rican fishermen is the recent mandate to use larger escape holes, especially in light of the fact that leatherbacks have never been recorded as shrimp trawl bycatch and loggerheads do not even occur in these waters. During the second phase of the project, technical evaluations are being held regarding the performance of different TED models and modifications, the results of which are presented in this paper.

A STRATEGY TO REDUCE THE MORTALITY OF SEA TURTLES IN THE LONGLINE FISHERY OF THE EASTERN PACIFIC OCEAN

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Bycatch in fisheries is one of the most significant sources of mortality for sea turtles. A strategy, combining a series of activities aiming to reduce this mortality, was put together in order to mitigate these impacts. The introduction of circle hooks (shown by NOAA researchers to result in fewer and more benign hookings) to replace the traditional J hooks is being promoted through the development of a voluntary program of hook exchanges that enables the fishers to test circle hooks under normal fishing conditions. Fishers are given the new hooks at no cost and with a commitment to return their original hooks to them if they were not satisfied with the results. A simple experimental design allows statistical comparisons among hooks types and sizes and observers are aboard many of the vessels that are part of the experiment to record detailed data on the results. In addition, instruments and procedures are introduced, demonstrated and provided when possible, to increase the chances of survival of hooked or entangled turtles. The problems, proposed solutions and results obtained are discussed with the fishers at frequent workshops. This program began in September 2003 in Ecuador and more recently similar programs have begun in Peru, Colombia, Panama and Guatemala. Results of the experiments and the information acquired will be discussed. More than 90 vessels are testing circle hooks in Ecuador and the results have been satisfactory in that the mortality of sea turtles has been reduced without reducing the catches of the target species.

THE END GAME IS DIFFUSION: ADOPTION OF TURTLE EXCLUDER DEVICES AND THE DIFFUSION PROCESS

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To solve problems such as bycatch, policy-makers resort to conservation technologies (i.e. a management method that uses a device for the primary purpose of conserving organisms or habitat). Unfortunately, there have been historical problems with widespread, long-term and proper use of conservation technologies. In order to better understand the adoption process for conservation technologies and what influences the success of the process, I studied the adoption of TEDs by the U.S. shrimp fishery. I conducted 36 on-site interviews with key informants selected with purposive and snowball sampling of representatives from the National Marine Fisheries Service (NMFS), state governments, Sea Grant (which is the program charged with marine extension, industry and conservation groups). In addition, I analyzed nearly 300 documents from NMFS, Sea Grant, NGOs and state governments using grounded theory. This technique allowed me to identify categories and concepts that emerge from the text and to link these concepts to existing theories and models, specifically diffusion theory and technology transfer.

In the TED case, there were two methods of extension i.e. means of promoting adoption. The first was technology transfer (which is the movement of know-how), technical knowledge, or technology from one organizational setting to another. The second was legislation and enforcement. I propose the use of a third model, diffusion, which is the movement of an innovation among individual members of a social system.

The case history reveals three distinct periods of extension. From 1981 to 85 was a federally sponsored voluntary use program that promoted the NMFS TED using technology transfer. Industry overwhelming viewed this TED as impractical, so adoption was low. From 1986 to 88 some state governments instituted either technology transfer efforts or laws requiring TED use. Also, shrimpers developed several TEDs that other shrimpers found acceptable and thus there was a slight increase in adoption. From 1989 to1998, the final year of this study, the federal government required mandatory TED use and during that time there was a gradual increase to high levels of adoption, resulting from manipulation of the

Adoption Equation:
BENEFITS OF COMPLIANCE = COSTS OF COMPLIANCE
OR
BENEFITS OF NONCOMPLIANCE = COSTS OF NONCOMPLIANCE

By increasing enforcement, managers increased the costs of non-compliance and swayed the equation in favor of compliance. Enforcement is a powerful tool but it has limitations. Even with the possibility of stiff penalties and in the face of increased enforcement patrols some shrimpers continued not to comply by not adopting TEDs or disabling them.

From this study, I concluded that (1) both Sea Grant and NMFS used technology transfer methods that promoted TED awareness but not wide-spread adoption, (2) some policy-makers and managers erroneously believed that a mandate negates the need for individual adoption decisions, (3) enforcement is not a substitute for nor can it assure true adoption, (4) the ideal extension equation is: COMMERCIAL PRACTICAL TECHNOLOGY + PERSUASIVE EFFORTS + ENFORCEMENT = ADOPTION and (5) diffusion theory would be a more appropriate model to realize the ideal adoption equation.

SEA TURTLE INTERACTIONS WITH AN INSHORE GILL NET FISHERY: A NOVEL APPROACH

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Juvenile sea turtles of several species forage in the sounds of North Carolina, USA during the summer. These estuarine systems are also an important nursery habitat for a variety of commercially valuable marine fishes, including southern flounder. In the fall large juvenile flounder are taken by a variety of fisheries, including bottom-set gill nets, as the fish migrate out of the sounds into the ocean. Sea turtles residing in the area also encounter these gears and turtle by-catch in gill nets has become a serious management issue in North Carolina. We used a novel approach to look at the interactions of sea turtles with flounder gill net fisheries in Pamlico Sound, North Carolina by addressing the issue from the perspective of the turtles. We tracked 45 sea turtles with satellite telemetry and examined their patterns of habitat use with respect to the distribution of gill nets. In addition, we used a predator/prey model to quantify the degree of spatial overlap between turtles and nets. Satellite tagged turtles were present in the Sound from September through December during the entire fishery season. Turtles present in the flounder fishing grounds spent most of their time in the deepwater section, which has been seasonally closed to large-mesh gill net fishing by the National Marine Fisheries Service since 1999. Patterns of habitat use could be used to refine or modify the boundaries of such area closures. Our results suggest that satellite telemetry is as an excellent tool for evaluating spatially explicit fisheries management measures.

BYCATCH OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) BY URUGUAYAN FISHERIES IN THE SOUTH ATLANTIC OCEAN

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Fisheries are an important sampling and data collecting tool for sea turtle research and conservation, but at the same time its bycatch represents a major threat for sea turtles, whose worldwide magnitude is still unknown. This work presents an overview of the reported incidental captures of leatherback turtles by Uruguayan industrial and artisanal fisheries, synthesizing data obtained from different sources. The PNOFA/DINARA (National Program of Onboard Observers of the Tuna Fleet/National Direction of Aquatic Resources) provided us information accounting for a total of 450 sets in which 647,722 hooks were deployed, from 1998 to January 2004. Seventy-two *D. coriacea* were incidentally captured during these sets, which occurred in the Uruguayan EEZ as well as in international waters of the South Atlantic Ocean. For the coastal bottom trawl fishery, the PROMACODA/ Karumbé (Onboard Tagging and Data Collection Program) has recorded 5 incidental captures of *D. coriacea* during 2 years of monitoring on fishing vessels that operated in the Uruguayan continental shelf, generally in the Rio de la Plata estuary. Since July 2002, Karumbé has documented 6 reports of *D. coriacea* individuals incidentally captured by artisanal fisheries, closer than 10 nautical miles from the Atlantic and estuarine coast of Uruguay. The monitoring has not been continuous in the trawl and artisanal fisheries and just a small part of the total fishing effort of these fleets has been observed. This analysis gives new information on leatherback occurrences in the South Atlantic Ocean and shows that adult and subadult leatherback turtles are incidentally captured year-round by Uruguayan fisheries. Most of the incidental captures recorded in the longline fishery occurred over the continental slope and 95% of the individuals were discarded alive but we have no estimation of post release mortality. We conclude that further monitoring of these fisheries is needed to better understand the quantity and spatio-temporal distribution of the leatherback turtle bycatch events produced by the Uruguayan fisheries in the South Atlantic Ocean. We suggest as a priority to test the efficacy and feasibility of implementing bycatch and mortality mitigation measures.

MITIGATION MEASURES TO REDUCE SEA TURTLE INTERACTIONS WITH LONGLINE FISHING GEAR: FROM THE LAB TO THE OCEAN

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This presentation focuses on the research aimed to reduce the interactions of sea turtles with longline fishing gear. The talk focuses on information gained from studies on the sensory mechanisms turtles use that attract them to fishing gear and the application of these findings to field trials on commercial longline fishing vessels. Research was conducted by a host of sensory biologists working together to define the most promising means to reduce turtles' attraction to fishing gear while maintaining high catch rates of targeted fish species.

In sum, experiments on the visual capabilities in sea turtles and pelagic fish found that while tuna and swordfish are similarly limited in their vision (having only one visual pigment), green turtles and marlin have 3 visual pigments and can see across the visible spectrum, well into the red. Given this greater color sensitivity in turtles, a visual repellent would have to incorporate more than just color, such as differences in the speed of vision between fish and turtles that was identified. Turtles' chemosensory capabilities were confirmed based on olfaction studies of loggerhead turtles in Galveston, Texas. Collaborators from Projecto TAMAR in Brazil set up floating pens to house turtles that have been brought in after their capture from fishing gear. In addition to monitoring their long-term health post-interaction, they have also been able to test turtles' feeding responses to foods marinated in various chemicals with the aim of identifying repellent compounds. No repellent compounds have been identified to date.

Field trials were conducted on commercial vessels in Costa Rica and Brazil to test the potential use of blue dyed bait and large circle hooks to reduce sea turtle bycatch. Blue dyed bait was not effective at reducing sea turtle bycatch in a shallow-set, daytime mahi-mahi fishery. Large (18/0) circle hooks have shown preliminary promise at reducing sea turtle bycatch in a swordfish fishery off Brazil. International collaborations are critical to the success of these efforts.

GENETICS

POPULATION GENETIC STRUCTURE OF GREEN TURTLE FORAGING LOCATIONS IN THE ATLANTIC WITH EMPHASIS ON A NORTH CAROLINA FORAGING AGGREGATION

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A significant gap in the understanding of the life history of green turtles (*Chelonia mydas*) is migratory behavior during the juvenile years. The Core and Pamlico-Albemarle Sounds of North Carolina support significant numbers of early and late juvenile green turtles. The animals comprising the North Carolina foraging aggregation primarily originate from the east coast of Florida and Mexico with the remainder coming from Costa Rica, Ascension Island and Guinea Bissau and finally Aves Island and Surinam. We detected trends regarding population genetic structure among both nesting and foraging locations in the Atlantic. We suggest that currents are the primary determinants of the composition of the foraging ground aggregation as those foraging aggregations located near areas where multiple currents converge exhibit high diversity both genetically and compositionally. We also suggest that green turtles may be natally homing to foraging grounds, but on a larger scale than that of loggerhead turtles (*Caretta caretta*).

PATERNITY STUDIES ON SEA TURTLES: OLD QUESTIONS, NEW INFORMATION REQUIRED

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Over the last ten years, we have seen an increase in the amount of information about the frequency of multiple paternity in sea turtles. Paternity studies are done in a few populations of sea turtles showing a wide variation on the multiple paternity frequency (ranging from 0 to 75%), which cannot be explained plainly by taxonomic issues. The meaning and value of this cross species variation must be explained in order to attain the correct explanation about this intriguing topic of biology which has relevance for the conservation of sea turtles. In this study I have shown fitness implications of the multiple paternity variations found over sea turtle species and have explained all the different scenarios observed, based on the available information. In order to get more robust explanations, I suggest using some of the information that has been used marginally or not at all on previous paternity studies on sea turtles.

SPATIO-TEMPORAL STRUCTURE IN A GREEN TURTLE FEEDING GROUND IN THE GULF OF GUINEA: SEARCHING FOR GENETIC EVIDENCE

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The Bay of Corisco, on the border between Equatorial Guinea and Gabon, hosts one of the most important green turtle foraging populations along the Atlantic coast of Africa. Genetic samples and biometric data have been collected from these individuals between August 1998 and November 2003. A total of 305 samples were analyzed, amplifying a fragment of the mitochondrial DNA control region and 9 microsatellite loci. We compared results from mitochondrial DNA mixed stock analysis and Fst pairwise comparisons and factorial correspondence analysis based on microsatellite genotypes. It has been suggested that feeding ground composition may vary seasonally, with the presence of different stocks originating from different locations at different times of year and that different subgroups (such as stocks or cohorts) may also be subdivided within a feeding population. Although pooling across years, sexes and stage classes may enhance the accuracy of mixed stock analysis, we determined whether significant genetic differentiation occurs between subsets of the Corisco Bay samples. We found that individuals can be clearly distinguished by rookery of origin and that genetic differentiation could be detected between males and females and between the turtles sampled in 2003 versus previous seasons. We also showed that genetic analysis can be a valuable tool to describe the illegal trade and commercialization of turtles, allowing us to track individuals from their capture site to the marketplace. Hunting green turtles is a way of life for the local Benga tribe and as many as 300-500 individuals are captured every year in Corisco Bay for sale in nearby urban centers. Additional threats in the area include oil exploitation and development. We have shown the importance of this green turtle feeding population on national, regional and global scales. Ultimately, we hope this research will contribute to the development of more effective conservation and management strategies for the Corisco Bay feeding population.

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PRELIMINARY FINDINGS ON LOGGERHEAD AND GREEN TURTLE POPULATION GENETIC STRUCTURE IN THE SULTANATE OF OMAN

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To investigate the population genetic composition of an Indian Ocean loggerhead and green turtle rookery, we examined mtDNA control region haplotypes of 100 loggerhead and 44 green turtle samples from the Sultanate of Oman. The goals of this research were to 1) investigate the relationship between Indian, Atlantic and Pacific Ocean rookeries, 2) document the genetic diversity in Oman's rookeries and 3) infer historical demographic patterns for both rookeries. Our results demonstrate extremely shallow mtDNA diversity in loggerheads nesting on Masirah Island, Oman. Plots of pairwise haplotype mismatch distributions indicate constant growth from a recent (<1mya) colonization/ bottleneck event. Additionally, mtDNA haplotypes found on Masirah Island suggest close affinity with Northern Atlantic (including Florida) rookeries and developmental habitats. Preliminary analyses suggest the possibility that loggerheads hatched in Indian Ocean rookeries may spend some portion of their developmental period in the North Atlantic Gyre. Initial data for green turtles sampled on nesting beaches in Ras al Hadd and Ras al Ginz, Oman suggest the potential for genetically distinct subpopulations to be isolated temporally based on the seasonal reversal of the Indian Ocean Somali Current. Two mtDNA control region haplotypes characterize the majority of individuals sampled and one of these is closely related to those described by Dutton et al. (unpublished) in the central and eastern Pacific. Contrary to our findings for loggerheads, these data suggest that green turtle rookeries in Oman have persisted without major population contraction for a significantly long period of time (>4 my).

INTERSPECIFIC COMPARISON OF CUBAN SEA TURTLES ROOKERIES, BASED ON THE STUDY OF A mtDNA MARKER

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Taking into account the significant contribution of each rookery to sea turtle metapopulation genetic background, there is growing interest to determine the identity of green turtle, hawksbill and loggerhead Cuban rookeries. For this reason, we intended to characterize and compare them with the rest of the studied rookeries that shared at least one haplotype, in terms of phylogenetic relationships, diversity indexes and population structure, as inferred from two partial sequences of mtDNA control region. Previous studies have rendered similar information for each partial sequence, suggesting the existence of a hot region for haplotype definition in the three species. In Cuban rookeries, haplotypes of a single lineage are present, thus determining low nucleotide diversity, except in loggerheads, where haplotypes of non-related lineages concurs. Loggerhead and green turtle Cuban rookeries showed high haplotype diversity, while in hawksbill it is low. Green turtles are the most philopatric, with 100% endemic haplotypes originated in less time than the distance among Cuban rookeries and the rest. Hawksbills followed with 50% and then loggerheads with a scarce 20%. Besides, in the latter two species, the origin of haplotypes is older than the distance among Cuban rookeries and the rest. The structuring among Cuban rookeries and the rest is maximal in green turtles, while in some hawksbill and loggerhead rookeries structuring is lost.

AND WHAT ABOUT THE MALES? MIGRATORY BEHAVIOR OF MALE HAWKSBILLS IN THE CARIBBEAN AS SEEN THROUGH GENETIC MARKERS

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Although we have gained considerable knowledge on the population biology and ecology of female and sub-adult hawksbills, we have only a cursory understanding of male migratory and reproductive behavior. We analyzed the extent of male fidelity to natal regions by comparing mtDNA sequences in 740bp fragments of the control region from

breeding males (n=38), juveniles (n=52) and nesting females (n=48) which were obtained during the 2003-04 nesting season in Mona Island, Puerto Rico (PR). Differing haplotype composition between the males and nesting females (chi-squared = 19.8006; p=0.0035) and greater proportion of non-PR haplotypes in the males (including possible Cuban, Mexican, Barbados and Antigua origins) strongly suggested a strong philopatry in males, almost comparable with that exhibited by females. A closer scrutiny through mixed stock analyses of the male sample estimated about 85% contribution by the PR rookery which, when compared with about 30% in PR juvenile foraging aggregation, suggests that males either gradually recruit to the vicinity of the mating sites and remain resident until sexually mature or preferentially migrate to the vicinity of natal grounds as mature animals for reproduction and then leave. Aware that current genetic information alone is not capable of identifying which behavior is accurate, we present this information combined with results from mark-recapture information and satellite telemetry showing that the complexity in the rookery source composition for breeding males in PR has important regional implications for hawksbill conservation-threats to both national and international populations and will be impacting the continued reproductive viability of the PR populations.

LICENSE PLATE RESULTS

FLORIDAS SEA TURTLE LICENSE PLATE MAKES GOOD ON ITS PROMISE TO "HELP SEA TURTLES SURVIVE" BY FUNDING THE SEA TURTLE GRANTS PROGRAM

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In 1995, the non-profit Caribbean Conservation Corporation (CCC), working with many other Florida sea turtle groups, initiated a statewide effort to establish the Florida Sea Turtle Specialty License Plate. In 1997 the Florida Legislature unanimously authorized the creation of the turtle tag. CCCs intent in pushing for the tag was to provide a permanent funding source for the states Marine Turtle Protection Program (MTPP), which is now part of the Florida Fish and Wildlife Conservation Commission and to establish a source of grant funds to support sea turtle projects in Florida.

There are over eighty specialty tags available for purchase in Florida. The sea turtle tag currently is the sixth most popular seller. Annual sales and tag renewals generate approximately $1.3 million each year. Seventy percent of the funding goes to Florida's MTPP. Thirty percent of the revenue goes to the Sea Turtle Grants Program, which is administered by the Caribbean Conservation Corporation. Grants are awarded each year on a competitive basis to eligible entities working in Florida. Funding must be used to support research, education or conservation projects that directly benefit Florida sea turtles. Eligible applicants include Florida coastal governments, Florida-based non-profit groups and research and educational institutions. Available funding has ranged from $200,000 to $260,000 per year since the program was launched in 2001. Grant application guidelines, reports from grant recipients and other information related to the Sea Turtle Grants Program are available by contacting CCC or by visiting the following website: www.helpingseaturtles.org.

ESSENTIAL HABITAT FOR KEMP'S RIDLEY TURTLES IN WESTERN FLORIDA

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Determining the habitat requirements of the Kemp's ridley turtle has been identified as a priority task in the conservation plans for this endangered species. A number of researchers have inferred habitat preferences, but only one study has quantified the use of benthic habitats by Kemp's ridley turtles. Estimates of habitat use and availability must be calculated to test for habitat preferences and these analyses can then be used to identify essential habitats. Telemetric monitoring and geographic information system (GIS) mapping were employed to investigate the habitat preferences of Kemp's ridley turtles in the Ten Thousand Islands of southwest Florida. The movements of turtles were monitored via radio and sonic telemetry and the locational data were used to identify their habitat use. Substrates were characterized and floral/faunal were classified from benthic samples collected within the area occupied by the turtles. A GIS database of benthic habitats was used to map the bottom types within the study area and to subsequently quantify habitat availability and use. Habitat preferences were tested by comparing the proportion of habitat used by turtles relative to the availability of habitats. Kemp's ridley turtles in the Ten Thousand Islands exhibited a preference for areas of shell-encrusted worm tubes and the associated sessile invertebrates. A similar affinity to live-bottom areas was reported in the Cedar Keys of west-central Florida, though limerock outcroppings provided the hard-bottom substrate. A pattern is emerging in western Florida that live-bottom areas are an essential developmental habitat for Kemp's ridley turtles.

FOUR YEARS IN THE DARK: WHAT WEVE LEARNED ABOUT FLORIDA LEATHERBACKS

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Important leatherback nesting beaches in the western Atlantic are found in South America and throughout the Caribbean. Although leatherback nests have been recorded on Florida beaches since 1947, recently the population has experienced rapid growth. We estimate the increase in nests to be 17.2% per year. In 2001 we began a mark recapture study to estimate the size of the population and to identify individuals. This project addresses several Federal Recovery Plan objectives.

Leatherbacks nest along the coast of Florida, but concentrate their efforts along 200 km of the east coast (Hutchinson Island to Juno Beach). We mark and identify each female using 1 PIT tag and 2 flipper tags. We take standard morphometrics and genetic samples. In addition, we draw blood for contaminant analysis and health assessment and we identify injuries. Using ATVs, we patrol 20 km of beach once every hour, 9 pm to 6 am, every night from March 15 June 20. This ensures that we see every single nesting female during this time period.

In four seasons in the dark, we have discovered many interesting things. First, the population number used by NMFS for the 2001 stock assessment was 100 individuals and we have already identified over 135 females on just 20 km of beach. However, as we see individuals only once or twice per season and have recorded recaptures from as far away as Melbourne, it is likely that Florida leatherbacks are not nesting-site specific. We have also documented a high rate of injury on Florida leatherbacks. Nearly 30% of nesting females have injuries consistent with human interaction.

In 2004 we began a satellite tracking program and found that one of our nesting females, Beatrice, spent 7 of 8 months swimming within the EEZ of the United States, predominantly in coastal mid-latitude waters. This, combined with data from other Florida leatherback tracks, illustrates the importance of coastal waters to these turtles.

Since our first season, we have managed a website (www.floridaleatherbacks.com) where we post our results. This is a fantastic way to get the public involved with our work and virtually take them on the beach with us. We also write a daily research BLOG (web log), during nesting season that hundreds of people now read during nesting season.

The Florida Sea Turtle Grants Program has generously provided funding for the Leatherback Project for 2 of our 4 seasons. We owe great thanks to the FSTGP and to all the drivers who renew their plates annually. We are also grateful for funding support from the National Save the Sea Turtle Foundation.

For more information and results, please visit the website or contact the authors.

A PRELIMINARY ASSESSMENT OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN PALM BEACH COUNTY WATERS, FLORIDA, USA

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This study represents the first effort to survey Palm Beach County coral reefs (Florida, USA) for hawksbill turtles (*Eretmochelys imbricata*) by incorporating both traditional tagging techniques (inconel and PIT) and carapacial numbering. Individual turtles have been hand-captured at depth using SCUBA, retained on a vessel for the collection of morphometric data, tagging, numbering, photographing and tissue sampling for DNA analysis. A reference library of local hawksbill photographs has been developed to document newly tagged individuals and the effectiveness of photographic identification is being assessed. Divers aboard local dive charters report sightings when tagged turtles are encountered. To date, 24 hawksbills have been captured in 20 dive days (average 1 dive day/week), representing 21.1 hours on SCUBA. Only one encountered turtle escaped capture, indicating the approachability of these turtles underwater. Turtles ranging from 41.8 - 82.3 cm (mean 59.5) straight carapace length have been captured at depths ranging from 13.4 - 22.5 m (mean 18.2). Due to logistical considerations, no turtles have been painted to date. Re-sightings have been confirmed for 7 tagged turtles, with a maximum of 5 sightings of one individual over a 116 day period. Preliminary data indicate strong site-fidelity and close association with both natural and artificial coral reef structures. Untagged turtles are still reported regularly within the survey area. Work in the near future will include blood sampling to allow for gender determination (presently under review for permitting) and mapping of capture/sighting location data.

LONG-TERM RESEARCH INSIGHTS

KEYNOTE ADDRESS: THE 21ST CENTURY, GOOD AND BAD TIMES FOR EVOLUTIONARY BIOLOGY AND CONSERVATION

John Avise

University of Georgia, Athens, Georgia, USA

Keynote Address – no abstract available

BIOLOGY OF IMMATURE GREEN TURTLES ON NERITIC FORAGING GROUNDS: INSIGHTS FROM A 30-YEAR STUDY IN THE SOUTHERN BAHAMAS

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Union Creek Marine Reserve on the north coast of Great Inagua is in a national park of the Bahamas National Trust. Union Creek is a foraging area for immature green turtles and hawksbills and is one of the few places in the Bahamas where green turtles have been protected from human exploitation over the past three decades. From mtDNA sequence analyses,

we know that the green turtle foraging aggregation represents a mixed stock with source rookeries throughout the Atlantic. Based on a combination of flipper tag returns and satellite telemetry, we know that when green turtles leave Union Creek, they move throughout the Greater Caribbean. Recapture records of individual green turtles in Union Creek, spanning up to 15 years, have allowed estimation of survival and emigration probabilities, as well as estimation of abundance and population trends. I will emphasize results from our study that are only possible from a long-term study including individual-based growth models, density-dependent effects, temporal variation in source rookeries and population trends. In particular, I will discuss the complexities of evaluating regional trends in abundance of immature sea turtles revealed during a recent analysis integrating trend data from Union Creek with trend data for green turtles nesting at Tortuguero, the primary source rookery for Union Creek green turtles.

BIOLOGY OF OCEANIC-JUVENILE STAGE ATLANTIC LOGGERHEADS: RESULTS FROM TWENTY YEARS OF RESEARCH ON THE HIGH SEAS

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The “lost year mystery” began to unravel 20 years ago for Atlantic loggerheads. I reviewed the history and successes of the University of Florida – University of the Azores collaboration on the biology of the oceanic-juvenile stage of Atlantic loggerheads. Results are presented from analyses of population genetics, growth rates, duration of the oceanic stage, survival probability estimates and diving behavior and movements from satellite telemetry. Longitudinal growth analyses based on skeletochronology are reviewed. Trophic analyses using stable isotopes are also discussed. Longline bycatch is the most significant threat to this life stage and results from experiments to reduce bycatch are presented. Future research directions that focus on gaps in our knowledge of this life stage are presented, including the role of oceanic-juvenile loggerheads in the oceanic ecosystem and development of survey methods to monitor population abundance and trends.

MODELLING THE BEHAVIOUR OF GREEN SEA TURTLE POPULATION DYNAMICS IN THE HAWAIIAN ARCHIPELAGO USING LONG-TERM STUDIES

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Long-term studies are essential for developing an understanding of the ecological processes affecting the demography of long-lived marine species such as sea turtles. We present results of a long-term (32 yr) study of Hawaiian green turtles. We used a 25 yr capture-mark-recapture program to derive temporal and spatial estimates of somatic growth and we evaluated the effect of the tumour-forming disease, fibropapillomatosis, on growth. To evaluate disease effect, we used Bayesian regression modelling that accounts for random effects due to individual heterogeneity and correlated growth measurements. The disease effect on somatic growth was limited to large immature turtles with advanced fibropapillomatosis. Moreover, disease severity has slowed since the mid-1990s and may be declining. We used a long-term (22 yr) study of green turtle strandings in the Hawaiian Archipelago to explore the temporal and spatial dynamics of the disease. Fibropapillomatosis is the most common cause of stranding in the Archipelago but boat strike and shark attack are more likely to result in a dead turtle stranding. The probability of a fibropapilloma-related stranding is higher around Maui and O’ahu but has declined since the mid-1990s. We used another long-term (32 yr) study of nesting Hawaiian green turtles to show that despite exposure to many hazards, this stock has increased significantly in abundance since the 1980s. These long-term studies provide sound evidence that the once depleted Hawaiian green turtle stock is recovering following protection from nesting habitat destruction and harvesting.

LONG TERM RESEARCH OF LOGGERHEAD NESTING NUMBERS IN JAPAN

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In Japan, beaches used by the loggerhead turtle for nesting can be found from the Ryukyu Archipelago to the middle of the Pacific coast of Honshu. In 2003, the Sea Turtle Association of Japan personally examined 258 such beaches where nesting or emergence occurred. The most concentrated region for nesting was the southern part of Kyushu, including Yakushima and Tanegashima Island. Seventy-three percent of the total nests examined in 2003 were found on beaches in Kagoshima and Miyazaki Prefectures, which are also in the southern part of Kyushu. Shizuoka Prefecture, located in the middle of Honshu, also had beaches where a relatively large number of loggerhead turtles nested. There are some beaches in Japan where volunteers have been conducting research for many years. In 1950 and again in 1954 at Hiwasa and Kamouda beach, two beaches located on the east coast of Shikoku, the junior high school and elementary school started a diary counting the number of turtle tracks on the beaches left after emergence. When the local schools stopped keeping a diary, the town and city offices continued recording up to the present day. Counting of emergences and nestings also started on the beaches of Kuroshima Island, Miyazaki and Omaezaki in the 1970s and in the 1980s on Nagata beach on Yakushima Island and Minabe on the Kii Peninsula.

SOUTH PACIFIC *CARETTA*: GUIDING CONSERVATION THROUGH INTEGRATED NESTING AND FORAGING STUDIES

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Spatial and temporal insights have developed from research on the *Caretta* population in the South Pacific at multiple index nesting beaches in south Queensland, Australia since 1968 and in coastal foraging areas since 1974. Emphasis has been on tagging census and associated intra- and inter-seasonal recaptures and embryology, temperature dependent sex determination, growth, migration and dispersal, diet, population genetics and population dynamics studies. Immature *Caretta* are tracked from recruitment from oceanic waters through 13 yr of growth to their first breeding migrations. First breeding occurs at about 30 yr. On average, females at first breeding are smaller, lay fewer and smaller clutches and have longer remigration intervals than in later breeding seasons over the next 20-30 yr. Breeding populations have declined by 86% since the 1970s, mostly from the result of fisheries bycatch. Fox predation of eggs was intense at the beaches that incubate most of the female hatchlings from the late 1970s to mid 1980s. The impact of this egg mortality is expected to be seen as reduced recruitment to the currently depleted adult population within the next few years. With TEDs now operational in the trawl fisheries since 2000, this mortality factor should be largely eliminated. Fox baiting programs have reduced egg loss to foxes to a trivial level since the late 1980s. Hatchling production at Mon Repos, a female producing beach, has been substantially enhanced by rescuing doomed eggs since ~1990. Monitoring the impact of TEDs, fox control management and hatchling enhancement on eastern Australian *Caretta* population dynamics is ongoing.

LINKING LOCAL COMMUNITIES AND LONG-TERM RESEARCH INITIATIVES

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Without the participation of local communities, many sea turtle conservation programs would probably fail. This is the foundation principle for the establishment of the Brazilian national sea turtle conservation initiative known as Projeto TAMAR, which was established in 1980. TAMAR now has 21 permanent field stations set up near the major sea turtle nesting areas along more than 1000 km of the Brazilian mainland coast. A comprehensive long-term research program operates from these and includes routine collection of information on nesting and hatching success. The research program also includes capture-mark-recapture efforts in the foraging grounds for some locations such as the Archipelago of Fernando de Noronha. These foraging ground studies are providing important demographic information on the status of the Brazilian sea turtles stocks such as somatic growth rates, survival probabilities and population abundance. However, TAMAR is far more than just a research program. For the last 25 years TAMAR has strived to incorporate human and social issues into all its conservation initiatives. It has done this by involving local communities directly in all its sea turtle conservation efforts. For instance, local fishermen who were previously turtle hunters and egg collectors were hired to protect major nesting areas along the Brazilian coastline. Changing the habits of local coastal communities whose livelihood depends on their consumptive use of sea turtles has been a major challenge. TAMAR has provided viable alternative socio-economic solutions for these communities. TAMAR now employs more than 1200 local people in various eco-tourism based activities including “Turtle by Night”. This generates local income and a sense of self-esteem for the communities as well as ensuring the long-term protection of the sea turtle stocks of Brazil. The involvement of fishermen and local communities has been a successful long-term strategy with most nesting areas showing significant increases in nesting activity along the Brazilian coastline since these community initiatives were put in place. Continuing the long-term research program is essential for providing the key indicators of the ongoing success of this community participation based conservation initiative.

REGIONAL INTEGRATION OF LONG-TERM STUDIES: THE MEDITERRANEAN CASE

Dimitris Margaritoulis

IUCNs MTSG Regional Chair for Mediterranean and NE Atlantic

The Mediterranean is a semi-closed sea featuring 21 states with about 11 languages and 5 religions. Long-time historic conflicts have gradually caused a mentality of mutual distrust and suspicion among its peoples.

Sea turtle research in the Mediterranean started towards the end of the 70s, when the first systematic studies were initiated. Although most of these studies were localized and therefore could not provide a regional outlook, they signaled the onset of long-term involvement, which is extremely important for sea turtle research (Demetropoulos & Hadjichristophorou, 1982; Geldiay et al., 1982; Margaritoulis, 1982; Argano & Baldari, 1983). However, the poor facilities of information exchange at that time and the previously mentioned mentalities rendered a variety of valuable data either to remain in the dark or with limited opportunities for integration in a regional perspective.

Regional cooperation among researchers started in the middle of the 90s and it was facilitated by several components: the regionalisation of the IUCNs Marine Turtle Specialist Group (MTSG) and the expansion of its membership in the region; the launching of MedTurtle, a regional listserver, which provided the means for broad and inexpensive communication; a multi-authored book chapter on loggerhead turtles which made public a diversity of data from several long-term projects in the region (Margaritoulis et al., 2003); the annual reunions of Mediterranean specialists in the context of the Sea Turtle Symposia; the organization of regional meetings, the most important being the First Mediterranean Conference on Marine Turtles (Rome, October 2001).

All these events improved relations, changed attitudes to a better understanding and provided a stable ground for designing and implementing cooperative projects.

LONG-TERM NESTING BEACH STUDIES: INSIGHTS AND OUTCOMES FROM THE TORTUGUERO PROGRAM

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Dr. Archie Carr began green turtle studies at Tortuguero, Costa Rica in 1955. In 1959, he formed the Caribbean Conservation Corporation that continues his work today. This presentation focuses on key findings from the long-term program that could not have been learned from shorter studies. Tagging of nesting females at Tortuguero has revealed reproductive longevity of up to 24 years for green turtles. At least 14 female green turtles have been observed to be reproductively active for ≥ 20 years. Repeated carapace measurements show that female green turtles display very limited growth (≤ 0.3 cm/year) once they are reproductively active. Long-term monitoring of remigration intervals has demonstrated modulated reproductive periodicity in green turtles, possibly influenced by environmental conditions. This would help to explain the large interannual variation in nest numbers observed at Tortuguero and other nesting beaches. Several important conclusions regarding the outcome of sea turtle conservation have been learned from the Tortuguero program. For late-maturing species such as green turtles, conservation efforts have to be sustained for decades to produce tangible results. This emphasizes the need for long-term commitments to fund and implement conservation actions in order to recover reduced nesting populations. The Tortuguero program shows that the policy changes and economic incentives needed for successful sea turtle conservation can take decades to attain. At Tortuguero, long-term protection of the nesting beach and adjacent waters in order to reduce egg collection and turtle hunting have contributed to a remarkable 412% increase in green turtle nest numbers between 1971 and 2004.

MANAGEMENT

DREDGING IMPACTS ON SEA TURTLES IN THE SOUTHEASTERN USA: A HISTORICAL REVIEW OF PROTECTION

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Hopper dredging along the southeastern USA potentially impacts five species of threatened or endangered sea turtles. Documented incidental takes of loggerhead, green and Kemps ridley sea turtles have occurred during dredging since 1980 in 38 coastal channels from the Texas-Mexico border through New York. Over the past 24 years, the U.S. Army Corps of Engineers (USACE) and dredging industry have worked to develop protocols, operational methods and modified dredging equipment to reduce dredging impacts to sea turtles. The success of these protection efforts is illustrated in the reductions in incidental takes compared to the increasing number of dredged channels monitored.

Engineering and biological studies were completed to develop a suite of protective tools to reduce dredging impacts. These investigations have included sea turtle relative-abundance, behavioral, acoustic-detection and dispersal and dredging equipment development. In addition to gaining valuable data for understanding sea turtle biology, these studies helped to establish environmental windows, draghead modifications, draghead turtle deflectors and protection protocols such as trawling to relocate sea turtles. The USACE is presently establishing an internet-based database to centralize and archive historical and future data regarding sea turtle impacts from dredging activities for long-term continuity and evaluation of these data.

COMPARING COSTS OF PROTECTING LEATHERBACKS AT NESTING BEACHES IN THE WESTERN PACIFIC

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We present preliminary data on the costs of leatherback nesting beach protection in the Western Pacific. Identifying the necessary components of projects and their associated costs can indicate how to achieve a given conservation objective at the lowest cost or how to get the biggest conservation bang for the buck, given limited funds. Furthermore, it can help to design effective and sustainable conservation programs, by providing insight into the incentives faced by people affected by the project. We collected data on costs of beach protection activities in three sites: Rantau Abang (Terengganu, Malaysia), Jamursba Medi (Indonesia) and Kamiali (PNG). We estimated current yearly costs of these projects (administration and field costs) as well as additional activities that would improve project sustainability. Cost information was graciously provided by project staff in the three sites.

In general, people have not considered that covering long-term recurrent costs is possible. Our data suggests that it is possible and affordable, particularly by creating endowment funds. We estimate the size of the endowment fund that would allow the annual operating costs of the projects to be met in perpetuity. The projects would each require approximately $1-2 million to fully fund administrative and field costs in perpetuity. It is also possible to create an endowment for field costs only, reducing the up-front funding requirements by approximately two thirds.

Many projects encourage locals to refrain from harvesting turtles or their eggs and to forego other economic activities such as logging, due to its potential to degrade nesting beaches. While turtle protection may provide non-economic benefits to communities, it also represents a loss to villagers in terms of foregone protein or income. As economic needs are great in many of the nesting beach areas, the economic losses from protecting turtles may hamper the sustainability of these projects. In some cases, community members receive wages as patrollers, creating a concrete economic benefit from turtle protection. However, this does not create conservation incentives for the community as a whole and is causing tension in some areas.

Ecotourism is often promoted as a conservation tool that can also benefit community members. The notion is that locals who would otherwise consume turtles or eggs can instead profit from providing a tourism experience for individuals with high values for turtle preservation. While the logic is correct, ecotourism is unlikely to be appropriate in many cases. Some places are remote and lacking in infrastructure so any substantial tourism will take years or decades to develop.

It also assumes that those who harvested turtles or their eggs are those who will now be employed in ecotourism and their income will be at least as high. Competition from other destinations, unanticipated market or ecological shocks, or political instability could cause the ecotourism market in a given area to crash. Tourism also has environmental, social and cultural impacts. Ecotourism is not a panacea and must be used discriminatingly and implemented with care.

Alternative approaches that have been discussed and applied in terrestrial settings are purchasing land outright or establishing contracts with communities that provide direct compensation (cash or in-kind) in exchange for environmental services, such as protecting a turtle nesting beach. An advantage of this approach is that the benefits depend on meeting specified environmental criteria, so incentives are clear and directly linked to the desired environmental outcomes. Our data suggests that it is quite affordable to cover community benefits. Trust funds would enable conservationists to make yearly agreements with communities as far into the future as is necessary to achieve long-term conservation.

CRAWL COUNTS: THE TURTLE EGG TRADE AND OLIVE RIDLEY POPULATION TRENDS ON THE PACIFIC COAST OF GUATEMALA

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ARCAS is a Guatemalan NGO managing the proposed Hawaii Protected Area under an integrated coastal zone management effort on the Pacific coast of Guatemala. As part of its sea turtle conservation activities in the area, it has for the last 6 years been conducting simple crawl counts of the olive ridleys nesting on the 16 kms of coastline that it covers in an attempt to determine how many turtles per year are nesting in the area. Using this crawl count data, as well as similar but limited historical data and also data gathered in the course of the management of its hatcheries, ARCAS is engaged in: 1) establishing baseline data and beginning to determine population trends among olive ridleys on this coast, 2) determining the economic value of the trade in sea turtle eggs in Guatemala in local and national contexts and 3) monitoring what percentage of eggs being laid on the beaches are actually being donated to local hatcheries and what percentage are being consumed. In following an active policy of sharing this information with government, NGOs and the local population ARCAS hopes to clearly establish the role of egg collection in local culture and economy and to guide future policy towards a balanced approach to both social and conservation needs.

ENHANCING COMMUNITY PARTICIPATION IN THE CONSERVATION AND MANAGEMENT OF MARINE TURTLES IN KENYA

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A participatory approach was used for a period of one year with an overall aim of developing a Community Action Plan (CAP) for the conservation and management of marine turtles within the Tana Delta area. Pairwise ranking, a seasonal calendar and a time line were used in identifying and prioritizing problems. Systematic surveys and transect walks were conducted. Semi-structured interviews were administered to 167 local community members while a total of 33 members drawn from the local community were trained in basic sea turtle biology and project management techniques. Education and awareness activities were conducted among the local communities and schools. The data and information obtained from transect walks and interviews served to provide a basis for the preparation of a participatory map and a GIS database of the major marine turtle nesting and foraging habitats within the project area. Initial geo-referenced data interpretations and overlays were derived from 1992 aerial photographs and GPS readings. The areas around Tenewi and Ziwayu Islands were identified as the major foraging grounds. For the entire project period, a total of 84 nests were sighted with 99% of all the nesting activity occurring in beaches to the north of the Kipini village. Mortality cases showed a mean value of between 54.5cm to 58.7cm for curved carapace length (CCL) and 50.3 to 53.4cm for curved carapace width (CCW) irrespective of species. Sixty percent of the mortality cases were sighted within the southern beach stretching from Mto Tana to Shekiko.

THE LUCRATIVE TRADE CONTINUES: A TEN-YEAR OVERVIEW OF ILLEGAL IMPORT OF SEA TURTLE PRODUCTS INTO THE UNITED STATES

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Despite protection efforts worldwide, trade in threatened and endangered sea turtles and their eggs continues throughout their range. Though poaching is widely recognized as a major contributor to sea turtle decline, it is difficult to measure the extent of this task since there are few quantified records. This study presents information gathered from the U. S. Fish and Wildlife Service and National Marine Fisheries Service law enforcement databases as one measure of the illegal trade in sea turtles and their products within and across U. S. borders. Between 1994 and 2003, imports originating in 68 countries included over 67,000 eggs, 1000 kg of meat, 2787 pairs of turtle leather boots and 2600 pieces of jewelry. Other imported products included oil, preserved turtles and medicinal products. These seizures indicate only the minimum quantity of illegal importation, since most were from declared and inspected shipments. Therefore, the illegal products being imported into the U. S. are much higher. Despite potentially grave consequences for the species which are illegally traded, wildlife criminals do not receive stiff penalties in the U. S. For example, in 110 cases involving seized sea turtle meat, none of the perpetrators received jail time or probation and the fines for these 110 cases totaled only $1400 US.

Sea turtle populations are dwindling in many regions of the world, yet no law will change the ingrained cultural practices that make sea turtle products so important to some people. In addition to their cultural importance, sea turtle meat and eggs are significant protein sources to some populations. Therefore, we must work within cultural and practical needs to more thoroughly protect sea turtles. A good place to start is with community involvement. If people understand the importance of sea turtles and have a hand in developing and implementing conservation strategies, the buy-in will be much greater. However, people who have been using sea turtles for their livelihood may need training and assistance in starting new, sustainable trades. For youth, education is vital so they will not be dependent on the turtle trade for their livelihood. Because of the integral cultural and nutritive role of sea turtles in some cultures, it may also be necessary to develop harvest limits in countries where take cannot practically be banned. However, harvest limits need to be sustainable and enforceable and if these standards cannot be reasonably attained, then harvest limits should not be considered. Additionally, if developed, harvest and use should be within country boundaries only, with no international trade permitted.

The United States has developed laws to accommodate indigenous people's traditional and cultural uses of native wildlife while protecting the future survival of these species. For example, Alaskan natives are permitted to harvest waterfowl in the spring, in keeping with their traditional use of this protein-rich resource, though springtime waterfowl hunting is not permitted in other parts of the country or by other users. There are also legal exceptions for Alaskan natives to harvest polar bears, marine mammals and some migratory bird eggs and to sell handicrafts they fashion from whale parts. Although there is no legal harvest of bald or golden eagles in the U. S., there is a method to distribute feathers from eagles that have been found dead to Native Americans for ceremonial purposes. These laws could serve as one model for similar regulations concerning use of sea turtles in other countries. It is important to recognize and accommodate some uses when they cannot be fulfilled by other means. Simply banning harvest would not work in many areas where sea turtles are integral to the culture.

Our recommendations are to: improve communications between countries and regions, continue life history studies, utilize national and international agreements to reduce by-catch and illegal harvest, improve and protect sea turtle habitats and work within the constraints of the myriad of cultures and human basic needs to find a balance between reasonable use and protection of sea turtles.

ECOLOGY AND MANAGEMENT OF GEORGIA'S NESTING LOGGERHEADS

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The Northern Recovery Unit of the southeastern U. S. loggerhead (*Caretta caretta*) population has declined over the last four decades with shrimp trawls believed to be the single largest source of mortality for juvenile through adult life stages. In response to increased sea turtle stranding rates, the South Atlantic Fisheries Management Council (2002) explored possible options for reducing shrimp trawler/loggerhead turtle interactions. Strategies for reducing sea turtle/fisheries interactions were difficult to assess due to lack of information on sea turtle abundance and distribution. This research was initiated to compare distribution and movement patterns of adult female loggerhead turtles during inter-nesting intervals with concurrent shrimp trawler distribution. Loggerheads were captured (n = 12) from May 25 through July 8 and outfitted with sonic and satellite transmitters. Turtle locations were observed via satellite and visual observations throughout the nesting season. Weekly aerial surveys conducted over the same time period were used to determine shrimp boat distribution patterns. Movement strategies exhibited by tagged turtles during inter-nesting periods can be described as either habitual or nomadic. Areas of high shrimp trawler density overlap areas of high use by tagged loggerheads in multiple locations but seem heaviest near the estuarine demarcation line separating fishable waters from closed waters behind the barrier islands. A preferred management action may entail shifting the demarcation lines further into open water.

NESTING BEACHES

HELEN REEF ATOLL, REPUBLIC OF PALAU TURTLE MONITORING PROJECT

Wayne Andrew, William Andrew, Benedict Pedro, Flave Andy, Paul Homar and Robinson Richard

Hatobei State Government, Palau

The Helen Reef Turtle Monitoring Program has been ongoing since August 2002. Six beach rangers are employed by Hatohobei State and Community Conservation Network (CCN) to monitor beaches everyday, alternating hours each day, seven days a week. The island is 3.1 hectares in area with a shoreline perimeter of 1,973-m at mean low tide. From June 2003 to April 2004, a total of 347 green turtles were observed. Only the green turtle, *Chelonia mydas,* was observed. The greatest number of tracks and turtles were observed in August 2003 (55 turtles) and April 2004 (60 turtles). Of the total 347 crawls recorded, only 3 were unsuccessful, no false crawls were recorded. From January 2004 to April 2004, a total of 350 hatchlings were observed of which 60% were seen during February, 36% in January, 3% in March and 1% in April. The Helen Reef Program has had a 3-year ban on turtle harvesting that will end October 24, 2004. This information will be used towards implementing a management plan for turtles at Helen Reef. Future studies will include ongoing monitoring of nesting and foraging turtles, environmental characteristics of the nesting areas, hatchling success, tagging and measuring turtles and management issues. The project has received financial and technical support from the David and Lucille Packard Foundation, MacArthur Foundation, Homeland Foundation, Bureau of Marine Resources, Hatohobei State, the Community Centered Network, US Fish and Wildlife Service and the Pacific Island Regional Office of NOAA Fisheries.

LINEAR EXTENT OF BEACH ARMORING AND OTHER BARRIERS TO SEA TURTLE NESTING ON BEACHES OF FLORIDA, USA

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Three species of sea turtles nest on the sand beaches of Florida from March to September. The availability of suitable nesting habitat is important for the recovery of sea turtles in Florida, which has substantial human development near its beaches. In the current study, we identified both anthropogenic and natural objects as potential barriers to nesting (PBNs) and determined the position and extent of these with a differentially corrected global positioning system. Barrier attributes, such as impediment (low, moderate, high), permanency (low, moderate) and entrapment (none, low, high), were assigned to each object to categorize the level of effects on sea turtle nesting. Data were collected from April 2001 to May 2002 in four regions of Florida: northeast, southeast, northwest and southwest. The length of randomly selected beaches was 80,450 m in each region. The total lengths of PBN coverage in the four regions are: southeast, 19,136 m (23.8%); southwest, 17,437 m (21.7%); northwest, 11,361 m (14.1%); and northeast, 9,897 m (12.3%). Anthropogenic structures are constructed and removed constantly from Florida beaches and also are covered or uncovered by sand, especially after storm events. The present assessment, therefore, only presents a snapshot of PBNs in Florida, but it describes what types are present and how abundant the structures are at each region in the surveyed period.

"MANIACAL EGG RELOCATORS": DATA AND SPECULATIONS ON STABILIZING SELECTION AND THE EVOLUTION OF NEST-SITE PREFERENCES

Nicholas Mrosovsky

Department of Zoology, University of Toronto, Canada

Invited lecture – no abstract available

HAWKSBILL (*ERETMOCHELYS IMBRICATA*) AND LEATHERBACK (*DERMOCHELYS CORIACEA*) TURTLE NESTING AT COMARCA NGÖBE-BUGLÉ CHIRIQUÍ BEACH, ESCUDO DE VERAGUAS AND BASTIMENTOS ISLAND NATIONAL MARINE PARK, PANAMA

Cristina Ordoñez[1], Sebastian Troëng[2], Argelis Ruiz[3], Earl Possardt[4], David Godfrey[5], Peter Meylan[6], Anne Meylan[7] and Natalia Decastro[1]

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Chiriquí Beach was described by Archie Carr as the most important Caribbean nesting beach for hawksbill turtles. During the mid-1900s, the population experienced a huge decline due to tortoiseshell exploitation. In 2003, a collaborative project undertaken by local, national and international organizations documented 491 hawksbill nests at Chiriquí, Zapatilla Cays and Escudo de Veraguas Island. Although nesting is now but a remnant of historic levels, the monitoring results emphasize the continuing regional importance of the areas hawksbill population. Monitoring was extended in 2004 to include the leatherback and hawksbill nesting seasons. Track surveys undertaken by local beach monitors at Chiriquí Beach during the 2004 leatherback season documented 3,077 leatherback nests. Based on these results and a review of recent literature, we conclude that Chiriquí Beach hosts more leatherback nests than any other beach in Central America. The levels of hawksbill and leatherback nesting at Chiriquí Beach establish the area as a high priority for conservation action. Preliminary results from 2003 and 2004 suggest that low level poaching of hawksbill nests and nesting females, predation of hawksbill and leatherback eggs and hatchlings by dogs and directed take of hawksbill and green turtles by local fishermen represent the major survival threats to sea turtles in the area. Several environmental education activities were conducted with school children and teachers. The interest expressed by the communities adjacent to Chiriquí Beach and by local, traditional and national authorities in Panama gives us great hope that long-term sea turtle conservation efforts can be successful.

DISCOVERY OF A MAJOR NEW NESTING AREA IN SYRIA FOR THE CRITICALLY ENDANGERED MEDITERRANEAN GREEN TURTLE

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Green turtle nesting in the Mediterranean is confined to the Eastern Basin with most nesting occurring in Turkey and Cyprus. Lower nesting levels have been recorded across the rest of the Levant coast (Kasparek et al, 2001). The Mediterranean population has recently been classified as critically endangered in the IUCN Red Lists (ERASG, 1996). Syrias 183km coastline was briefly surveyed in 1991 and limited nesting (attributed to loggerheads) was found on 2 beaches at Lattakia and between Tartous and Lebanon (Kasparek, 1995). No follow-up surveys were subsequently carried out to better quantify nesting levels.

In 2004, a two-month survey of the 12.5km beach south of Lattakia (35.440°N 35.895°E), that was shown to have most turtle tracks by Kasparek (1995), was undertaken to confirm nesting levels, species responsible and train local workers in conservation methods. The beach was patrolled daily on foot to record turtle nesting and hatching activity and factors impacting nest survivorship. Nests and suspected nests were marked with labeled stones or sticks.

To estimate total number of nests on Lattakia beach, we added the number of nests observed during the surveying period to the number of unmarked nests (made prior to the surveys) that were discovered through hatching or depredation. The conservative estimates of nest numbers were calculated to be 104 green and 6 loggerhead nests. The main threats to nests identified were predation of eggs and hatchlings by foxes, dogs and ghost crabs, disorientation of hatchlings by artificial lights, vehicular use of the beach and nest inundation from storm waves. A recent review of green turtle nesting in the Mediterranean (Kasparek et al, 2001) classified beaches with over 100 nests per season as nesting areas of major importance. The 104 green turtle nests at Lattakia rates the beach in this category and in the top ten nesting beaches of the Mediterranean. Thus, Syria hosts one of the most important nesting populations in the region, worthy of extensive conservation activity.

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KEMP'S RIDLEY NESTING INCREASING IN TEXAS

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Overall, the number of Kemp’s ridley nests found on the Texas coast has increased during the last decade and a record 42 were found there in 2004. Additionally, during the last 50 years, more confirmed Kemp’s ridley nests have been found at Padre Island National Seashore (PAIS) than at any other location in the USA. Kemp’s ridleys that nest in Texas today are a mixture of returnees from the experimental imprinting and head-starting projects conducted in Texas and others from the wild stock. Documentation to date shows that 13 different individuals taken from Rancho Nuevo, Tamaulipas, Mexico as eggs for the experimental project to establish a secondary nesting colony at PAIS returned to lay eggs in Texas, with a total of 23 nests recorded from these head-started turtles. Additionally, eight different individuals that had been taken directly from Rancho Nuevo as hatchings between 1989 and 1993 and head-started have been recorded producing a total of nine nests in Texas. Many other confirmed Kemp’s ridley nests have been documented on the Texas coast, but either the nesting turtles lacked tags linking them to the experimental imprinting and head-starting projects, or the nesting turtles were not examined for tags and hatchlings confirmed the species. As the Kemp’s ridley population continues to increase and more turtles from the egg translocation and captive rearing projects as well as their offspring reach maturity, it is likely that increasing numbers of Kemp’s ridleys will come to Texas to breed and nest.

MONITORING AND CONSERVATION OF THE LARGEST LOGGERHEAD TURTLE (*CARETTA CARETTA*) NESTING POPULATION IN AFRICA: SUCCESSES AND CHALLENGES

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The Republic of Cape Verde is situated about 500 km off the coast of Senegal, West Africa. The islands of Sal, Boa Vista and Maio constitute the Eastern group and harbour the most important nesting beaches for loggerhead turtles in the Archipelago.

During 1998-2004 nesting seasons, fieldwork has been focused on the eastern beaches of Boa Vista and, occasionally, in other beaches of Boa Vista and in the islands of Maio, Sal and Santa Luzia. The main study area includes a total extension of 3.1 km of suitable nesting beaches. All through these years, a tagging program has been carried out, alongside recording of biological data and monitoring of nests. Daily beach surveys have been carried out since 2001 in order to record the number of sea turtle tracks and nests over the nesting seasons.

The mean SCL (75.8 cm) of female nesting loggerheads was similar to that of Mediterranean specimens. Currently, a total number of 3,968 nesting females have been tagged in the island of Boa Vista. The remigration interval mean value was 2.4 years, with a range of 1 to 6 years. The inter-nesting interval was 14.5 days. Clutch size averaged 83.2, with a maximum of 140 eggs. The clutch frequency ranged from 1 to 7 per year, with a mean value of 2.3 nests per female. Mean incubation period for the different seasons ranged from 54.2 days in 2000 and 60.9 days in 2002. The ghost crab appears to be the most important predator of eggs and hatchlings.

The nesting season runs from June to October, though there may be some seasonal variations. Mean nesting success was 28.9%. The number of nests per season in the 3.1 km of the study area averaged 1,771. The highest density corresponded to the 2004 season with a total of 2,728 nests. Taking into account some sporadic surveys conducted in other beaches of the island and in those of Maio, Santa Luzía and Sal, we estimated that the number of nests in the whole Archipelago could be as high as 15,000 per season, which correlates to about 4,000 breeding females each year. Although a lot of work is still necessary, we suggest that the Cape Verde loggerhead nesting population is likely to be the largest in Africa and is certainly one of the most important in the world.

Human predation (direct hunting of nesting females and adult males at sea and egg harvesting) has been identified as the most important threat to the population. Today, the existing law for the protection of Fauna and Flora of Cape Verde protects these marine reptiles all year round. Even so, harvesting of adults and poaching of nests are still common in the archipelago and although some conservation measures are being applied, more effort is required from local and national authorities in order to preserve this important sea turtle population.

PATHOLOGY, HEALTH AND REHABILITATION

GEOGRAPHICAL COMPARISON OF PERSISTENT ORGANOCHLORINE POLLUTANT LEVELS IN LOGGERHEAD EGGS (*CARETTA CARETTA*) COLLECTED ALONG THE SOUTHEAST COAST OF USA

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Geographical assessments of persistent organochlorine pollutants (POPs) in sea turtles are lacking. Unhatched loggerhead eggs were collected from 41 nests located on beaches from three areas of the Southeast coast: western Florida (Sarasota, n=10), eastern Florida (Juno Beach, n=4; Hutchinson Island, n=5; Boca Raton, n=9; Melbourne Beach, n =4) and North Carolina (Cape Lookout, n=9). One to 10 egg yolk samples were pooled from each nest and eggs with late stage embryos were not included. Predominant PCB congeners (99, 105, 138+163, 153, 170, 180 and 187) and 4,4'-DDE were measured using gas chromatography with electron capture detection. The respective average nest concentrations (ng/g lipid) ± SD of predominant PCBs and 4,4'-DDE were 1060±1100 and 816±901 for North Carolina, 199±355 and 116±232 for eastern Florida and 25.6±36.3 and 22.6±25.3 for western Florida. Significant differences were found for PCBs ($p = 0.001$) and 4,4'-DDE ($p < 0.05$) concentrations among these areas (Kruskal-Wallis test). North Carolina nests had the highest levels and also exhibited the highest incidences of embryonic abnormalities, such as embryos with two heads, crossed-jaws, or microcephalic heads. This finding suggests that POPs may have a larger impact on reproduction in the northern subpopulation, which has not shown signs of recovery. Because these compounds are transferred maternally into the eggs, future studies should compare where nesting females feed in order to address why the northern subpopulation accumulates higher levels.

LOGGERHEAD HEALTH ASSESSMENT PROGRAM IN GEORGIA, USA

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We conducted health assessments of loggerhead turtles (*Caretta caretta*) along the coast of Georgia from 2001 to 2004. The main study objective was to determine base line health values for free-ranging turtles and to compare results from free-ranging (i.e., foraging and nesting) and stranded turtles. Biomaterials were collected from nesting and foraging turtles in conjunction with on-going ecological studies and all turtles were tagged at the time of sampling. Samples were collected from stranded turtles as part of the clinical evaluation to determine prognosis and therapeutic needs of the turtle. Samples collected from all turtles included blood, feces and epibiota from live animals, as well as complete necropsies and tissue preservation from eggs, hatchlings and adult turtles that were found freshly dead or euthanized. Additionally, physical examinations were conducted on all live caught turtles. Laboratory analyses of blood samples included hematology, plasma chemistries and protein electrophoresis. Blood toxin levels were determined for a subset of live captured turtles and histopathologic evaluations were conducted on tissues and toxin levels were determined for dead turtles. These data are not presented in this talk.

Physical findings, hematology, chemistry profiles and protein electrophoresis results from 39 foraging, 31 nesting and 13 stranded loggerheads were determined and statistical comparisons were made between these behaviors (foraging, nesting, stranded). These data will be presented in this talk and subsequently published in a wildlife health journal. Baseline blood parameter data, such as those determined in this study, are imperative for assessing the health status of individual turtles and populations. Disease is one of the challenges in the conservation of sea turtles and is often associated with anthropogenic changes occurring in coastal regions. We must strive to minimize consequences of such changes on the health of sea turtles as one important measure in the conservation of these species.

CONTAMINANTS IN SEA TURTLES FROM BAJA CALIFORNIA, MEXICO

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Little is known regarding the baseline levels of contaminants in sea turtles from the Pacific coast of the Americas. Heavy metals (Pb, Fe, Se, Cd, Ni, Cu, Zn and Mn) and organochlorine residues were analyzed in four different tissues (kidney, liver, muscle and adipose) collected from 3 sea turtle species of the Baja California peninsula, Mexico. Seventeen of 21 organochlorine pesticides analyzed were detected, with heptachlor epoxide and hexachlorocyclohexane the most prevalent. PCBs were detected in 88% of the turtles studied. Levels of organochlorines detected in the present study were low, potentially attributable to the feeding habits of the predominant species collected in this study (herbivorous) and/or the samples obtained in an unindustrialized region. However, levels of some metals (Cd in particular) were exceptionally high in every species analyzed and were similar to more industrialized regions of the world. Interspecies comparisons suggest a potential effect of dietary differences in the bioaccumulation of contaminants among the herbivorous and the carnivorous turtles. The potential effects of these contaminants on the health of Baja California sea turtle populations will be discussed.

DEBILITATED LOGGERHEAD TURTLE (*CARETTA CARETTA*) SYNDROME ALONG THE SOUTHEASTERN US COAST: INCIDENCE, PATHOGENESIS AND MONITORING

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In 2003, there was an increased occurrence of emaciated and barnacle-laden loggerhead turtles (*Caretta caretta*) found stranded along the southeastern US Atlantic coast. To investigate this situation further, a workshop was held on St. Catherines Island, GA in November of 2003. Fifteen people attended including: turtle biologists from four states, veterinarians, toxicologists and immunologists. The group determined that there was an increasing trend in strandings of debilitated sea turtles from 1992-2002 and a substantial increase in 2003. The species composition of these strandings was primarily loggerheads. The stranding of debilitated turtles occurred all year in Florida; however, strandings were found to be concentrated in the spring and summer in the other states. The turtles were stranded across the southeastern US coastal region; however, areas of high stranding density were identified. A debilitated turtle was defined as emaciated with small barnacles covering the skin. Health assessment and necropsy data presented indicated the turtles were being affected by secondary bacterial and parasitic infections with the primary cause still to be determined. Preliminary contaminant data in debilitated turtles showed significantly higher blood levels of polychlorinated biphenyls and organochlorine pesticides compared to apparently healthy turtles, while mercury levels in scutes were not significantly different between debilitated and healthy turtles. The group determined several areas that need to be addressed over the next 2 years. Standardized protocols have been developed for a wide range of antemortem and postmortem diagnostics. Preliminary results from 10 necropsies and 3 cases followed through the rehabilitation process will be discussed.

PERFLUORINATED CONTAMINANTS MEASURED IN SEA TURTLE BLOOD CORRELATE TO MODULATIONS IN PLASMA CHEMISTRY VALUES AND IMMUNE FUNCTION MEASUREMENTS

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Perfluorinated contaminants (PFCs) have been measured in blood samples from both wildlife and humans; however, the health effects of these compounds have not been adequately assessed to date. This study determined if PFCs could modulate sea turtle health parameters. Blood samples were collected from 67 free-ranging juvenile loggerhead and 5 Kemp's ridley turtles from the North Carolina to Florida coasts between May 30th and July 27th 2003. PFC concentrations, immune parameters (lymphocyte proliferation and lysozyme activity) and veterinary diagnostic endpoints were measured. In the loggerhead sea turtles, T-cell proliferation correlated positively with perfluorooctanesulfonate (PFOS), perfluorohexanesulfonate (PFHxS), perfluorododecanoic acid (PFDoA) and total PFCs. In the Kemp's ridley sea turtles, B-cell proliferation correlated positively with PFOS, PFHxS and total PFCs, while T-cell proliferation correlated positively with PFDoA and negatively with perfluorononanoic acid. Hematology and plasma chemistries were measured in 22 of the loggerhead sea turtles and packed cell volume (PCV), total plasma protein and blood glucose were measured in the 5 Kemp's ridley sea turtles. In loggerhead turtles, significant positive correlations with aspartate aminotransferase (AST), globulin, glucose, potassium, total protein and urea nitrogen were observed with most all individual compounds and also total PFCs. In the Kemp's ridley turtles, significant positive correlations were seen with glucose, PCV and total protein. These data suggest that even low levels of PFCs (106 ng/mL) may alter biomarkers of health in sea turtles and that further efforts should be made to assess health and risk of sea turtles in relationship to these compounds.

DIAGNOSTIC VALUE OF BLOOD CULTURE AND SENSITIVITIES IN THE MEDICAL MANAGEMENT OF SEA TURTLES

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Previous studies of debilitated sea turtles have demonstrated systemic bacterial infections and bacteremia. Current recommendations for the medical management of stranded sea turtles often include empirical choices of antibiotics. Ideally, antibiotic choice should be based on culture and sensitivity results, which may increase treatment success, decrease treatment duration and minimize the occurrence of bacterial resistance. In the case of the septic animal, the bacteria present in the blood would usually be the most logical target for antimicrobial treatment. Treatment appropriateness, in human medicine, can be increased from 63% with empirical antibiotic choice to 97% after blood culture results. This clinical study, involving 15 stranded sea turtles of varying species (including *Carretta carretta*, *Lepidochelys kempi* and *Chelonia mydas*), demonstrates the usefulness of blood culture and anti-microbial sensitivities, the appropriate venipuncture and culture technique, the correlation with bloodwork and subsequent clinical improvement and the organisms most commonly recovered in debilitated sea turtles. All bacteria grown in our study demonstrated multi-drug resistance, including common resistance to ceftazadime (Fortaz), a popular empirical choice. In our study, treatment appropriateness,

based on alternative choices other than ceftazidime, was increased from approximately 40% to 80%. Blood cultures, CBCs and biochemistries were repeated prior to release of the animals to further demonstrate treatment success.

TOXICANTS PRESENT IN THE UNHATCHED EGGS AND DEAD HATCHLINGS OF LEATHERBACK SEA TURTLES IN PLAYA GRANDE, COSTA RICA: ARE THEY THE CULPRITS?

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The number of nesting females at Las Baulas, Costa Rica has declined dramatically. Many researchers have attempted to explain the reduction in nesting females and have hypothesized that toxicants may be a contributing factor. Potential toxicants like heavy metals and pesticides have been proposed as contributing factors by possibly reducing hatching success or fitness of hatchlings. Currently no study has documented the toxicant levels in eggs or hatchlings of any leatherback population. This study quantified the toxicants present in the unhatched eggs and dead hatchlings of the first and fourth nests of remigrants and new nesters and determined the effects of these metals on hatching/emergence success and hatchling mass and size. Metal levels were highly variable within and between groups of females. We also found no detectable levels of the pesticides tested. This study showed that there were no significant differences in metal concentrations between groups of females within the population or between nests within groups. This indicates that older females (remigrants) do not have higher levels of metals than younger females (new) and there is no tendency for females to deposit toxicants in early or later nests. Although, this study provides evidence to support the hypothesis that females accumulate metals over time, this analysis excluded new nesters. This study was unable to link metal concentration to any endpoint such as hatching/emergence success, hatchling size, or hatchling mass. Furthermore, it seems as though eggs may take up some metals from the nest environment and deposit other metals in the egg shell; unhatched eggs contain significantly more nickel, copper and cadmium and contain significantly less iron, manganese and zinc than dead hatchlings. Increasing metal concentrations during incubation may have some effect on developing embryos and necessitates further research.

RETROSPECTIVE PATHOLOGY SURVEY OF GREEN TURTLES (*CHELONIA MYDAS*) WITH FIBROPAPILLOMATOSIS IN THE HAWAIIAN ISLANDS, 1993-2003

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We necropsied 255 stranded green turtles (*Chelonia mydas*) with fibropapillomatosis (FP) from the Hawaiian Islands, North Pacific, from August 1993 through May 2003. Of these, 214 (84%) were euthanized due to advanced FP. The remainder were found dead in fresh condition. Turtles were assigned a standardized tumour severity score ranging from 1 (lightly tumoured) to 3 (heavily tumoured). Turtles in tumour score 2 and 3 categories predominated and tumour score 3 turtles were significantly larger than the other two categories. Total cross-sectional area of tumours increased significantly with SCL. There were significantly more tumours in the front than rear of turtles. Eighty percent of turtles had oral tumours and 51% of turtles with oral tumours had tumours in the glottis. Thirty nine percent of turtles had internal tumours and these were most often seen in the lung, kidney and heart. Fibromas predominated in lung, kidney and musculoskeletal system; whereas, myxofibromas were more common in intestines and spleen. Fibrosarcomas of low-grade malignancy were most often in the heart and heart tumours had predilection for the right atrium. Turtles with FP had significant additional complications including inflammation with vascular flukes, bacterial infections, poor body condition and necrosis of the salt gland. Turtles with oral tumours were more likely to have secondary complications such as pneumonia. Most turtles came from the island of Oahu (74%) followed by Maui (20%), Hawaii, Molokai and Lanai (<3% each). On Oahu, significantly more turtles were stranded along the northwestern and northeastern shores.

POPULATION BIOLOGY

SEX RATIOS, MORPHOMETRICS AND ORIGINS OF A LARGE NORTHERN FORAGING POPULATION OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*)

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Waters off the Atlantic coast of Canada support a large seasonal foraging population of leatherback turtles. Using commercial fishing vessels as a platform for research, this population has been studied for five years. Morphometric data collected from leatherbacks captured at sea and from stranded animals reveal that waters of the western Atlantic north of 44ºN are principally utilized by large sub-adult and adult turtles. Confirmation of nesting origins of 16 turtles demonstrates that leatherbacks from widely disparate nesting sites aggregate in Canadian waters. Preliminary recapture data suggests that projects monitoring nesting populations in the Caribbean and South America encounter a large percentage of mature females that forage off the Atlantic coast of Canada. While it has been suggested that northern foraging populations of Atlantic leatherbacks have male-biased sex ratios, our sample indicates that this may not be so.

CHELONIA MYDAS AT RAINE ISLAND: MASS NESTING CONCEALING A POPULATION IN CRISIS

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Raine Island is the major rookery for the northern Great Barrier Reef *Chelonia mydas* genetic stock. On average, approximately 40,000 females breed annually on this 1.8 km nesting beach in remote north Queensland. The population is characterized by a declining size of the annual nesting population, reducing size of the breeding females, extremely poor nesting success, reduced number of clutches per season and high egg mortality. The poor nesting success, reduced number of clutches per season and high egg mortality are the result of environmental parameters at the island. This nesting population migrates from dispersed foraging areas with a 2,500 km radius. Over recent decades, this stock has been subjected to a regular substantial harvest of principally large females over an extended part of its foraging range in northern Australia, eastern Indonesia and southern Papua, New Guinea. Under current environmental conditions and management practices, this very large *C. mydas* population is on track for a significant population decline within the next few decades (in less than one generation). This decline also threatens the continuity of culturally significant linkages between indigenous coastal communities and green turtles in Torres Strait, northern Australia and southern New Guinea.

RELATIVE ABUNDANCE OF LOGGERHEAD TURTLES IN THE NEARSHORE WATERS OF THE SOUTHEAST UNITED STATES

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Catch data from a recent large-scale fishery independent trawl survey targeting sea turtles will be presented. Approximately 750 randomly selected locations were sampled annually in the nearshore waters between Winyah Bay, South Carolina and St. Augustine, Florida. A 30-minute tow was conducted at each station using a pair of 65' large-mesh nets. Catch rates were calculated and standardized using the methods of Henwood and Stuntz (1987) as modified by Jamir (1999). Catch rates of the present study were compared to catch rates in the literature. These comparisons suggest that abundance of loggerhead turtles in the nearshore waters of the southeast United States has increased significantly during the last 30 years, although genetic data indicate a majority of these turtles may be from the southern Florida subpopulation.

DENSITY-DEPENDENT SOMATIC GROWTH AS A MECHANISM AFFECTING POPULATION DYNAMICS AND PERSISTENCE OF GREEN TURTLES

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Assessing population dynamics and investigating critical life demographic parameters is often complicated by the lack of information on the biology and behaviour of sea turtles. Recently, in an attempt to better incorporate and capture complexity of species life history, stochastic simulation models have also been developed, including stochastic projection models (Chaloupka, 2002), simulation modelling approaches (Chaloupka, 2003) and individual based models (IBM) (Mazaris et al., in press). The knowledge about the possible effect of a density-dependent somatic growth in the age of first breeding and reproduction cycles is still scarce. In a recent study Bjorndal et al. (2001) recognized the existence of a density-dependent growth on immature green turtles in the southern Bahamas. However, the effect of this mechanism upon population dynamics has received little attention.

In the present study we use a stochastic individual based simulation model in an attempt to investigate the effect of density-dependent somatic growth on sea turtle population dynamics and persistence. The developed model simulates life history characteristics of a virtual population of green turtles. The model was parameterized by using data derived by the literature. To facilitate the inclusion of a possible density-dependent variation in somatic growth, we used information derived by Bjorndal et al. (2000). All members of the population were simulated simultaneously. In an attempt to reduce computational burden, a modular type of IBM was developed. Three primary units were used for model development: super-individuals (aggregation of animals of the same age), packs of individuals (aggregation of animals within the same stage class) and individual turtles. Life history of the species was divided into five stages (egg/hatchling, small juvenile, large juvenile, immature and mature stages). The behaviour of the population (i.e. growth, breeding, reproduction and death) was modeled for each individual.

Results of the study were twofold. First, our results showed that probability of population persistence was significantly affected by the age of first breeding. Moreover, our findings highlighted the importance of breeding cycles on population persistence. Therefore, in the context our model, we recognized density dependence as a critical mechanism affecting population viability.

On the other hand, considering this study as an example of the applicability of IBM, we concluded that flexible IBMs could be successfully applied in sea turtle studies and used for investigating population dynamics and persistence.

SEVENTEEN YEARS OF SATURATION TAGGING DATA REVEAL A SIGNIFICANT INCREASE IN NESTING HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA)* ON JUMBY BAY, LONG ISLAND, ANTIGUA, WEST INDIES

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Hawksbill (*Eretmochelys imbricate)* nesting on Jumby Bay, Long Island, Antigua, West Indies, has been monitored continuously since 1987. Although numbers of nesting females have remained constant for the first eleven survey seasons (1987-1997), inclusion of more recent data (1998-2003) in the analysis reveals a statistically significant upward trend. We examined two reproductive subpopulations, neophytes (primaparous females) and remigrants (experienced females), in order to assess their respective contributions to population growth. We found that neophytes have shown a statistically significant upturn in numbers, while the remigrant subpopulation has remained stationary. This indicates that the increase in numbers of neophytes in the Jumby Bay nesting population is driving the upward trend in the total number of nesters. Predictive models based on the Poisson distribution suggest that the neophyte subpopulation will continue to grow in size by an average of 12% per annum. We discuss model-based predictions and their limitations. The Jumby Bay Hawksbill Project, which has protected nesting hawksbills and their eggs since the projects onset in 1987, is only one of several factors which may contribute to the recent increase in nesting females. Other possible causes are discussed.

DISTRIBUTION AND DYNAMIC OF REPRODUCTIVE PATCHES OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) OFF RUSHIKULYA ROOKERY, ORISSA, INDIA

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The distribution of olive ridley sea turtles off the coast of the Rushikulya rookery, Orissa was studied during the 2003-04 breeding season. Line transects of 1 km length were laid perpendicular to the shore by boat every alternative day from November 2003 to March 2004. Locations of mating pairs were recorded to estimate the extent of the reproductive patch and to identify spatio-temporal changes in the distribution of olive ridley turtles in the near shore waters of Rushikulya. Environmental parameters such as area, water depth, air and sea surface temperature were recorded. Additionally, turtle entanglements in nets were also studied; data was collected on length and mesh size of nets, duration of netting and number of turtles entangled, if any. The estimated surface density of olive ridley individual turtles was 35.067 per sq. km (CV: 11.22 %) and the encounter rate was 3.68 turtles per km. The reproductive patch was found to shift during the season. The area of maximum utilization for mating pairs was 57.92 sq. km. The mating pairs had a patchy distribution in the near shore waters at a depth between 16-28 m (mean: 26 m). The maximum sea turtle congregation occurred between 2-5 km from the shore. Mating pairs sightings were maximum between 11.00 hrs and 13.00 hrs and at a sea surface temperature between 25 and 26ºC (mean: 24.6ºC). Factors such as time of the day, sea surface temperature and sea states were found to influence the sea turtle congregations.

POPULATIONS OF SPECIAL CONCERN

CURRENT STATUS OF THE LEATHERBACK TURTLE IN THE MEXICAN PACIFIC: IS THERE ANY HOPE?

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It's been ten years since the first alarm regarding the situation of the leatherback turtle (*Dermochelys coriacea*) in the Mexican Pacific, once considered the largest population in the world after the collapse of the Malaysian population. The daily track counts done from 1982 to 2004 have shown a declining trend for the number of leatherback nests in the four index beaches of the Mexican Pacific (Mexiquillo, Tierra Colorada, Cahuitn and Barra de la Cruz). The worst nesting season was 2002-2003, in which only 120 leatherback nests were recorded in the index beaches combined. The decline is attributed to a combination of extensive egg harvest in all Mexican Pacific beaches prior to conservation activities and high mortality of large adults in pelagic fisheries. From 1982 to 2004, a total of 229,751 leatherback hatchlings were released into the wild. It is a relatively small number compared to the whole reproductive potential of the population since the early 80s, hence the continuing decline in spite of 20 years of protection activities. The leatherback turtle in Mexico is on the brink of extinction and only drastic and immediate measures can change the trend. But there is hope for the future of the population given by the protection of at least 90% of the clutches laid on the index beaches, the participation of local communities in the conservation activities and increased awareness of the situation of the leatherback among the Mexican society.

THE MARINE TURTLE CONSERVATION ACT OF 2004 - NEW FUNDING SOURCE FOR INTERNATIONAL COLLABORATION

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On July 2, 2004 the Marine Turtle Conservation Act of 2004 (MTCA) was signed into law by U.S. President George Bush. This legislation, the culmination of three years of work, is a triumph for sea turtle conservation efforts around the globe. The MTCA has great potential for advancing global sea turtle conservation efforts by supporting projects to protect and manage nesting populations, nesting habitats and addressing other threats through research, monitoring, law enforcement, community outreach, education and capacity building. The focus of the law is to support efforts on nesting beaches. The bill establishes a fund to be administered by the U.S. Fish & Wildlife Service, Office of International Conservation and authorizes up to $5,000,000 annually. Based on appropriations experience with other similar multi-species funds, it is anticipated that initial funding may be around $1.5 million but Congressional appropriations could increase substantially each year if there is widespread support from sea turtle conservationists, foreign governments and non-governmental organizations. Eligible applicants include wildlife management authorities of foreign countries as well as any other person or group with demonstrated expertise in sea turtle conservation. Information about grant guidelines and other program information can be found at the USFWS website: www.fws.gov . The text of the MTCA (Public Law 108-266) can be found at http://Thomas.loc.gov.

OLIVE RIDLEY TURTLES (*LEPIDOCHELYS OLIVACEA*) IN ORISSA, INDIA: A REVIEW OF STATUS AND CONSERVATION

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Orissa, on the east coast of India, is one of three major mass nesting rookeries for olive ridley turtles in the world. A review of arribada data from 1976-1999, failure of arribadas in recent years and a decrease in the size of breeding adults suggest a potential or imminent decline, consistent with strandings of at least 100,000 dead turtles since 1994. Genetic studies suggest that this large and distinct Indian population is likely to be the ancestral source for contemporary global populations of olive ridley turtles as a result of recent (re)colonization events from the Indian Ocean. Tagging and satellite telemetry have demonstrated that at least some of these turtles forage off the coast of Sri Lanka and migrate along the east coast of India. Though > 200,000 olive ridley turtles (*Lepidochelys olivacea*) have been reported to nest during mass nesting events at Gahirmatha in Orissa on the east coast of India, this population currently suffers severe fishery related mortality. Unfortunately, the conservation of sea turtles in Orissa has become highly contentious, with fishing communities and conservationists deeply divided over many issues. The lack of consultation and dialogue and the unilateral implementation of conservation measures has led to the current impasse. Other threats include habitat loss, depredation of eggs, beach lighting and development projects including oil exploration and ports. Fresh approaches, that incorporate the livelihood concerns of local communities and participatory management, may provide a way forward.

PUBLIC EDUCATION AND POLICY

DIRECT PAYMENTS FOR SEA TURTLE CONSERVATION AND THE NEED FOR EMPIRICAL PROGRAM EVALUATION

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Economic incentives are increasingly being used to globally protect biodiversity. In particular, practitioners are experimenting with direct payments (or “performance payments”) for species and habitat protection. These payment approaches are based on a willing buyer-willing seller model. Sellers deliver conservation outcomes in exchange for a negotiated payment in cash or in kind. Payments are conditional on conservation outcomes. These payments tie the welfare of those in the best position to protect biodiversity to the conservation objectives of society.

In comparison with terrestrial conservation initiatives, the application of these payments is much harder in initiatives aimed at protecting migratory marine species like turtles. Despite this difficulty, sea turtle conservation practitioners are experimenting with pure or hybrid direct payment initiatives. With a focus on conservation interventions that aim to protect nesting beaches and improve hatchling survival rates in low-income nations, I highlight some of these payment initiatives. Through the lens of economic theory and extant empirical experience, I identify the strengths and weaknesses of such initiatives and consider the potential for using performance payments and trading schemes (i.e., offsets) to contribute to sea turtle conservation objectives.

I conclude by introducing the symposium members to the field of program evaluation and argue that conservation practitioners lag behind their colleagues in other policy fields with regard to their understanding of what interventions work to achieve their objectives. The role of experimental and quasi-experimental analyses to evaluate the effectiveness of education, incentives and regulations is explored with concrete examples from the field.

DEVELOPING A STEWARDSHIP ETHIC IN RESOURCE USERS: CONSERVING LEATHERBACK TURTLES IN CANADA

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Studying and protecting leatherback turtles in their northern foraging habitat is challenging as these animals are widely distributed and largely inaccessible. This renders enforcing conservation measures almost impossible. Since 1998, we have collaborated with commercial fishers to learn more about the biology of this species in temperate waters. To effectively conserve the leatherback turtle in this part of the world, however, it has been necessary to enlist the fishers not just as research partners, but also as champions of the turtle. Our attempts to instill a stewardship ethic and an affinity for the leatherback turtle amongst local fishers include an extensive public information and outreach campaign shaped by the culture of the fishing community and informed by fishers' traditional ecological knowledge. Our efforts to liaise with and integrate coastal community members in leatherback turtle research and conservation initiatives have resulted in 500 volunteers (the Nova Scotia Leatherback Turtle Working Group) who document the occurrence of turtles off Canada's east coast annually, promote safe and appropriate disentanglement techniques and assist with field research. Their sustained interest in our work and the signs of their growing sense of the intrinsic worth of the leatherback have been essential to our conservation efforts and can serve as a model for conserving sea turtles elsewhere.

THE ROLE OF SEA TURTLES IN DETERMINING MULTI-NATIONAL PRIORITY CONSERVATION AREAS

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Many species range across international boundaries, suggesting marine resource managers must implement conservation efforts at both the international and local levels in order to be effective. The Baja California to the Bering Sea (B2B) initiative is a tri-national effort to conserve the marine biodiversity of North Americas Pacific Coast. The Commission for Environmental Cooperation of North America (CEC) and Marine Conservation Biology Institute (MCBI) coordinated the effort between Mexico, the United States and Canada to identify priority conservation areas (PCAs) for this region.

The CEC and MCBI held a planning meeting in Monterey, California, USA in 2001. In 2002, at a Data Potluck Workshop in Portland, Oregon, USA, nearly 80 participants from 30 governmental, non-governmental and academic institutions offered and exchanged datasets relevant to the B2B spatial scale. MCBI compiled this spatial data into a common projection and resolution and performed analyses to identify benthic and pelagic features that affect marine species, which served as the groundwork for PCA identification.

Finally, in 2003, 45 marine experts from government agencies, non-governmental organizations and academia, representing interests of resource uses, management, science and conservation from the three nations, met at a workshop at Simon Fraser University, British Columbia, Canada to identify PCAs (Morgan et al 2005). MCBI and the CEC defined a PCA as an area with high ecological value, high anthropogenic threats (i.e. in need of immediate or future protection) and high conservation potential (i.e. strong conservation support or existing protective measures). Sea turtles were important criteria in determining areas to conserve as they are species of multi-national importance and conservation concern. Nineteen of the 28 PCAs from Islas

Maras to Kodiak Island contain sea turtle habitats and we found links between countries for three of the four sea turtle species in the B2B region. As part of another initiative, the CEC designated olive ridley, East Pacific green and leatherback turtles as Marine Species of Common Conservation Concern (Wilkinson et al, in review). The CEC determined key habitats for their foraging and nesting as part of this initiative and all key habitats within the B2B extent were included in the PCAs.

The CEC and the environmental ministers of Mexico, the United States and Canada officially adopting the 28 PCAs though implementation of pilot site actions plans is just beginning. Individual countries will determine the implementation process and will rely heavily on community-based groups and initiatives to implement, enforce, monitor and build community support for conservation of these areas. As a result of this process, marine resource managers now have a new tool for sea turtle protection in North America and they can use the selection criteria to determine the effectiveness of the sites once they are implemented. Conservation planners can also use the methods as a model for similar processes in other regions of the world.

RARE: INNOVATIVE APPROACHES PROTECT SEA TURTLES FROM MEXICO TO PALAU

Brad Nahill and Megan Hill

Rare

Rare's three main programs—Pride, Radio and Enterprises—use creative methods to build support for sea turtle conservation. The Pride program uses proven social marketing techniques and the leadership of local conservationists to dramatically increase public support for sea turtles in intensive year-long education campaigns. The campaign coordinators use turtle costumes, music videos, puppet shows and community festivals to spread the conservation message. A campaign run by the Palau Conservation Society built momentum for a moratorium on turtle taking in a culture that values sea turtle shells as currency and a food staple—draft legislation is now being reviewed by congress. The Rare Radio program uses serial dramas to change attitudes and behavior on public health and environmental issues in island communities throughout Micronesia and the Eastern Caribbean. These programs, which address issues such as turtle egg poaching and coastal development, are developed and managed by local actors, writers and producers, with Rare's support. By building community-based ecotourism businesses, Rare Enterprises helps bring jobs and economic benefits to residents of ecologically fragile areas-- offering alternatives to activities like blast fishing and turtle poaching. Intensive nature guide trainings focus on natural history, interpretation and conversational English, while the Ecotourism Promoters Training builds small business skills. Graduates of these programs are helping rural communities earn a sustainable income by protecting their nesting turtles. By focusing on developing the skills of people who live and work near important sea turtle habitat, all of Rare's main programs are building the constituencies needed for long-term sea turtle conservation.

SAVING SEA TURTLES THROUGH LOCAL EDUCATION: SEA TURTLE ECOLOGY PROGRAM AT PACUARE NATURE RESERVE, COSTA RICA

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Ecology Project Internationals Sea Turtle Ecology Program (STEP) introduces Costa Rican high school students to sea turtle conservation and research. Students join scientists for a three-day field course to monitor and research nesting leatherback sea turtles (*Dermochelys coriacea*). To evaluate the success and impact of STEP, students completed pre- and post-course surveys designed to identify shifts in attitudes towards conservation, determine changes in level of knowledge of sea turtle biology, distinguish factors affecting knowledge and assess the awareness and attitudes of students regarding local poaching issues. This study analyzed surveys from 291 students participating in the program between 2001 and 2003. Overall, attitudes toward conservation and knowledge of sea turtle biology improved significantly after participation in the STEP. Attitudes on poaching, litter and the protection of sea turtles significantly shifted to a more conservation-oriented response after program participation. Student knowledge scores of sea turtle biology improved by 47%, with both pre- and post-program scores increasing over time. Students from public schools scored significantly lower on post-survey knowledge scores than students from private schools. Furthermore, student response to poaching-related issues revealed that (a) illegal poaching was present in the majority of regions represented, (b) poaching was the most commonly listed threat to sea turtle populations and (c) students considered the sale and consumption of sea turtle eggs to be a problem. This program thus results in a significant and rapid enhancement of conservation knowledge and awareness. Further research should focus on whether these effects persist in the longer term.

AN ASSESSMENT OF LEGISLATION REGULATING MARINE TURTLE HARVEST IN THE UK OVERSEAS TERRITORIES IN THE CARIBBEAN

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The presence of laws regulating take of marine turtles and their eggs in the current legislature of all of the UK overseas territories in the Caribbean reflects the historical importance of turtle harvest in these countries. Turtle harvest is still permitted in British Virgin Islands, Cayman Islands, Montserrat and the Turks and Caicos Islands but is completely prohibited in Bermuda. Anguilla has imposed a temporary moratorium on the harvest of turtles and their eggs that will be reviewed in 2005. This paper describes the diversity of turtle harvest legislation in these UK overseas territories and discusses the utility of the current legislation in each territory. This paper also describes legislative amendments as proposed by the recently completed Turtles in the Caribbean Overseas Territories (TCOT), a 3-year UK government-funded project commissioned to assess the status and exploitation of marine turtles in these territories.

GRASSROOTS EDUCATION AND SEA TURTLE ECOTOURISM

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Since its establishment in 1995, one of the major tools for the management of the sea turtle refuge site at Wan-an Island, Penghu Archipelago, Taiwan is eco-tourism. However, due to the insufficient knowledge of the local residents and the political interferences from local government, the activity has not been carried out yet. Long-term insufficient government funding has created a questionable future for the refuge site. This is an unhealthy development for sea turtle conservation in Taiwan. A recent study, however, suggests that the grassroots education may be a feasible method to solve this problem. A two-day beach patroller re-training program was carried out at the beginning of September 2004. Fifty-six people, including patrollers and local residents, attended the program. Questionnaire interviews on each participant before and after the program showed that economic incentives (i.e. available jobs) are the major motivation for the local people to learn the knowledge of sea turtle ecology and conservation. The awareness of importance of sea turtle conservation increased from 52% to 89%. The willingness to cooperate with the conservation activities also increased from 13% to 68%. The knowledge of sea turtle ecology improved significantly after the training program. Results of this study suggest that the problems that ecotourism is facing, which also threats the management of the refuge site, can be solved or decreased through the grassroots education.

SENSORY BIOLOGY

OVERVIEW OF PROJECTS INVESTIGATING SEA TURTLE AND PELAGIC FISH SENSORY PHYSIOLOGY AND BEHAVIOR WITH THE AIM OF DEVELOPING TECHNIQUES THAT REDUCE OR ELIMINATE SEA TURTLE - LONGLINE INTERACTIONS

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The interactions of sea turtles with longline fishing gear have resulted in severe time-area closures for the U.S longline fleet. This approach to bycatch reduction is, however, not readily exportable to foreign fishing nations. The distributions of turtles and targeted fish species often overlap, so time-area closures are unlikely to be simultaneously effective at reducing turtle-fishing gear interactions and acceptable to the fishery. A more effective strategy is the development of techniques and gear modifications that reduce the incidence or severity of interactions to acceptable levels but that maintain economically viable catch rates of targeted fish species. In order for any approach to reduce sea turtle bycatch globally, it must be: relatively inexpensive, readily available, easy to use and easy to enforce. Ideally, it should also not require direct effort on the part of fishers. Defining and exploiting differences in sea turtle and fish sensory physiology (either vision, hearing or olfaction) is one possible approach. An international collaborative investigation is currently underway to do just this. The projects are intended to characterize vision, hearing, olfaction and gustation in sea turtles so that a comprehensive assessment of potential sensory attractants and repellants may be made. The immediate objective is to define specific and exploitable differences in the sensory capabilities of turtles, tunas and billfishes. The overall objective is development of devices or techniques that make fishing gear repulsive (or at least less attractive) to sea turtles but that are undetectable by the targeted fish species.

DIFFERENCES IN THE VISUAL CAPABILITIES OF SEA TURTLES AND BLUE WATER FISHES IMPLICATIONS FOR BYCATCH REDUCTION

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Sea turtles are unfortunate bycatch in the longline fisheries, mainly because they share the same habitat as fish species targeted by this type of fishing activity. Both turtles and blue water fishes are highly visual animals, suggesting that visual attraction plays a role in interactions with longline fishing gear. In our study we compared the visual capabilities of sea turtles and a number of blue water fishes with the hope of finding differences that might be used to design more species-specific fishing gear. We investigated eye design and optics, sensitivity to light and spatial resolving power, as well as the possibilities for colour vision in green turtles (*Chelonia mydas*), tunas (*Thunnus* spp.) and billfishes (Istiophoridae & Xiphiidae). Compared to blue water fishes the eyes of sea turtles appear to be better adapted for bright light vision, with a longer focal length and a smaller pupil in relation to the size of the eye. Billfishes and tunas have a more restricted range of spectral sensitivities (colour vision). For instance, longer wavelength (such as red) are invisible to swordfishes but not to sea turtles. We also found that the lenses of tunas and billfishes block ultraviolet (UV) light, while the ocular media (cornea, lens and vitreous humor) of green turtles transmit it, potentially allowing these animals to perceive UV light. We conclude that there are a number of differences in visual capabilities that could potentially be used for designing more species-specific fishing methods.

SELECTIVE INVISIBILITY: THE DESIGN OF FISHING LURES THAT CANNOT BE SEEN BY SEA TURTLES

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Sea turtles suffer substantial mortality as bycatch in longline fisheries. While chemical and other cues play a role in luring the animals to the hooked lines, visual cues likely also play a significant role. Because marine visual systems differ, it may be possible in certain cases for an object to be visible to one species yet invisible to another. The current study had two goals: 1) to design fishing gear that was invisible to all species and 2) to design lures on this gear that were visible to billfish but visually undetectable by sea turtles. Using measured profiles of the optical parameters of oceanic and coastal waters and radiative transfer software, the underwater light field was modeled at a number of depths. These light fields were then used to calculate the reflectance spectra (i.e. color) of perfectly cryptic objects as a function of depth and orientation. After these reflectances were determined, they were adjusted to increase their visibility to billfish while minimizing their visibility to sea turtles. Given current data on the spectral sensitivity of sea turtles and billfish, it appears that the most successful strategy is to increase the reflectance at violet and ultraviolet wavelengths. Additional strategies, using striped and flashing lures, which attempt to capitalize on differing spatial and temporal sensitivities of turtles and billfish, were investigated. While the similarities between billfish and turtle visual systems were problematic, the calculations still resulted in predictions that should be tested.

NIGHT-TIME SPECTRAL SENSITIVITY OF ADULT FEMALE LEATHERBACK SEA TURTLES

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Flicker electroretinography (ERG) was used to measure the spectral sensitivity of adult female leatherback sea turtles in vivo on a nesting beach on the southern Caribbean island of Trinidad. Individual turtles were selected for examination after the completion of nesting. A total of 4 turtles were successfully weighed, sedated, evaluated and subsequently released without incident. Gross ERG's were monitored with a corneal contact lens electrode. Sensitivity was evaluated from 440 nm to 610 nm using flickering (4-12 Hz) monochromatic stimuli. Although testing was attempted beyond this range of wavelengths and flicker rates, measurable responses could not be obtained. Maximum sensitivity for all subjects occurred at or slightly above 500 nm in concurrence with previously reported rod photopigment sensitivity data for this species (~502 nm). Results indicate that the rod visual pigments of the leatherback are similar to those of other sea turtles and are not shifted in sensitivity below 500 nm as seen in many other marine animals active in deep sea environments. Interestingly, the ERG responses of leatherbacks were quite different from those of green and loggerhead turtles when similarly tested. This disparity suggests that there may be underlying differences in retinal organization or that diurnal variation in retinal activity may exist in these sea turtles.

BEYOND THE FIVE SENSES: THE MAPS, COMPASSES AND SENSORY BIOLOGY OF SEA TURTLE NAVIGATION

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The long-distance migrations of sea turtles involve some of the most extraordinary feats of orientation and navigation in the animal kingdom. Hatchling turtles entering the sea for the first time immediately establish courses toward the open ocean and steadfastly maintain them after swimming beyond sight of land. As the turtles mature, they often follow complex migratory pathways across vast distances that sometimes span entire ocean basins. Older turtles take up residence in feeding grounds but periodically migrate long distances to particular mating and nesting sites. How sea turtles guide themselves across vast expanses of seemingly featureless ocean remained an enduring mystery for many years. During the past decade, however, research has revealed that the remarkable navigational skills of sea turtles are based at least partly on several unusual and previously unknown sensory abilities. Among these are the ability to perceive the direction of ocean waves by monitoring underwater acceleration sequences and an ability to approximate geographic position by using the Earth's magnetic field as a kind of navigational map.

CHEMORECEPTION IN LOGGERHEAD SEA TURTLES: IMPLICATIONS FOR LONGLINE FISHERIES INTERACTIONS

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Incidental capture of sea turtles in fishing gear is a cause of concern for fishermen and environmentalists alike. The degree to which sea turtles are attracted to and incidentally entangled in, fishing gear and bait is not well understood. A collaborative investigation is underway to characterize the sensory biology of sea turtles so that a comprehensive assessment of attractants and repellants may be made. We conducted experiments with juvenile loggerhead turtles at the NOAA Fisheries Sea Turtle Facility to investigate behavioral responses to various chemical cues. Our objectives were to develop a behavior assay to effectively quantify responses of loggerhead turtles to sensory stimuli and to test chemicals that could potentially be used as turtle repellents.

Juvenile loggerhead turtles were placed in a rectangular choice tank (6.1 x 0.9 x 0.7 m) filled with seawater. The designs of the tank and flow conditions within the tank were such that a chemical cue could be present on one side (the stimulus side) but not the other. Four chemical treatment groups were designated: food homogenate (attractant), shark semiochemical (potential repellent), methyl anthranilate (potential repellent) and 2-phenylethanol (novel control). Turtles in each treatment group underwent a chemical trial in which the chemical being tested was introduced into the stimulus side of the tank and a control trial in which no chemical was introduced. All trials were conducted in darkness to eliminate visual cues and the behavior of the turtle was monitored and recorded by an IR-sensitive video surveillance system. The amount of time turtles spent in the stimulus side of the tank during chemical and control trials was compared using repeated measures ANOVA. We predicted that attraction to a chemical would result in a significant increase in time spent on the stimulus side of the tank during chemical trials; whereas, presence of a deterrent chemical would result in avoidance of the stimulus side of the tank.

There were significant differences in behavior of turtles during chemical and control trials for the food treatment group. Turtles spent significantly more time in the stimulus section of the tank where food homogenate was present in combination with turbulent flow conditions (i.e., near the drain grate) (P = 0.014). Also, turtles frequently displayed a behavior in which they suddenly stopped swimming, put their nostrils to the tank floor and used rear flippers to paddle backwards or spin in circles around the same area during food trials. This behavior is typical of captive sea turtles feeding in enclosed pens and was displayed with significantly greater frequency during food trials compared with control trials (P = 0.014).

Loggerhead sea turtles are assumed to be primarily visual predators, but our results suggest that chemosensory cues may also play an important role in foraging behavior and potentially attract sea turtles to longline bait. The degree to which loggerhead turtles rely on chemical cues and other sensory systems for prey detection and location in natural foraging habitats remains to be determined.
There was no significant difference in the amount of time spent on the stimulus side of the tank between chemical and control trials for the shark semiochemical, methyl anthranilate, or 2-phenylethanol treatment groups. None of the chemicals tested during the course of this study showed potential as an effective turtle repellent.

Further research into the comparative sensory mechanisms of marine turtles and marine fishes are necessary to properly evaluate the feasibility of using a sensory deterrent to prevent interactions between endangered sea turtles and longline fishing gear.

ASSESSING THE IMPORTANCE OF OLFACTION FOR SEA TURTLES BY USING ALLELIC VARIATION TO SHOW SELECTION ON OLFACTORY RECEPTOR GENES

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Little is known about the importance of olfaction in the life of a sea turtle. Behavioral studies have shown that sea turtles can distinguish odors under water and in the air which suggests that olfaction might play a role in locating feeding sites, nesting beaches and in mating interactions. One way to assess the importance of a system to the life history of an animal is to see how active selection has been on the genes involved in that system. This can be accomplished by assessing the allelic variation of a gene across populations of the animal. Low allelic variation suggests strong selection, thus, high importance of a gene. Odors are detected in the olfactory system by odor receptors (ORs) embedded in the nasal tissue. OR genes code for these receptors. By cloning and sequencing OR genes from blood DNA, several sea turtle OR genes were identified. Two of these genes showed remarkable conservation between loggerhead, leatherback and green sea turtles. An allelic variation study was conducted on these two genes plus several more of the turtle OR genes found. Blood samples were obtained from 20 Atlantic, 10 Pacific and 18 Mediterranean loggerheads plus 19 Pacific greens and 25 Atlantic leatherbacks. Allelic variation for the two conserved genes was zero within populations and extremely low (1-6 amino acids different) between populations and species. Variation was also low in the other genes surveyed suggesting that olfaction is indeed very important for these animals.

LIGHT STICKS USED IN LONGLINE FISHERIES ATTRACT JUVENILE LOGGERHEAD SEA TURTLES

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Longline fisheries are a significant cause of mortality for several species of sea turtles. An improved understanding of the stimuli that induce turtles to approach longline sets may therefore be useful in efforts to minimize the impacts of such fisheries on sea turtle populations. Among the cues that may attract turtles are the glowing light sticks (chemiluminescent lights or battery-powered electrolumes) that are attached to many longlines and are believed to attract fish. To investigate whether these lights also attract sea turtles, we studied the responses of captive-reared juvenile loggerhead turtles to a variety of light sticks used in longline fisheries. Experiments were conducted at the NMFS Galveston Sea Turtle Facility. Each turtle was tethered to an electronic tracking system inside a large, water-filled arena, so that the orientation of the turtle could be monitored. Results indicated that turtles were strongly attracted to glowing light sticks. All colors (orange, yellow, green, blue and near-ultraviolet) and types of light sticks (chemical or battery-powered electrolumes) attracted turtles. Light sticks that flashed intermittently, however, failed to attract turtles. Another promising modification involved shading the top of the light so that light projects downward (away from turtles near the surface). Thus, the results suggest two possible ways in which light sticks might be modified to reduce their attractiveness to turtles.

SOCIAL AND CULTURAL ISSUES

LORETO, BAJA CALIFORNIA SUR COMMUNITY ATTITUDES SURVEY

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Loreto Bay National Marine Park in Baja California Sur, Mexico was an historical hotspot for green turtle foraging and development (*Chelonia mydas*) and possibly an important nesting area (*Lepidochelys olivacea*). Today, Loreto is also one of the few places in northwest Mexico where hawksbills (*Eretmochelys imbricata*) are still found. Low population densities in Loreto Bay compared to other sites on the peninsula are evidenced from an in-water volunteer monitoring program conducted by the Grupo Tortuguero (Wildcoast 2003). The average number of hours to catch one turtle using a 100 meter-long entanglement net (20 cm mesh) was 48 hours in 2001, 144 hours in 2002 and 192 hours in 2003. Most were green turtles (Grupo Tortuguero unpubl. data).

Loreto's turtles have been tracked to nesting beaches in Michoacán, Mexico (Nichols et al. 1999; Nichols 2001), where numbers have also declined steeply over the past three decades. Local fishermen witnessed this decline as the number of turtles hunted exceeded recruits. Although banned in 1990, turtle hunting for personal consumption and black market sales continues to occur in Loreto, where sea turtle meat can bring in MN$200-300/kg (US$20-30/kg) or more in northern markets. There are just a few well-known turtle poachers in Loreto, but their take is very high around 360 turtles per year. Actions by the Loreto authorities and local fishers could help curb poaching and reverse the population decline.

For this project, a questionnaire on knowledge and attitudes concerning sea turtles was administered in 2003 by the Universidad Autonma de Baja California Sur and San Diego State University. We surveyed 77 community members using stratified random sampling techniques and face-to-face interviews. Eighty-two percent of the participants were aware that Loreto Bay is a protected area, although only 26% of those interviewed thought that quality of life had improved since the parks establishment and 46% thought quality of life had remained the same. Perhaps this is because 26% thought the park was not properly managed.

In terms of sea turtle populations, 67% of surveyed Loretanos claimed it was possible to see a sea turtle in Loreto Bay. Most participants thought the number of sea turtles in the bay had increased or increased drastically in recent years (40%), while 31% did not know, 21% thought sea turtle numbers had decreased or decreased drastically and 7% thought the populations had been stable. Since population trends for sea turtles are costly and require many years of research, these anecdotal data are very important in assessing historical trends. As a preliminary marketing analysis tool, we asked people how much they would pay to enter a hypothetical Loreto Bay Sea Turtle Refuge. Forty-six percent of participants thought an entrance fee of 25 pesos (US$2.50) would be appropriate. Many thought there should be no charge (26%) and a small percentage of people (3%) claimed a fee of MN$500 (US$50) would be fair. The authors recommend pursuing the establishment of sea turtle refuge for Loreto Bay with three main goals: conservation of sea turtles, protection of marine habitat for all species and economic gain for the community, particularly by increasing sport fishing stock and ecotourism. If established, this refuge would be the first of its kind in the region and could bring international recognition and economic resources to Loreto.

LOCAL PERCEPTIONS AND OCEAN CONSERVATION: A STUDY OF HUMAN CONSUMPTION, EXPLOITATION AND CONSERVATION OF ENDANGERED SEA TURTLES IN BAJA CALIFORNIA SUR, MEXICO

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The five species of endangered sea turtles inhabiting the waters of Baja California Sur (BCS), Mexico have been protected by Mexican law since 1990, yet human actions such as local consumption, economic exploitation and fisheries bycatch of sea turtles as well as destruction and pollution of their habitats - continue to threaten these animals. To gain a better understanding of the social factors associated with this ecological dilemma, a two-month, mixed-methods study was conducted in four communities in the Baha Magdalena region of BCS. Specifically, conversations with and observations of local community members and conservationists were used to construct a 24-question survey that was applied to 159 individuals from four local communities. Survey questions were designed to explore local demographic data, information-gathering habits, perceptions regarding major local environmental issues, beliefs and knowledge regarding sea turtle endangerment, extent of and reasons for sea turtle consumption and exploitation, beliefs and knowledge regarding sea turtle conservation and opinions about means to improve the conservation of these endangered species. Based on qualitative and quantitative analyses, we recommend strategies for future grassroots and mass media communication and education campaigns promoting sea turtle and environmental conservation for BCS and other regions.

INTERACTIONS WITH ARTISANAL FISHING COMMUNITIES: THE EXPERIENCE FROM ECUADOR

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As an important component of a program to reduce bycatch of sea turtles in the Ecuadorian artisanal longline fisheries, a series of workshops were planned to explain the objectives and to create a communication system with the fishing communities. The concept was to ask the fishers to participate in the process of identifying the solutions to the problem and to test the alternative technology in their own boats. After 9 months of activity and the organization of dozens of workshops, we have acquired an experience we'd like to share. Statistical results are presented in another paper; here, we focus on the approach to the fishing community. Over time, the structure of the workshops has evolved into a format we believe is effective. The fishers' participation is voluntary, their opinions are heard and they don't feel threatened by the program. Honest reports and correct information are allowing us to identify the problems that need to be faced. The combination of a trusting relationship with the fishers, the observer reports and the captain interviews are providing us with a clear picture of the situation that is guiding our approach to the solutions. Stimulating their creativity has resulted in potentially interesting ideas that are beginning to originate in them for experiments to reduce bycatch. In this contribution, we'll focus on the interactions with the individual fishers and their organizations, the dynamics of the groups and the problems caused by competing organizations, individual agendas and other difficulties of the interaction.

THE UTILISATION OF MARINE TURTLE PRODUCTS ALONG THE COAST OF GHANA

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Like many other natural resources, marine turtles have been used in various ways by local communities. We looked at the situation in Ghana and how the use of turtle products varied from tribe to tribe. We used semi-structured questionnaires in combination with site observations to collect information on all aspects of utilisation. Preliminary results show that there are two extreme situations of utilisation. The people living on the east coast used most of the products for medicine and featured prominently in their cultural practices. On the other hand the major use for turtles on the west coast is for food as protein. This would suggest that there would be the need to adopt different conservation and management approaches to the various species found along the entire coast of Ghana.

THE HUMAN FACE OF COMMUNITY-BASED CONSERVATION: PARTICIPANTS' PERCEPTIONS OF THE TURTLE CONSERVATION PROJECT (TCP), SRI LANKA

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'Community-based conservation' (CBC) is widely promoted as an ideal means of engaging stakeholders in long-term marine turtle conservation and has been extensively discussed. However, an area that has received relatively little attention is the experience and perception of stakeholder participants. This paper examines the results of a rapid appraisal of stakeholder participants' perceptions of the establishment, development and current state of the Turtle Conservation Projects (TCP) community-based *in situ* marine turtle rookery protection programme in Rekawa, Sri Lanka. Personal accounts were gathered, through a structured interview, from community members who have been directly involved with the TCP in Rekawa over the past decade. Analysis of the data sheds light on participants' experiences of the impact of the CBC approach on their lives and provides an insight into their evaluation of the projects methodological successes and failures. This paper identifies potential pitfalls in the CBC approach and highlights lessons that have been learned from examining the participants' experiences.

OPTIONS & CHALLENGES FOR DEVELOPING ECOTOURISM AS A CONSERVATION MANAGEMENT TOOL AT SHELL BEACH, GUYANA

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The Shell Beach Area, in the North-West of Guyana, has been identified as a site for protection primarily because of its biological importance as a marine turtle nesting site and secondarily for its high concentrations of wading birds. Turtle conservation at Shell Beach is therefore about to undergo a switch from a voluntary conservation effort to one with government backing and a Protected Area (PA) declaration. The Guyana Marine Turtle Conservation Society (GMTCS), the lead agency for the planning team for this area, has recognised that the success of conservation, specifically marine turtle conservation at Shell Beach, may depend on the empowerment of local communities. GMTCS has been actively looking for sustainable economic projects for the main stakeholder community, the Almond Beach Community (ABC) and is currently promoting community-based eco-tourism as a sustainable and income generating partnership.

This research explores the current and potential ecotourism development at Shell Beach, assessing whether and how community-based ecotourism is a realistic option for the Almond Beach Community and conservation management efforts. This study looks at: a) the potential for eco-tourism development; b) the potential for community participation; and c) the impacts of community-based ecotourism on marine turtle conservation.

Theoretically, it would be fine if there were community-based ecotourism within the Shell Beach PA; this works for many national parks in the world and is a source of employment and income that consolidates the support of PA by governments. At Shell Beach however, tourism development of any scale that is going to bring sufficient economic benefits to the PA and the ABC, without having heavy social and environmental impacts, is not.

In recent years large donor organizations have insisted that projects they fund have a sustainable development component. This has meant that humble turtle conservation projects have had to identify a 'community' to work with before they are considered for funding. The ABC, defined by geographic location, has undergone almost its entire development from temporary fishing camps to what it is today (a settlement of 187 souls) in the last decade. When GMTCS was founded in 2000 to satisfy major donor insistence of routing funds through a legally established agency, it needed a community to work with to secure the funds it had been set up to attract. GMTCS has therefore unwittingly forced the somewhat transient souls of Almond Beach, as the closest settlement to the turtle conservation camp, to organise themselves into a community. While not a direct threat to the turtles, ABC could in the future present a serious threat to the proposed Shell Beach PA and conservation efforts; with over half the population being under the age of 18 years, if the rate of increase of ABC is projected into the decades to come, its presence could quite literally kill any chances of having a meaningful PA. By creating employment opportunities on Shell Beach before a PA has been established, there is a grave danger that even more people will be enticed to relocate to gain economic opportunities.

An interesting development is that there has now been a shift in NGO's thinking about involving local communities in conservation activities, as the list of projects working to develop local communities to satisfy conservation needs has resulted in an ever mounting pile of failures. Discussion of the "natural" alliances between conservationists and indigenous people and the need to work with local communities, common just a few years ago, has largely disappeared. It has been displaced by talk of changed priorities and the importance of refocusing on species and habitat conservation. The impact of this change in thought has yet to be monitored at ground level.

In the meantime, back on the ground, the ABC has a tourist facility ready to go that stands empty, waiting for tourists to discover Shell Beach. The ABC is becoming increasingly frustrated - so much talk of the money they could be making from the elusive or illusory 'tourists' they have heard so much about. The PA process grinds on to the tune of increasing skepticism from ABC that what they are being told is the truth. And somewhere in the midst of this symphony of frustrations, the next human generation is developing and the turtles crawl unaware, as priorities shift to new and nebulous preconceptions.

TAGGING AND TECHNOLOGY

USING TAG RECOVERY METHODS TO ESTIMATE SURVIVAL RATE OF SEA TURTLES

Cathi Campbell

Wildlife Conservation Society, Gainesville, Florida, USA.

Invited talk – no abstract available

MODELLING POST-RELEASE MORTALITY OF PELAGIC LOGGERHEAD SEA TURTLES EXPOSED TO THE HAWAII-BASED PELAGIC LONGLINE FISHERY

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The loggerhead sea turtle is an endangered species that is exposed to anthropogenic hazards such as pelagic longline fisheries. Many loggerheads caught in these fisheries are alive when released from the gear but it is assumed that many will die soon after because of injuries caused by the hooks or line entanglement. There are no robust estimates of post-release mortality for sea turtle species despite being essential for stock assessment and for evaluating the benefit of releasing turtles caught alive in the gear. We used satellite telemetry deployed by a NOAA Fisheries observer program to investigate the post-release mortality of loggerheads caught in the Hawaii-based pelagic longline fishery. We modelled time-to-failure of all transmitters using nonparametric statistical modelling (Kaplan-Meier-Turnbull, local regression) to derive survival and hazard functions for light- and deep-hooked loggerheads. We found a significant difference between the survival functions for light- and deep-hooked loggerheads within 90 days after release but no difference between survival functions after this time. But satellite transmitters fail for many reasons (defects, battery failure, transmitter detachment, turtle death), which results in a hazard function that confounds these competing risks. Hence it is impossible to infer post-release mortality based on satellite telemetry unless the cause of each transmitter failure is known, which is rarely the case. We discuss other survey design and statistical modelling challenges involved in the evaluation of post-release mortality based on satellite telemetry.

STATE OF THE ART IN DESIGN, MODELLING and SOFTWARE FOR TAGGING STUDIES

William L. Kendall

U.S.G.S. Patuxent Wildlife Research Center, Laurel, Maryland, USA

Invited talk – no abstract available

TECHNOLOGY

COLLABORATION, DATA SHARING AND THE FUTURE OF SEA TURTLES

Larry B. Crowder

Duke University Marine Laboratory, Beaufort, North Carolina, USA

Sea turtle researchers work hard to gather their data whether it be long hours on a loggerhead nesting beach, as observers on a swordfish longline vessel, or by placing satellite tags on leatherbacks. They do much of this work with limited or no funding. But each of us only examines a part of any sea turtle's life history or a part of any one population. So understanding our hard won data requires placing our results in a larger context. This is where research networks and data sharing become critical to the future of sea turtles. In this talk, I recap my experiences on a number of synthesis efforts from the Turtle Expert Working Group (TEWG), to the Loggerhead Recovery Team, to the State of the World's Sea Turtles (SWoT) introduced at the last ISTS meeting, as well as several large collaborative research projects. In order to be successful in managing and protecting sea turtles at a local, regional, or global level, we must collaborate effectively. Here I hope to open a dialog on data sharing and collaboration. The future of sea turtles will depend upon the ability of concerned scientists and managers to work together, build a comprehensive understanding and encourage strong national and international management.

OBIS-SEAMAP: DEVELOPING A BIOGEOGRAPHIC RESEARCH DATA COMMONS FOR THE CONSERVATION OF MARINE MAMMALS, SEA BIRDS AND SEA TURTLES

Patrick D. Halpin[1], Andy Read[2], Larry Crowder[2], Ben Best[1], Michael Coyne[1], David Hyrenbach[2] and Sloan Freeman[2]

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In this presentation, we describe the Spatial Ecological Analysis of Marine Megavertebrate Populations (SEAMAP) program, a node of the Ocean Biogeographic Information System (OBIS) and a component of the Census of Marine Life. OBIS-SEAMAP is a digital database of geo-referenced marine mammal, seabird and sea turtle distribution and abundance data to augment the understanding of the ecology of these megavertebrates by: (1) facilitating the study of potential impacts on threatened species, (2) enhancing our ability to test hypotheses about biogeographic and biodiversity models and (3) supporting modeling efforts to predict distributional changes in response to environmental change. To enhance the research and educational applications of this publicly available database, OBIS-SEAMAP provides a broad array of products (e.g., tabular data, maps and explicit meta-data) and services (e.g., web-based query, visualization and analysis tools). OBIS-SEAMAP provides managers with the ability to place the habits and habitats of marine megavertebrates in an oceanographic context, which is essential to design effective conservation measures. The OBIS-SEAMAP information system integrates data from disparate perspectives (e.g., movement data, vessel-based surveys, remote sensing information) required to analyze design fisheries bycatch mitigation measures, such as time-area closures and marine protected areas. Additionally, OBIS-SEAMAP provides educational products and analytical tools geared toward a broad audience of educators and students. The integration of disparate data sets into a global data commons will enhance our ability to place the behavior of these organisms in a large-scale oceanographic context and to design effective conservation measures.

SATELLITE TELEMETRY OF MARINE MEGAVERTEBRATES: THE COMING OF AGE OF AN EXPERIMENTAL SCIENCE

Kristen M. Hart and K. David Hyrenbach

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The number of published satellite telemetry papers has increased steadily since this technology was first used to track the movements of marine vertebrates in the late 1980s. The popularity and widespread use of satellite telemetry warrants a thorough evaluation of the progress and limitations facing this field of study. We reviewed satellite telemetry studies published during the last 16 years (1987-2003) and focus this presentation on marine turtle literature. We address the following aspects: (1) Objectives and Hypotheses, (2) Experimental Design, (3) Processing Telemetry Data, (4) Animal Movement Analysis and (5) Habitat Use Analysis. Our objective in conducting this critical review is three-fold: 1) we want to elevate the standards against which future satellite tracking studies will be evaluated by highlighting published papers that have undertaken in-depth and statistically rigorous analyses, 2) we hope that this review will increase the awareness of existing analyses and enhance communication across taxonomic groups and 3) we wish to stimulate the retrospective re-analysis of telemetry data that have already been collected and paid for but were originally analyzed in a very limited fashion. Because conservation funding will always be limited, relatively low-cost re-analysis of existing data represents an efficient use of resources. In particular, retrospective analyses using standardized techniques will help to identify existing knowledge gaps to be addressed by future studies. Additionally, we seek to promote carefully designed experiments that test specific hypotheses to make the most of valuable telemetry data.

MAKING THE MOST OF IT: HOW THE WORLDWIDE WEB CAN ENHANCE TURTLE RESEARCH AND CONSERVATION

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In recent years, technological advances in the worldwide web have revolutionised the way in which the turtle research and conservation community access and share information. Setting up a website is no longer the domain of the cyber specialist. Do-it-yourself software has lead to a significant increase in the number of NGOs creating their own sites with online capabilities ranging from tracking tagged turtles, accessing photo archives, sharing raw and meta-data, to interactive GIS. As more NGOs come online, an opportunity now exists to centralise the sharing of practical information through an online guide for turtle research and conservation. The guide will act as a hub for all, enabling access to the latest and geographically relevant sources of knowledge and information on turtle research, conservation and sustainable management practices globally. However, more importantly, it will provide an online toolbox to enable users to identify or characterise their turtle-related issues/problems and then advise on a solution(s) based on existing practices and methodologies. The flexibility and speed of up-dating information online will also promote users to share their expertise on turtle conservation and management by adding their own findings and solutions to the toolbox.

THE STATE OF THE WORLDS SEA TURTLES (SWOT) 2004

Roderic B. Mast[1], Brian J. Hutchinson[1], Maria Fernanda Pérez[2] and Ben Best[3]

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The State of the Worlds Sea Turtles Initiative (SWoT) was launched in late 2003 and is now gathering data from hundreds of sea turtle researchers worldwide. Founded by Conservation International, the ISTS, the Marine Turtle Specialist Group and Duke University's OBIS-SEAMAP project, SWoT is a long needed effort to create a publicly available, high quality, consensus driven, permanently evolving, global geo-referenced database of nesting beaches, migration routes and foraging areas for all species of marine turtles. This tool will allow the sea turtle movement as a whole to identify conservation priorities and gaps, readily see global or regional trends in turtle numbers and the mapped results will be used to engage governments, donors, corporations and lawmakers. For SWoT's first year, we have chosen to map all leatherback nesting beaches worldwide with nesting data from the most recent season. In the future, the SWoT report will be expanded to include data on all sea turtle species and at-sea data, such as migratory routes and foraging areas. Advancing a global data sharing initiative of this magnitude presents a serious challenge. This presentation will discuss lessons learned, successes, failures and future directions for the project. Most importantly, we will discuss potential applications for the SWoT results and demonstrate how sea turtle researchers and conservationists worldwide can get the most out of the SWoT initiative.

TESTING OF ARGOS-LINKED GPS SATELLITE TRANSMITTERS FOR SEA TURTLES

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We deployed Telonics ST-20 satellite transmitters equipped with integrated GPS receivers on loggerhead turtles under semi-captive and wild conditions. We compared the frequency and accuracy of Argos-linked GPS positions to conventional Argos Doppler locations under semi-captive conditions where the true location and surfacing behavior of the turtle was known. We deployed identical units on one adult female and four adult male loggerheads captured in Florida Bay (USA) just prior to the reproductive season. We examined the frequency of Argos-linked GPS positioning vs. Argos Doppler positioning. The Argos-linked GPS transmitters provided fewer overall location transmissions as compared to the conventional Argos tag, but the Argos-linked GPS positions were much more accurate. We were able to determine nesting and non-nesting emergences and locations of these emergences for the breeding female during the entire nesting season. Argos-linked GPS satellite transmitter technology offers significant promise to collect high resolution and extremely accurate location data for marine turtles; however, certain improvements will be needed to increase the frequency of acquiring GPS positions.

POSTER PRESENTATIONS

ANATOMY AND PHYSIOLOGY

COMPARATIVE ANALYSIS OF ELEMENTS FROM EGGSHELLS TAKEN IMMEDIATELY AFTER OVIPOSITION AND AFTER HATCHING USING X-RAY MICROANALYSIS AND IMAGE MAPPING

Abdulaziz Y. A. Al Kindi, Ibrahim Y. Mahmoud, Saif N. Al-Bahry, Issa S. Al-Amri and Abdulkadir Elshfie

Sultan Qaboos University, Muscat, Oman

Eggshells were collected from green turtles' (*Chelonia mydas*) nests at Ras Al-Hadd Reserve, Oman. The eggshells were taken from freshly laid eggs immediately after oviposition and from eggs shortly after hatching. The eggshell samples were analyzed for the elemental composition and image mapping done using the Oxford energy dispersive x-ray spectrometer (EDS) at 20 kV. Quantitative analysis of composition and distribution were displayed to compare weight and atomic percentages. In addition, eggshells were examined under a low vacuum and viewed with back scattered electron detector at 20 kV or examined at a higher vacuum (gold coated) with secondary electron detector at 5 kV using JSM-5600 LV. Eggshells are composed of three layers: an outer layer made up of predominately loose calcium carbonate crystals and an inner shell layer of compact calcium carbonate. The shell membrane is made up of a thin sheet containing numerous fibers. Comparing the percentage of element weights in eggshells after egg laying with the ones after hatching, it revealed that the elements (C, O, Na, Mg, Al, Si, S, Cl, Cu, Zn and Pb) were significantly higher ($P < 0.05$).

ACCUMULATION IN LIVERS AND EXCRETION THROUGH EGGS OF HEAVY METALS IN A NESTING POPULATION OF GREEN TURTLES, *CHELONIA MYDAS*, IN THE NW INDIAN OCEAN

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The green turtle, *Chelonia myda,s* nesting population of Ras Al Hadd, Arabian Sea is the largest in the Indian Ocean (13,000 - 20,000 ind nesting annually). The area has a busy maritime traffic connecting the Indian Ocean to the Arabian Gulf and is one of the most oil-polluted areas of the world. In this study, conducted in 2003, trace-metal concentrations (cadmium, Cd; cobalt, Co; chromium, Cr; copper, Cu; manganese, Mn; molybdenum, Mo; nickel, Ni; lead, Pb; and vanadium, V) in livers of 6 stranded female adults and excreted through eggs of nesting females (n = 3 eggs/clutch, 8 ind.) have been analyzed at Ras Al Hadd by Atomic Absorption Spectrophotometry (AAS). Mean levels in livers were: 1408 ppm ww (wet weight) for Cd, 4.088 ppm ww for Co, 10.199 ppm ww for Cr, 534.610 ppm ww for Cu, 43.530 ppm ww for Mn, 9.848 ppm ww for Mo, 14.729 ppm ww for Ni, 5.852 ppm ww for Pb and 21.298 ppm ww for V; and in eggs (whole) were: 0.399 ppm ww (wet weight) for Cd, 0.336 ppm ww for Co, 1.827 ppm ww for Cr, 14.637 ppm ww for Cu, 2.738 ppm ww for Mn, 0.101 ppm ww for Mo, 3.185 ppm ww for Ni, 0.951 ppm ww for Pb and 2.107 ppm ww for V. Values in livers are in general similar to or lower than those in livers of several turtle species found elsewhere. Values in eggs are in general lower than those observed elsewhere.

EXERCISE NOT SIZE KEEPS LEATHERBACKS WARM

Brian Bostrom and David R. Jones

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Leatherback turtles can maintain body temperatures well above that of the ambient water but this regulatory ability is poorly understood due to a lack of experimental data. We propose that leatherbacks actively maintain their body temperature due to swimming activity while keeping thermal insulation constant. We consider a leatherback as a cylinder that loses heat produced by the metabolic cost of maintaining various swimming speeds. The cost of locomotion depends on body drag and the metabolic efficiency of conversion. Our model provides quantitative evidence that behavior is the major contributor to maintenance of body temperature in cold environments.

IDENTIFICATION OF STEROID HORMONES IN THE ALLANTOIC FLUID AND PLASMA OF LOGGERHEAD HATCHLINGS

Brooke L. Botterill[1], Sarah L. Milton[1] and Stephen M. Blair[2]

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Assessing sex ratios for populations of sea turtles is an important aspect of species conservation. Laboratory studies of temperature and sex ratios have provided the community with good estimates of sea turtle pivotal temperatures, but may not be predictive in natural environments where temperatures are consistently changing. This project has developed a novel procedure for detecting the estrogens and testosterone in allantoic fluid and blood plasma of hatchling loggerhead sea turtles. Collection of egg fluids is non-invasive to the turtles, while blood collection is relatively easy for conservationists and scientists. Eggs were incubated in individual cups approximately 1 week prior to the estimated hatch date. Upon hatching, 2 mls of allantoic fluid were collected and 200µl of blood was collected from the 2-3 day old hatchlings. These samples were frozen, extracted twice with ethyl acetate, dried under nitrogen and finally resuspended in an acetonitrile and distilled water mixture. High performance liquid chromatography was performed in the laboratory to determine hormone profiles. These profiles were compared to known standards to determine concentrations within the initial sample and percent recovery. Steroid hormones are readily detectable in both the allantoic fluid and plasma, with estrone concentrations highest in the egg fluids. Estrone and estradiol levels are both high in the plasma. Fluid estriol levels were below equipment detection limits, but this hormone was detectable in plasma. This method could provide a means to assess sea turtle sex ratios in large populations at different ages and life stages.

A VALID TECHNIQUE TO STUDY THE WATER POTENTIAL DURING THE EMBRYOGENESIS OF SEA TURTLES

I-Jiunn Cheng, Ko Pou-Chung and Huang Tsung-shun

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A recently developed dry tensior coupled with a temperature data logger were used, in the field, to determine the influence of water potential on the nest temperature and subsequent embryonic development of the green turtle. The changes in water potential and nest temperature throughout the incubation period were compared in a partially-blocked cage with horizontal water cut-off (the caged nest) and a nest without caged isolation (the uncaged nest). Results showed that caged isolation had a significant impact on water potential, especially during the second phase of development. This, in turn, decreased the nest temperature throughout the incubation period, affecting the hatching success and phenotypic characteristics of the hatchlings. Thus, a decrease in water potential had a negative impact on reproductive fitness of the population. Results of the study suggest that the dry tensior is a valid instrument for the field study of sea turtle embryogenesis.

CLUTCH-SPECIFIC VARIATION IN PIVOTAL TEMPERATURE: IMPLICATIONS FOR SEA TURTLE STUDIES

Keela L. Dodd, Chris Murdock and Thane Wibbels

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The concept of a pivotal temperature (the incubation temperature producing a 1:1 sex ratio) is a useful parameter in describing temperature-dependent sex determination (TSD). The results from TSD studies often estimate a specific pivotal temperature. However, some studies suggest that the pivotal temperature estimate should be considered a mean rather than a specific value. For example, several studies in sea turtle as well as freshwater turtles have suggested inter- and intraspecific variation in pivotal temperature. These studies have prompted suggestions that the pivotal temperature of an individual turtle could be affected by underlying genetic factors or egg-specific factors like maternal hormone levels in the yolk. The current study addresses pivotal temperature variation within clutches. Due to the endangered and threatened status of sea turtles, a freshwater turtle model (*Trachemys scripta*) was utilized. This species has a similar pattern and transitional range of temperatures to those of sea turtles. For each of three nesting seasons (2000, 2001, 2003), sex ratios were examined in forty to fifty-five clutches throughout the nesting season. The results indicate that pivotal temperature varies significantly between clutches. In fact, when incubated at the estimated pivotal temperatures, clutch sex ratios ranging from 100% male to 100% female were obtained. These results indicate that pivotal temperature studies should control for clutch-specific variation by using large numbers of clutches. This should be taken into account when designing pivotal temperature studies for sea turtles.

SIAMESE SEA TURTLE IN QUINTANA ROO, MÉXICO

Roberto Herrera Pavon[1], Ana Cecilia Negrete[2], Alejandro Arenas[2] and Julio Zurita[3]

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Six Siamese hatchlings (five green and one loggerhead turtle) were recorded from 1990 to 2004 along the central coast of Quintana Roo. Two of the hatchlings died when tropical storm "Diana" hit the state. One of the greens that survived at X'cacel lived for four months, while one green and the loggerhead turtle lived for two months. The green that hatched at Aventuras DIF on September 2 1992 is still alive. This poster describes the current condition of the 12-year-old turtle and its medical chart from the last 7 years. The presence of this turtle at X'cacel, where environmental education took place for the ultimate goal of protecting this beach, is reviewed.

VALIDATION OF THE USE OF DOUBLY LABELED WATER IN THE GREEN TURTLE (*CHELONIA MYDAS*): MEASUREMENTS OF BODY WATER, WATER TURNOVER AND METABOLISM

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Daily energetic costs or time energy budgets have long been sought after by sea turtle biologists. These measurements give insight into a turtle's daily food requirements and allocation of energy to various activities (i.e. growth, reproduction, movements, heat production, etc.) all of which are important factors in management of an endangered species. Estimation of these costs and budgets has been limited to modeling and determinations of individual costs of resting, swimming, digestion etc. We used 6 green turtles (mass 16.80 + 1.46 kg) imported from the Cayman turtle farm in a validation study of the Doubly Labeled Water (DLW) method for determinations of daily energetic expenditure versus real-time respirometry. Although several biologists have attempted to use DLW in sea turtles this study represents the first validation of its use. Animals were injected with DLW then placed in a respirometer for 5-day trials in both fed and fasted states. Blood samples were taken at the start, mid and end points for DLW determinations and oxygen consumption was monitored continuously. Green turtle total body water (TBW) ranged from 62.3 to 66.5 %, water flux rates ranged from 6.25 to 10.3 % of TBW and the DLW method gave energetic determinations which deviated from respirometry determinations by 0.26% to 30%.

EMBRYONIC LIMB FORMATION IN THE LOGGERHEAD SEA TURTLE, *CARETTA CARETTA*

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Sea turtle anatomy is unique and is characterized by one of their most distinctive characteristics: wing-like flippers. Sea turtles are secondarily marine (their ancestors were terrestrial or semi-terrestrial); all evolved flippers that propel them efficiently in the water. We studied the development of the flipper skeleton to understand how such a design might evolve. Comparison of sequential embryonic stages from limb bud to near hatching allows us to identify the pattern and process of limb formation. Specimens were collected from unhatched eggs in natural nests, preserved, staged and subsequently cleared and stained to identify skeletal elements. *Caretta caretta* embryos were fixed in 10% buffered formalin and cleared and stained for cartilage skeletal elements. Miller's (1985) staging criteria were used to describe embryo stages when limbs form. Specimens were prepared as whole mounts for the anatomical description of limb structures. The degree of cartilage condensation and outgrowth at each stage was described in detail as well as documented through photographs and illustrations. Sea turtle fore limbs form similarly to fore limbs of other tetrapods; however, the flipper plan is due to differences in later stages of limb growth. Flippers begin as typical limb buds which grow out laterally from the body wall. Fore limbs appear earlier during development than hind limbs. As the limbs elongate, digital plates (the prospective digits) develop distinct grooves and ridges form. The flipper then forms through prolonged elongation of the phalanges and reduced cell death in the soft tissues of the manus. Flipper development appears to be , in part, a heterochronic event in the evolution of turtle limb form.

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CORRECTION OF AN ERROR IN THE TESTOSTERONE RADIOIMMUNOASSAY FOR EVALUATING SEX RATIOS AND REPRODUCTIVE STATUS OF SEA TURTLES

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Since 1980 the Owens lab has used a testosterone radioimmunoassay to determine the sex of immature sea turtles of several species. In addition, several studies of the reproductive physiology of sea turtles have been generated from this lab and in collaboration with several other labs. We recently discovered an error, which does not affect relative levels of hormone but does impact absolute levels. The concentrations of the testosterone standards were found to be incorrect. We determined that the stock solution from which the dilutions were made for the assay's standard curve was labeled incorrectly by a previous investigator. New testosterone (Sigma-Aldrich, Inc., St. Louis, Missouri) was purchased and a new testosterone stock solution (50µg/100ml) was prepared. New standards were serially diluted from this stock solution (1250, 625, 312.5, 156, 78, 39 and 19.5 pg/ml). Experiments compared the old standards to the new. The old standards were determined to be approximately ten times higher than they were previously reported. Therefore, all testosterone values reported between 1980 and 2000 need to be multiplied by a correction factor of ten in order to correct for this mistake. The testosterone levels used by the Owens lab for sex determination were validated through laparoscopy, so the range for each sex is corrected by multiplying by ten. It is important to emphasize that all sex ratio predictions previously reported remain unchanged since the sex determination component of the assay depends on relative amounts of hormone in males versus females and not on the absolute levels.

HATCHLING HEARING

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Turtles are unique in that they have bony shells and half their cochlear hairs cells (*Chelonia mydas*) rest on a bony shelf (limbus). Are these two parameters, unique to turtles, related to hearing? The simplest assumption is that hatchlings are just smaller versions of adults and their hearing abilities are essentially mirrored. Cochlear potentials data from one fresh water species support this view, in terms of the inferred audiometric thresholds from 100-1000 Hz. Hair cell counts for receptors on the basilar membrane are similar for hatchlings and adults, consistent with similar audiograms.

Strikingly, turtles are the only vertebrate group that has a substantial population of hair cells on the bony limbus in the inner ear. The importance of the limbic hair cells is that mechanical stimulation must be in a different manner than for hair cells on the membrane. The hair cells on the membrane would be the most sensitive to air conduction stimulation, including natal beach acoustics. None-the less these limbic hair cells are richly innervated, suggesting functional significance. The basilar membrane hair cells may be those needed for sensitivity, i.e. the audiometric thresholds and the limbic hair cell may code more intense sound, a view proposed by Wever twenty five years ago. His assumption is that the limbic hair cells provide a larger dynamic range of hearing. Hatchlings have less than half the adult population of limbic hair cells and may simply have a restricted loudness range. Alternatively, basilar hair cells may provide the sensory substrate for air conduction hearing (with a more restricted dynamic range). The limbic hair cell population could respond to intense aerial sound but would be more sensitive to vibration or bone conduction hearing. Thus, according to this view, the developmental form of hearing gradually shifts from primarily air conduction in the hatchling to bone conduction in the more massive adults. There are more hair cells per area in the hatchling cochlea, producing a compression effect. Cochlea compression (hatchlings) yields a broader frequency response due to the almost uniform hair cell density across cochlea.

Limbic hair cells, the rule in fish and amphibians, are considered the primitive condition. Turtle sound sensitivity is much like a fish. They have also adapted to aerial sound with an eardrum, an ossicle, an air filled middle ear (spring) and hair cells on a membrane. They retain bone conduction sensitivity for aquatic hearing. Hatchlings, with less substrate coupling, most likely use aerial hearing to detect surf sounds with energy with two peaks.

HEAT SHOCK PROTEIN EXPRESSION AND FIBROPAPILLOMATOSIS: NOVEL USE OF MOLECULAR TECHNIQUES TO EVALUATE HEALTH AND STRESS LEVELS IN MARINE TURTLES

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Green turtle fibropapillomatosis, first described in *Chelonia mydas* in 1938, has since been diagnosed in virtually all species of marine turtles. This disease, characterized by the proliferation of highly debilitating benign tumors, has reached almost epidemic proportions worldwide, primarily affecting juvenile turtles. Although a viral agent has been suggested, the etiology of this disease is as yet uncertain and is likely multifactorial in nature. Studies have shown an association between fibropapillomatosis and juvenile developmental habitats in areas of high anthropogenic disturbance. In addition, turtles in these disturbed areas, even those without visible tumors, have been shown to be chronically stressed and immunosuppressed. Recently, there has been considerable interest in the identification of molecular markers indicative of both general and specific stressors in a wide variety of aquatic and terrestrial organisms. One group of such potential markers, the heat shock or stress proteins, are expressed in response to a wide variety of environmental and physiological stressors, including viral infections and tumors. This study examines stress protein expression in both healthy and fibropapilloma afflicted green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles from a highly stressed environment (Indian River Lagoon, FL) and compares this response to that of individuals from more pristine offshore reef environments.

OCCURRENCE OF MUTANT HATCHLINGS IN A POPULATION OF GREEN TURTLES *CHELONIA MYDAS* IN THE NW INDIAN OCEAN

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At Ras Al Hadd Turtle Reserve, NW Indian Ocean, a team of Park Rangers deployed by the government of the Sultanate of Oman is involved in monitoring the nesting grounds for green sea turtles. One of the measures taken to protect hatchlings from predators on beaches is to collect hatchlings that hatch in early morning and keep them in containers of seawater (to avoid desiccation) to release at night. Observation of these hatchlings in April 2002 and September 2003 showed that 5% of hatchlings in 2002 and more than 10% in 2003 presented either asymmetrical distribution of pleural carapacial scutes or asymmetrical malformation of vertebral and pleural carapacial scutes. Mutant hatchlings were also about 1 cm longer than apparently normal individuals (CCL = 4.5 cm; CCW = 4.4 cm). Mutations may occur spontaneously but are relatively rare and it is likely that they were not caused by contamination by petroleum hydrocarbons or trace metals, as values of these were estimated as within ranges found elsewhere. Higher occurrence of malformations may occur also due to exposure to radioactive materials. A recent study showed that seaweeds (eg. *Chaetomorpha* spp. and *Enteromorpha* sp.) and sea-grasses (eg. *Halodule* sp., *Halophila* spp. and *Sargassum* spp.) known to be important components of the diet of these turtles, are contaminated with several radionuclides including the man-made Cesium-137. The algae and seagrass were collected from a major feeding ground for this turtle species in the area. An estimation of radionuclide concentrations in hatchlings is needed.

CARAPACE FRACTURE MANAGEMENT USING EXTERNAL FIXATION

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Large, unstable carapace fractures are frequently presented to rehabilitation facilities due to boat-hit injuries. Application of standard fracture repair techniques in sea turtles is complicated by numerous factors: limited cortical bone to anchor implants, implant loosening due to significant plastron and carapace movement during breathing and the fact that attachment of any implant to the shell will alter normal growth and development. A 130 kg adult male loggerhead was presented to the Marinelife Center with a fracture to the caudal carapace involving the vertebral bones and thus, potentially the spinal cord. This fracture was unstable enough to warrant aggressive treatment due to its size, depth and location. A technique using human orthopedic external fixators was elected to accomplish the reduction and stabilization necessary to promote healing. Threaded cortical bone pins were placed through the peripheral bones on either side of the fracture and at a stabilization point on the opposite side of the carapace. Engaging both cortices of the bone created greater implant stability. A fixator allowing for several centimeters of reduction on the fracture as well as lateral and horizontal stabilization was then installed onto the pins. Two months after stabilization, granulated tissue was forming along the debrided carapace edges and beneath the bone within soft issue. The bones of the carapace did not knit as hoped but the wound was healing by second intention. After 4 months, healing of the fracture had progressed to the point where the turtle was releasable.

TEMPORAL VARIABILITY OF HEMATOLOGY AND BLOOD BIOCHEMISTRY IN THE BLACK SEA TURTLE, *CHELONIA MYDAS AGASSIZII* (CRYPTODIRA: CHELONIIDAE), IN THEIR NATURAL ENVIRONMENT

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The black sea turtle (*Chelonia mydas agassizii*) is an endangered species that is widely distributed along the Mexican Pacific. However most of the protection efforts for this subspecies have been focused in nesting areas and little is known related to feeding and developmental regions, such as those along the Baja California peninsula. As the landscape of Baja California is changing due to human impacts, it will be necessary to better understand the health of juvenile and adult sea turtles on their feeding grounds and to identify any possible disease conditions. Monitoring hematology and blood biochemistry can be used as a sensitive and reliable tool for assessing the health status, condition, stress and other environmental impacts if sufficient specimens are collected in a population. However a basic understanding is lacking of the normal variation in blood hematological and biochemical parameters in sea turtles and how these parameters change over differing time scales (for example: diurnal and seasonal cycles), sex, age, foraging aggregation and different feeding habits. The present project addresses the urgent need to establish normal blood and biochemistry values in black sea turtles in Baja California. In addition, we will attempt to understand how these parameters change over time scales to provide reference values for identifying natural or human related impacts due to stress, feeding habits, sex, age or disease exposure. The data collected will establish the baseline data needed as a standard for future studies of wild populations of black sea turtles in Baja California.

BLOOD BIOCHEMISTRY VALUES OF GREEN TURTLES (*CHELONIA MYDAS*) IN THE GULF OF VENEZUELA, HIGH VENEZUELAN GUAJIRA

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Blood biochemistry represents a valuable diagnostic tool for monitoring the health and condition of free-ranging wildlife, allowing evaluation of renal, hepatic, cellular and muscular health. The establishment of baseline blood biochemistry profiles for healthy wild sea turtles is a priority for their conservation and management. Normal blood biochemistry values have not been established for most free-ranging sea turtle populations.

The objective of this study was to determine the baseline blood biochemistry values of green turtle (*Chelonia mydas*) in the western Gulf of Venezuela. Between April and June of 2004, 30 green turtles (29 clinically healthy and 1 with fibropapillomas (GTFP)) were collected from the Gulf of Venezuela. Green turtles were captured placing nets off the coast of the Gulf of Venezuela. Turtles were measured and thoroughly examined for the presence of fibropapillomas.

A blood sample was taken from the dorsal postoccipital sinuses (Owens and Ruiz 1980). Blood was collected in vacutainer tubes containing lithium heparin using 21 gauge needles and 5 ml or 10 ml syringes. Plasma was separated by centrifugation at 2000 rpm for 10 minutes and split into vials. Vials were stored in a freezer at -70 ºC. Blood biochemistry variables were determined on a spectrophotometer using the commercial kits from Sigma, Bioscience, Wiener Lab and Biogamma C.A.

Total protein, albumin, creatinine, phosphorus and glucose were compared to mean and reference intervals reported for healthy juvenile wild green turtles from Hawaii (Aguirre et al. 1995 and Aguirre and Balazs, 2000). The Gulf of Venezuela green turtles presented higher blood urea nitrogen, cholesterol, uric acid and alkaline phosphatase values. Triglycerides levels were significantly lower when compared to those reported by Aguirre et al. 1995 and Aguirre and Balazs 2000; however, observed cholesterol levels were higher.

This study showed variability when compared to values established by other authors due to differences in capture technique, condition, units reported, biochemistry determination technique, sex, reproductive state, stress, temperature, and age/size classes. The green turtles from Gulf of Venezuela showed a condition of stability and good health status.

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HEMATOLOGICAL VALUES OF GREEN TURTLE (*CHELONIA MYDAS*) IN THE GULF OF VENEZUELA, HIGH VENEZUELAN GUAJIRA

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The field of reptile hematology will evolve as more clinicians and technicians gain experience and expertise. Hematological values play an important role in diagnosis and treatment of all species and are useful parameters that indicate the health status or state of disease in sea turtles. The objective of this study was to establish the baseline hematological values for green turtles (*Chelonia mydas*) in the Gulf of Venezuela, High Venezuelan Guajira. Between April and June of 2004, 30 green turtles (29 clinically healthy and 1 with fibropapilloma GTFP) were collected from Gulf of Venezuela. Turtles were captured by placing nets along the coastline. Green turtles were measured and examined for the presence of fibropapillomas. A blood sample was taken from the dorsal postoccipital sinuses (Owens and Ruiz 1980). Blood was collected in vacutainer tubes containing lithium heparin using 21 gauge needles and 5 ml or 10 ml syringes. Hematologic erythrocyte (RBC) count and leukocyte (WBC) count were determined with microscopy using Natt and Herrick's solution technique. The packed cell volume (PCV) was determined for centrifugation at 16500 rpm for 5 minutes. The leukocytes were visualized using Diff Quik stains.

This study showed some variations in blood values when compared with previously established values. Many factors, such as age, sex, season, stress, diet, circulating hormones, temperature, oxygen pressure and body hydration affect these blood values. Hematological values obtained in this study come close to those reported by Aguirre et al. 1995 for blood samples taken from turtles 3 to 4 hours after capture, due to the green turtles in the research presented here remaining in the nets after capture for 6 to 12 hours during the night. Four types of leukocytes were observed: heterophils, eosinophils, lymphocytes and monocytes. Only one turtle presented fibropapillomas; it was lightly affected with 3 tumors of 1-3 cm in the front extremities and neck. This is the first report of fibropapilloma in the extreme western Gulf of Venezuela. The results indicate some variations in the hematological values when compared with values established by other authors, attributed to the differences in the methodology applied as to capture technique, population, the hematological determination technique, age, sex, reproductive state, stress and temperature. The green turtles from Gulf of Venezuela showed a condition of stability and good health status, with only one presenting fibropapillomas.

Acknowledgments: We are grateful for the hospitality of the ethnos Wayúu, Pacheco and Friends. In addition, we thank Dr. Dave Owens for sending me papers and the Ministry of Environment and Natural Resources for providing a scientific hunting license to work with these reptiles. The symposium organizers are also gratefully acknowledged and the Western Pacific Fisheries Management Council, NMFS Office of Protected Species, NMFS Southeast Fisheries Science Center, National Fish and Wildlife Federation, Walt Disney's Animal Kingdom and Wildlife Computers for making possible my participation in the Sea Turtle Symposium.

SEA TURTLE-SHARK INTERACTIONS: INJURY CLASSIFICATION CRITERIA

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Sea turtles face numerous threats within their marine environment. These threats include predation at various life history stages that may affect population levels within each species. Recent attention has been drawn to the interspecific interactions between sharks and sea turtles. In an attempt to gain insight into these shark-turtle interactions, researchers have started using the tool of injury identification to infer estimates of injury resulting from attempted predation. During our efforts to systematically classify injuries present on the turtles entrained within the intake system at the St. Lucie Nuclear Power Plant, Florida, USA it has become evident that there are no standard criteria used when classifying an injury as shark-related. This is an important component when comparing data within and among study locations. In this presentation, we present clearly defined shark-related injury criteria for researchers to use when attempting to discern shark-related injuries from other injury sources, thereby standardizing shark-related injuries being reported.

DO STABLE ISOTOPE SIGNATURES VARY AMONG LOGGERHEAD HATCHLING TISSUES? AN INTER- AND INTRA-CLUTCH COMPARISON

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Naturally occurring stable isotopes are increasingly being used in ecological studies involving migratory patterns, trophic structure and foraging strategies. In this study, we used stable isotope analysis to determine how isotopic fractionation from egg nutrients to hatchling tissue varies among recently hatched loggerhead turtles. Five tissues (liver, epidermis, scute, brain and muscle) and yolk sacks were dissected from 15 hatchling loggerheads, three turtles from five different clutches (n = 90 tissues). We compared isotopic signatures of carbon and nitrogen in the five tissues and yolk within each hatchling, within each clutch and among clutches to test for significant variation. Differences in signatures among tissues would indicate that heavy and light isotopes of nitrogen and carbon contained in the egg are routed differentially among tissues during embryonic development. The results of this investigation also provide information on appropriate sample sizes and relevant tissues for further studies involving stable isotopes and loggerhead hatchlings.

A COOL YEAR FOR KEMP'S RIDLEYS: SIGNFICANT INCREASE IN THE PRODUCTION OF MALE HATCHLINGS DURING THE 2004 NESTING SEASON AT RANCHO NUEVO, MÉXICO

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All sea turtle species, including the Kemp's ridley, possess temperature dependent sex determination (TSD). This form of sex determination can generate a wide range of sex ratios. As a result, it is of ecological interest and conservational importance to monitor hatchling sex ratios produced in nesting beach conservation programs. The Kemp's Ridley Conservation program has historically relocated the majority of nests into protected "egg corrals" at the main nesting beach of the Kemp's ridley near Rancho Nuevo, México. In more recent years, this program has examined the effect of leaving a subset of nests in situ on the natural nesting beach. In the current study incubation temperatures were monitored within egg corrals nests and also in nests that remained in situ on the natural nesting beach. The average incubation temperature during the middle third of incubation was used to predict sex ratios. In contrast to recent years, the 2004 nesting season was relatively cool. The results indicate that significantly more males were produced during 2004 in comparison to the previous six nesting seasons (1998-2003). This was consistent for both the corral nests as well as in situ nests. These findings exemplify the advantage of long-term studies when evaluating sex ratios in sea turtle populations. Further, these findings have significant implications for the ecology and conservation of the Kemp's ridley.

DIET-TISSUE DISCRIMINATION AND ISOTOPIC TURNOVER OF STABLE CARBON AND NITROGEN IN LOGGERHEADS

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Stable isotopes have been used increasingly to address questions of migrations, feeding ecology and ecosystem trophic structure. To interpret stable isotope data, the difference in isotope ratios between diet and tissues when they are at equilibrium (= discrimination) must be quantified and the time it takes for equilibrium to be reached (= turnover) must be determined. These values can only be obtained with certainty under controlled conditions and they have never been determined in sea turtles. We derived diet-tissue discrimination and isotopic turnover rates of stable carbon and nitrogen (13C/12C and 15N/14N) in post-hatchling loggerheads (n=120). Under controlled conditions, loggerheads were initially fed a soy-based diet (mean δ13C: -22.27 ± 0.07, mean δ15N: 3.25 ± 0.13) containing minimal amounts of fish oil (menhaden) for 128 days. A treatment group (n = 11) was then switched to a herring based diet (mean δ13C: -21.29 ± 0.08, mean δ15N: 9.45 ± 0.11) for 232 days. Blood, epidermis and scute samples were collected at specific intervals. An exponential model described patterns of isotopic turnover for 13C and 15N in loggerheads. After turnover was reached, discrimination values were determined for the three tissues. These values will allow researchers to use stable isotopes to address ecological questions.

CIRCADIAN AND CIRCANNUAL CHANGES IN THE METABOLIC RATE AND RESPIRATORY CONTROL IN RED-EAR SLIDERS (*PSEUDEMYS SCRIPTA*)

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Metabolism in ectotherms is highly influenced by temperature, which varies with circadian and circannual rhythms. Metabolic and ventilatory rates are expected to vary with the same rhythms. Evidence has shown, however, that there are also circadian and circannual changes in chemosensitivity independent of changes in temperature. It has also been shown that turtles can undergo seasonal metabolic suppression. If this is so, then it should lead to variations in breathing pattern and diving profiles, while total ventilation remains unchanged, resulting in implications on their natural behaviour. There are increasing concerns of the effects of daily and seasonal temperatures on the survival of sea turtles. The effects of circadian and circannual cycles on physiological variables such as metabolic rate, ventilation and chemosensitivity are rarely studied on sea turtles, due to the difficulties of performing such experiments in the field. Therefore, red-ear sliders serve as a useful model to elucidate these mechanisms.

Experiments were carried out on two groups of red-ear sliders (*Pseudemys scripta*) from October 2003 to September 2004. One group was kept outdoors allowing photoperiod and temperature to fluctuate seasonally. The second group was kept indoors, under constant temperature (21˚C) and photoperiod (12L:12D). Four sets of experiments were conducted throughout the year (one each season) at indoor and outdoor conditions on both groups of turtles. Tidal volume, breathing frequency, apnea length and ventilation were recorded to obtain breathing pattern. Oxygen consumption and CO_2 production determined daily and seasonal metabolic suppression, as well as temperature independent changes in chemosensitivity.

MARINE CHELONIAN ILLUSTRATION PART THREE: *DERMOCHELYS*, TRAVELS, CABINETS AND ENCYCLOPAEDIAS

Chuck Schaffer

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As with other organisms, *Dermochelys* biological investigation incorporated graphics as an integral element. Although this poster focuses on the Leatherback, background on historical illustration is provided (as in the first two installments - *Eretmochelys* and *Chelonia*), this time covering Travelogues, “Cabinets of Curiosities,” and Encyclopedias. As zoological visual documentation evolved from cave art to modern photography, so did knowledge of the Leatherback. *Dermochelys* manuscript images exist from 1460, but most representations appeared much later. These wood engravings were exaggerated or enhanced, seeking appeal with symmetrical unrealistic poses or stylized designs, the result of social/religious pressure and perhaps simple aesthetics. Eventually, steel and copper engravings replaced those of wood. Later, color was added, each plate done by hand. Plagiarism was rampant, or perhaps just a good source for material. But books were not common and those of this era were not for the masses, rather for the rich or religious. Popular literature would come much later and incorporate many of these likenesses. For such a significant and imposing animal, it is extraordinary that it was not better represented in early works. Also surprising is that Vandelli’s description and Vallisneri’s figure did not occur until 1761, five years prior to Linnaeus’ seventh edition of Systema Naturae. While some early material was surprisingly accurate (Tempesta’s 1600 Leatherback), other turtles were pictured with teeth. Scientific fact was rarely represented in early works, but those skewed depictions are vital in understanding the changing view of *Dermochelys*, providing a time capsule of this era’s world vision.

PRELIMINARY WORK ON VITELLOGENIN'S PURIFICATION FROM SERUM OF *CARETTA CARETTA* COLLECTED AT THE WWF SEATURTLE RESCUE CENTER LAMPEDUSA, SICILY, ITALY

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The presence of vitellogenin (VTG) in males is a useful marker of endocrine disruption in oviparous vertebrates such as sea turtles and its quantification helps to evaluate the habitats' quality. Considering the lack of commercial systems for vitellogenin analysis and the lack of specific standards for sea turtles, we focused the work on the definition of a reliable method for vitellogenin's purification and quantification in *Caretta caretta*. Heparinized blood samples (2cc) and morphological data were collected from *Caretta caretta* hospitalized at the WWF Sea Turtle Rescue Center in Lampedusa, Sicily (Italy). The plasma was stored frozen at -20°C until analysis. For VTG purification, 100 µL of each sample was used. The VTG purification was obtained by precipitation while its quantification was performed with the spectro-photometric method, using standard staining and protocol ("DC protein assay", BIORAD). Although it was not possible to estimate the gender of all the animals as they were smaller than the 75 cm carapace length threshold for gender determination, the VTG levels, detected in sexed animals, are in agreement with the gender. The marker was detected in all animals. Due to the lack of data on VTG in *Caretta caretta* and the uniformity of VTG trend for all turtle species, we arbitrarily choose the 1 mg/ml VTG level as a starting threshold concentration, as from the data of Tada et al. (2004) who worked on *Chinemys reevesii*. Even if in male turtles the levels were very low, one male presented high concentration of VTG. Overall, there seems to be no risk for reproductive health of sea turtles from Sicily. Nevertheless, the vitellogenic male poses some concern about possible endocrine disruption effect induced by pollutants which are present in the Mediterranean Sea.

BEHAVIOR AND MOVEMENTS

NESTING PREFERENCES OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) ON JUMBY BAY, LONG ISLAND, ANTIGUA, WEST INDIES

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Most hawksbills on Jumby Bay, Long Island, Antigua in the West Indies nest in vegetation, the root systems of which may protect eggs from washing away in tropical storms. We seek to determine whether individuals in the Jumby Bay nesting population display consistent nesting behaviors within and among nesting seasons by looking for patterns in proximity to vegetation and high water line. We also examine whether experience has any bearing on the tendency to nest in vegetation or in open sand by comparing the frequency of these behaviors in neophyte and remigrant hawksbills on Jumby Bay.

ENDOGENOUS PROGRAMS AND THE DEVELOPMENT OF SEA FINDING ORIENTATION OF LOGGERHEAD HATCHLINGS (*CARETTA CARETTA*)

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Previous experiments have shown that newly emerged loggerhead hatchlings (*Caretta caretta* L) transfer a crawling vector to their magnetic compass, used later to swim offshore. My objective was to determine if that transfer was expedited by crawling for a specific time period – one that corresponded to the typical duration of a crawl from the nest to the surf zone. Support for that hypothesis would suggest that hatchlings possessed an "endogenous program" that optimized vector transfer when the turtles crawled for "appropriate" time. To find out, I measured how far nests were placed from the surf zone, then measured hatchling crawling speed. I then did experiments to determine whether vector transfer occurred more readily after turtles had crawled in the lab for different time periods. On average hatchlings crawled to the ocean in less than 4 min. In the lab, 1 and 5 min crawls did not result in vector transfer whereas those of 2 min did. A period of non-directional crawling interfered with the ability of a 2 min crawl to promote calibration. These results suggest that transfer of a crawling vector to the turtles' magnetic compass occurs most readily when crawls are directional and last on average about as long as a natural crawl.

INSIGHTS INTO MOVEMENTS OF CARIBBEAN GREEN AND LOGGERHEAD TURTLES TRACKED BY SATELLITE FROM THE CAYMAN ISLANDS

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Detailed results will be presented on satellite tracking of four post-nesting green turtles (*Chelonia mydas*) and three post-nesting loggerhead turtles (*Caretta caretta*) from critically reduced sea turtle nesting populations in the Cayman Islands. Critical habitat was defined for these highly vulnerable populations by tracking internesting movements and migrations to foraging grounds in a range of Caribbean jurisdictions. Degree of site fidelity for nesting and foraging was elucidated over the course of two reproductive seasons for an individual green turtle. Oceanic internesting intervals/post-nesting oceanic circles were observed in loggerhead and green turtles. This research highlights the effectiveness of community sponsored conservation efforts and presents new information on the migrations and habitat requirements of endangered Caribbean green and loggerhead turtles.

THE EFFECTS OF SOCIAL INFLUENCE ON PERFORMANCE IN LOCATING FOOD SOURCES (LOCAL ENHANCEMENT) AND ON NEOPHOBIA ASSOCIATED WITH NOVEL ENVIRONMENTS IN GREEN SEA TURTLES (*CHELONIA MYDAS*)

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Previous research has shown that post-hatchling green sea turtles (*Chelonia mydas*) are an excellent species for experimental procedures involving learned behaviors. Here we address the question of whether the green sea turtle will show socially mediated learned behaviors. Although socially mediated learning has been extensively studied in mammals and birds, virtually nothing is known about this behavior in reptiles. Eight month old green sea turtles (N = 35) were used. They were not given any food on the experimental day until after the experiment was completed to ensure that they were hungry and highly motivated to locate food. A food source was located in one part of the tank and a mesh barrier sequestered an observing turtle in the other part of the tank where it (a) watched a trained turtle feed from the source, (b) watched a naïve turtle discover food from the source, or (c) spent time alone (control). When the barrier was removed, allowing the subject turtle (by itself) to feed from the food source, it did so faster in the "watch-naïve turtle" condition (b) than either of the other two conditions, a phenomenon known as "local enhancement." The failure of the subjects observing the trained subjects to differ from the control subjects may have been due to the fact that the trained "models" found and consumed the food too efficiently to be effective role models for foraging.

DO TURTLES FORM LEKS? A COMPARISON OF MATING SYSTEMS IN SEA TURTLES AND TERRAPINS

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A lek mating system can be defined as an aggregation of males during the mating period that females visit solely for courtship and mating. Four main criteria are used to distinguish lekking species: (i) males make no parental investment besides gametes, (ii) males form aggregations which females visit and where most mating occurs, (iii) males (or their gametes) are the only useful resources available to females at the lek area and (iv) females choose their mate(s), although the importance of this criteria for a lekking species is debated. Lek formation is most common among birds and has not yet been reported in any aquatic turtle species. However, the estuarine turtle, *Malaclemys terrapin*, the diamondback terrapin, has been observed forming mating aggregations that seem to fit the criteria of a turtle lek. We documented one such mating aggregation in Charleston Harbor, South Carolina using visual surveys, mark-recapture and automated sonic tracking of individuals and mounted pairs in the aggregation area. This aggregation appears to fit the main criteria of a turtle lek. The aggregation area does not appear to contain useful resources, such as food. Like marine iguanas, which lek, male terrapins were sighted at the aggregation site before females and females left the aggregation first, presumably to nest. Previously documented behavior of olive ridley, green and loggerhead turtles in courtship/mating areas shows similarities to that of terrapins. Comparisons are made between the mating behaviors of these aquatic reptile species, to explore the idea that turtles may form leks.

INTERSPECIFIC INTERACTIONS BETWEEN MARINE MAMMALS AND SEA TURTLES

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The National Marine Fisheries Service conducted an aerial survey, Mid-Atlantic *Tursiops* Survey (MATS), during July-August 2004 from Ft. Myers, Florida to Atlantic City, New Jersey. This survey was designed to estimate occurrence and abundance of bottlenose dolphins (*Tursiops truncatus*) on the western North Atlantic continental shelf. On several occasions, the junior author observed bottlenose dolphins and Atlantic spotted dolphins (*Stenella frontalis*) harassing loggerhead sea turtles (*Caretta caretta*). The dolphins chased the turtles, tossed them out of the water and pushed the turtles underwater with their rostrums (beaks). We conducted a preliminary review of the interactions of marine mammals with sea turtles in the wild and in captivity.

Marine mammals interact with both captive and free-ranging sea turtles. Reported free-ranging interactions came from a variety of locations including Australia, New Zealand, French Polynesia, Vanuatu, Hawaii, México, Azores, the Mediterranean, Brazil and the Gulf of México. We located reports of interactions between eight cetaceans (whales, dolphins), two pinniped (seals) and one sirenian species with six sea turtle species. Interactions included dolphins apparently feeding on fish hiding under turtles, as well as apparently mischievous and possibly aggressive (e.g., harassment) encounters by cetaceans, pinnipeds and sirenians, which included physically moving turtles across tanks in captivity; chasing and poking at turtles; attempting to flip sea turtles onto their backs; pushing turtles underwater with their rostrums; and even tossing turtles high out of the water or onto sandy beaches. Attempted and successful predation attempts by both cetaceans and pinnipeds were also documented. There was even an instance of predation on a freshwater turtle by an Amazon River dolphin. Of particular interest were descriptions by marine mammal stranding network coordinators in Australia who use sea turtles as behavioral enrichment for stranded dolphins. We hope that this review will encourage the reporting of observations and promote their publication in the scientific literature.

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POST-NESTING MIGRATIONS AND RESIDENT AREAS OF FLORIDA LOGGERHEAD TURTLES (*CARETTA CARETTA*)

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During the latter part of the nesting seasons in 1998, 1999 and 2000, we outfitted 38 nesting loggerhead turtles with carapace-mounted satellite transmitters from Telonics (model ST-14) or Wildlife Computers (model SDR-T16). Twenty-eight of these turtles were from the south Florida nesting assemblage (15 from the east coast and 13 from the west coast) and ten were from the Florida Panhandle nesting assemblage. The females typically departed from the vicinity of the nesting beach within 24 hours of depositing what we presumed to be their last clutch. Post-nesting movements appeared to be highly directed and only a few of the turtles appeared to wander. Some of the turtles traveled along coastal routes, but some crossed deepwater even when a coastal route to their destination existed. Females departing from the same nesting beach and sharing a similar post-nesting destination did not necessarily follow the same route. However, half of the females from the east coast (8 of 15) followed a similar path (moving close along southeast Florida and the Florida Keys) as they moved into the Gulf of México. Within a few weeks of departing from nesting beaches, the females took up residence in well-defined, relatively small (median of 2000 km^2) areas on the continental shelf adjacent to Florida, Texas, México, the Bahamas and Cuba. The majority of the females (22 of 38; 60%) from both nesting assemblages took up residence off the west coast of Florida between the Dry Tortugas and Cape San Blas. With few exceptions, turtles remained in their resident areas for the duration of the life of the satellite transmitters (mean of 364 days, range 11–712 days). Some turtles had resident areas that were near their nesting beach (< 50 km) and some had resident areas distant from their nesting beach (> 700 km). Assuming that the resident areas we identified were ones the turtles had used previously, most turtles migrated to a more distant nesting beach even though there were nesting beaches that were closer to their resident area. The distribution of resident areas of females from both nesting assemblages overlapped off the western coast of Florida, the western and northern coast of the Yucatan Peninsula and the northern coast of Cuba.

POSSIBLE USE OF GEOMAGNETIC CUES IN SEAFINDING BY LOGGERHEAD HATCHLINGS

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Sea turtle hatchlings emerge from their nests at night and quickly crawl to the sea. Although visual cues are thought to be of primary importance in seafinding, secondary cues might also be involved. To investigate whether geomagnetic cues might play a role in seafinding, hatchlings were permitted to crawl across the beach with tiny magnets or nonmagnetic brass bars attached to their carapaces. On nights with little or no cloud cover (and thus significant beach illumination), no differences in orientation were observed between the two groups. On dark nights with dense cloud cover and extremely low visibility, however, the orientation of turtles bearing magnets differed significantly from that of controls, even though both groups located the ocean. These preliminary findings suggest that loggerhead hatchlings may use magnetic information to orient toward the sea under conditions in which visual cues are limited.

POST-RELEASE MOVEMENTS OF COLD-STUNNED REHABILITATED LOGGERHEAD SEA TURTLES

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The North Carolina Aquarium on Roanoke Island collaborates with local and state organizations to rehabilitate and release cold-stunned juvenile loggerhead sea turtles stranded along the North Carolina coast. Until recently, post-release survival and behavior were unknown. Satellite telemetry can be used to follow migrations and previous studies of wild caught juvenile loggerheads have shown they travel north of Cape Hatteras, NC in summer but by January most are south of Cape Hatteras with few remaining off the coast of NC. Between 2003 and 2004 we attached Wildlife Computers (Redmond, WA) SPOT3 satellite transmitters to four rehabilitated loggerheads before release. To compare release protocols, two were released from the beach north of Cape Hatteras during the summer and two were released offshore south of CapeHatteras during the winter. The transmitters recorded location and water temperature data for eight hours daily. Supporting the hypothesis that rehabilitated cold-stunned turtles can successfully re-enter the wild, all four behaved as predicted based on previous tracking studies. Loggerheads released during the summer moved north and generally remained in water above 20.1º C. The lone sea turtle released in 2003 moved south when water temperature dropped below 20.1º C and over wintered south of Cape Hatteras, NC. Sea turtles released during the winter moved south and over wintered in water above 20.1º C. One turtle returned north of Cape Hatteras, NC when water temperature rose above 21.8º C; the transmitter on the second turtle failed after two months. This is the first in-depth study involving post-release movements of cold-stunned sea turtles. Tracking maps are available at www.ncaquariums.com/turtletrails/ and www.seaturtle.org.

SUN ORIENTATION IN HATCHLING LOGGERHEAD SEA TURTLES

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Under laboratory conditions, hatchling loggerhead sea turtles can maintain headings while swimming toward a light source and then maintain this heading using only magnetic information after the light cues have been removed. Hatchling loggerheads from the east coast of Florida, USA, emerge from nests on sandy beaches, crawl to the water and swim offshore to the Gulf Stream (a heading that is generally eastward). Because the Sun rises roughly east of Florida, it has been suggested, though not yet demonstrated, that the rising Sun may play a role in the offshore orientation behavior of these animals. As a first step toward investigating this possibility I observed the behavior of two groups of hatchlings swimming in pools of water on an eastward facing beach in Florida. One group of turtles could view the rising sun unaltered while the other group could not view the rising sun directly but could view a reflection of the sun in a mirror. The mirror was positioned so that the reflected sun was shifted 90° from the bearing to the natural Sun. Hatchlings that were exposed to the natural Sun were significantly oriented toward the Sun while hatchlings exposed to the reflected Sun were significantly oriented toward the reflection. The mean headings of the two groups were significantly different. These results demonstrate that hatchlings can use the Sun as an orientation cue; however, it is not yet clear how this ability might fit into the overall offshore migratory program.

DETECTION OF WAVE DIRECTION BY JUVENILE GREEN TURTLES

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Laboratory studies have shown that hatchling turtles can detect the direction of the orbital motion of waves. This ability may play a role in their offshore migratory behavior. However, it is not known whether older turtles maintain this ability. To test whether juvenile turtles can determine wave direction, we observed the behavior of six juvenile green turtles as they were subjected to the orbital motion of simulated waves in the absence of other sensory information. Each turtle was tested under conditions that simulated waves approaching from one side for 5 minutes and then from the other side for five minutes. All turtles alternated between short periods of vigorous activity and longer periods of relative inactivity. During the active periods, turtles often made powerful strokes with only one of their front flippers (a behavior consistent with turning). The number of strokes made with each flipper was compared for each turtle. All turtles made significantly more strokes with one flipper than with the other during each phase of the test and, with all turtles, the flipper that was used more switched when the direction of simulated waves was reversed. The stroking behavior of five of the turtles was consistent with turning into oncoming waves while the behavior of one turtle was reversed. Therefore, while these results demonstrate that juvenile green turtles can determine the direction of waves, it is not clear how this information is used in the natural environment.

FORAGING SITE FIDELITY IN A POPULTION OF JUVENILE GREEN TURTLES IN BOCA RATON, FLORIDA

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Since the spring of 2003 regular in-water surveys have been conducted on an area of near shore, hard-bottom reef known to support a population of green turtles in Boca Raton, Florida. The primary objectives of this project were to visually monitor the number of turtles utilising a limited section of reef and to study behaviour. Observations were made while snorkeling in the same location several times per week. Digital photographs were taken of as many turtles as possible each time and scute patterns, particularly on the head, were compared in order to positively identify individuals. Over thirty different turtles have been recorded. The majority of these are juveniles, ranging in size from approximately 25cm to over 55cm. The turtles appear to be attracted to this area by an abundance of red algae, such as *Bryothamnion* sp. and *Gracilaria* sp., upon which they feed extensively. About a third of the turtles recorded have been observed regularly for a year or longer while more than half have been seen repeatedly over several months. A few were present only occasionally, with up to eight months between sightings. Several individuals have consistently permitted close approach, providing the opportunity to note certain interesting behaviours. For example, turtles smaller than 35cm show a tendency to float on the surface taking several quick breaths whereas larger turtles usually take just one deeper breath. Flipper slapping similar to that documented in Hawaii (by Peter Bennett and Ursula Keuper-Bennett) has often been noticed, usually associated with agitation.

UNRAVELING THE MAGNETIC MAP OF SEA TURTLES

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Sea turtles possess a "magnetic map" that enables them to navigate to specific destinations such as feeding sites. However, the precise features of the Earth's magnetic field that turtles use have not been determined. Turtles can detect the intensity (strength) of the field and the inclination angle (angle between the field lines and the Earth's surface). Because both intensity and inclination vary predictably across the surface of the Earth, turtles might use either or both in their magnetic map. To investigate the organization of the map, juvenile green turtles captured in their feeding grounds were tethered inside a large magnetic coil system and exposed to one of two magnetic fields. One group was exposed to a field that exists north of the test site. The second group was exposed to a field that does not exist in nature; this field paired the intensity of the northern site with an inclination angle from the south. Turtles exposed to the first field oriented southward as if navigating to their feeding site, whereas turtles exposed to the second field oriented randomly. These results imply that turtles do not rely exclusively on magnetic field intensity, because if they did, then turtles tested in the second field should have oriented south. Similarly, turtles do not rely on inclination alone, because if they did, then the second field should have elicited northward orientation. Instead, the results imply that both inclination and intensity play important roles in the ability of turtles to determine geographic position.

MORPHOLOGICAL ASPECTS OF MALE BLACK TURTLES

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Black turtles (a.k.a. east Pacific green turtles, *Chelonia mydas*) are an endangered subpopulation of the pantropical green turtle. The Mexican stock consists of two primary rookeries located in Michoacán and the Revillagigedos Islands. Turtles originating from these sites inhabit coastal foraging areas from Guatemala to the United States. While much information is available on the biology of nesting females, comparatively less is known about the biology of black turtles at sea, particularly for males. In this study we examined the morphometrics of 122 sexually differentiated (i.e. apparent) male black turtles in both breeding and foraging areas. Data were gathered during the 1977/1978 nesting season in Michoacán, México (MICH), from 1995-2004 at the Bahia de los Angeles foraging area along the Baja California peninsula, México (BLA) and from 1990-2004 at the San Diego Bay foraging area in Southern California, USA (SDB). Most turtles were captured with entanglement nets or by hand capture, although some data came from stranded turtles, captive turtles and those confiscated from the black market. At MICH, BLA and SDB, straight carapace length (SCL; 0.1 cm) was recorded from the nuchal notch to the posterior-most portion of the rear marginals using a foresters caliper. At BLA and SDB tail length (TL; 1.0 cm) of turtles was measured from the tip of the tail to the trailing edge of the plastron using a flexible tape measure. A tail/length index (t) was calculated to establish the relationship between SCL and TL ($t = TL/SCL$).

The comparison of historic vs. current data from Michoacán revealed that female mean SCL from 1977/1978 data (77.0 ±3.9 cm, n = 61) did not differ significantly ($p = 0.55$) from female mean nesting size (SCL = 77.3 cm) recorded by Figueroa et al. (1993). The non-significant difference is interesting considering the dramatically different population status between these two sampling periods. In comparisons between reproductive males and females we found that mean SCL of reproductive male black turtles at MICH (72.7 ±3.4 cm, n = 75) was significantly smaller than the mean for females (77.0 ±3.9 cm, n = 61) ($p < 0.01$). Based on this result, it is evident that mean female nesting size is not a reliable size proxy for estimating life stage and sexual maturity for both sexes. The visual inspection of back-transformed SCL distributions for MICH (72.7 ±3.4 cm, n = 75) BLA (80.4 ±7.0cm, n = 30) and SDB (91.6 ±8.1 cm, n = 17) suggests that morphology (i.e. size at maturity) varies among foraging and nesting sites of black turtles. Mean SCL (log transformed) differed significantly among MICH, BLA and SDB ($p < 0.01$).

The reasons for the observed differences in size among the three samples are unclear but likely relate to variation in mean size-at-maturity between the Michoacán and Revillagigedos Islands subpopulations and the differential contribution of these nesting stocks to the two foraging sites examined in this study. Using a comparison between tail length and SCL as an index for sexual differentiation ($t = TL$ (plastron-tip)/ SCL) we compared sexually differentiated males with turtles of undetermined gender. The analysis indicated that there is a clear threshold falling between the smallest male index ($t = 0.36$) and the largest undetermined index ($t = 0.38$). Conservatively $t = 0.38$ would be our male/undetermined threshold, with larger values indicating male status. In the absence of hormonal assays and laparoscopic techniques tail/length index (t) can be useful in estimating sexual maturity in male black turtles. We concluded that historical data, when substantiated, can be useful in drawing inferences about current populations. We must recognize and account for the morphological differences among and within nesting subpopulations when developing demographic models for Mexican black turtles. Finally, we can refine our efforts to measure black turtle population structure by including data from male turtles.

DO HATCHLING LOGGERHEADS USE WAVE SOUNDS AS AN ORIENTATION CUE DURING SEA-FINDING BEHAVIOR?

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Sea turtle hatchlings emerge from underground nests and immediately crawl to the ocean. Several experiments have provided evidence that this sea-finding behavior is mediated primarily by visual cues such as light intensity and horizon elevation. Hatchlings may crawl toward a lower, brighter seaward horizon or away from a dimmer, elevated landward horizon (Salmon et al. 1992; Mrosovsky and Kingsmill 1985). On moonless nights or on beaches with little slope, however, visual cues may not reliably indicate seaward direction. It is therefore possible that additional sensory cues, such as the sounds of breaking waves, help guide hatchlings to the ocean under some conditions. To investigate whether hatchling loggerheads use wave sounds as an orientation cue, hatchlings were placed in the center of a runway in complete darkness and exposed to wave sounds emanating from a speaker placed at one end of the runway. Under these conditions, the turtles did not demonstrate a significant preference for crawling toward or away from wave sounds; instead, approximately half of the turtles oriented in each direction. Although additional studies are needed, these initial results are consistent with the interpretation that auditory cues are not used by loggerhead hatchlings in sea-finding.

SEA TURTLE SURFACING BEHAVIOR AND AERIAL CENSUS: HOW SEASONAL TURTLE ‘SIGHTABILITY’ AFFECTS JUVENILE DENSITY ESTIMATES IN VIRGINIA

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The Chesapeake Bay serves as a seasonal foraging habitat for thousands of juvenile loggerhead (*Caretta caretta*) and hundreds of juvenile Kemp’s ridley (*Lepidochelys kempii*) sea turtles. Aerial survey estimates indicate that maximum turtle densities occur during the spring as turtles migrate into the Bay. Turtles are visible to aerial observers only when swimming at the water’s surface. Historically, a correction factor has been applied to density estimates accounting for turtles below the observable surface. This is based on percent time turtles spend at the surface (turtle ‘sightability’) during the summer and fall in the mid-Bay (5.3% or, for every one turtle at the surface, there are approximately 18 turtles not seen below the surface; Byles 1988). Springtime surfacing data in the lower Bay were not included in calculating this historic correction factor. Springtime surfacing behaviors of juvenile Kemp’s ridleys and loggerheads were determined in the lower Bay during 2002-2004 using radio/sonic telemetry. Observed springtime and early summer mean daytime loggerhead surfacing times were 9.9% (+/- 2.9% SD; 1:10) in 2002 (n=5 loggerheads) and 25.0% (+/-16.3% SD; 1:4) in 2003 (n=2). In 2004, only one loggerhead was tracked, resulting in a daytime surfacing time of 12.3% (1:7 to 1:8). Mean loggerhead surfacing times ranged as high as 36.5%. Observed springtime and early summer mean daytime Kemp’s ridley surfacing times were 32.9% (+/- 23.1% SD; 1:3) in 2003 (n=2) and 30.0% (+/- 25.8% SD; 1:3) in 2004 (n=3), with mean surfacing times ranging as high as 59.8%. There were significant differences among all individuals tracked (ANOVA, $p< 0.05$). The highest overall mean surfacing times among all individuals were observed among the Kemp's ridleys (30.0% to 59.8%). All observed spring surfacing times were higher than those recorded by Byles (5.3%; 1988) in the summer and fall. Therefore, turtles observed in the spring more likely to be counted during aerial surveys. Large differences (1:18 vs. 1:10, 1:4, or 1:3) in seasonal sea turtle 'sightability' bias historic abundance estimates.

Aerial population surveys were conducted in Bay waters between 2001 and 2004. Predicted surfacing rates were calculated using simultaneous linear equations assuming constant abundance, solving for 'sightability' or surfacing time. Predicted 'sightability' by survey and year modeled the observed early season (spring) peaks in densities followed by sharp declines in late June or early July. Peak predicted values for 'sightability' ranged from 0.25 (or 25.0%) in 2001, to 0.28 in 2002, 0.21 in 2003 and 0.27 in 2004 and corresponded to recorded sea surface temperatures of 21° to 25° C. Predicted 'sightability' estimates for the summer/fall months closely modeled Byles' observed surfacing time of 5.3%, indicating a behavioral shift in surfacing behavior between the spring and summer/fall months: a decrease in 'sightability' due in part to an increase in benthic feeding behavior.

Using the historic respiratory correction factor (5.3%; Byles 1988), mean springtime population estimates ranged between 1,600 and 5,800 turtles. Adjusting for increased sea turtle 'sightability' (25.0% based on predicted values), these estimates are dramatically reduced to between 350 and 1,250 turtles, indicating that historic juvenile sea turtle densities in Virginia have been overestimated for springtime observations. Managers should not assume that sea turtle 'sightability' or surfacing behavior is constant at all times of the year or in all geographic locations when analyzing aerial data.

A PRELIMINARY STUDY ON POLARIZATION VISION IN LOGGERHEAD HATCHLING SEA TURTLES (*CARETTA CARETTA*)

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Sea turtles migrate over large distances during their lives and they use a variety of cues to find their direction, including light, wave action and the earth's magnetic field. In the present study we investigated if hatchling loggerhead sea turtles have the ability to detect polarised light. Animals that have this ability may use the information for orientation. Turtle hatchlings were collected from nests, placed in a harness and tethered in a circular tank filled with sea water. To mask the earth's magnetic field, a small magnet was placed on the dorsal side of the harness. An LED light source was placed inside the tank, just above the water surface. The tank was illuminated from above with linearly polarised light, created by a sheet of HN-32 Linear Polaroid filter. The hatchlings were allowed to swim towards the LED with the Polaroid filter in place. The LED was then removed and the hatchling's orientation behaviour was monitored. Most turtles established a steady course towards the LED when first placed inside the tank. When the LED was removed, the hatchlings apparently lost their ability to orient, despite the presence of polarised light. This initial experiment failed to provide evidence that hatchling loggerheads use linearly polarised light for orientation during the first few hours after emerging from their nests. Nevertheless, we cannot exclude the possibility that such a sensory ability exists and that it can be demonstrated under different experimental conditions.

SEASONAL CHANGES IN RESTING-DIVE DURATION OF GREEN SEA TURTLES IN JAPAN

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Ogasawara is one of the major nesting grounds for green turtles in the North Pacific. A tagging program has revealed that their foraging area is the Pacific coast of the main islands of Japan, which are to the north of the rookery. In order to examine the seasonal changes in diving behavior of postnesting green turtles, time-depth and time-temperature recorders were deployed on two nesting females at the Chichijima, Ogasawara Islands, Japan, during September 1996 and October 1997. One female was recaptured in a pound net in Miyazaki, Kyushu after 77 days of release. Although the other female was not recaptured, the dataloggers for her were found and recovered underseas in Hachijojima, Izu Islands after 290 days of release. A range of different dive profiles were observed. However, both turtles performed dives where they remained at a fixed depth (~ 20 m) for a long period. We assumed that such dives were caused by the turtles resting on the sea bed. Resting-dive duration and percentage of total resting time per day changed seasonally with water temperature (16 to 28º C). The maximum dive duration of 253 minutes was recorded when the water temperature was 15.3º C. There was a significant negative correlation between water temperature and resting-dive duration.

MOVEMENT PATTERNS OF THE GREEN TURTLE (*CHELONIA MYDAS*) IN AND TOWARDS CUBAN WATERS AS EVIDENCED BY TAG AND RECAPTURE STUDIES

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To study the movement patterns of green turtle populations in the Caribbean region recruiting into Cuban habitats, tag-recapture data from local (Cuban National Tagging Program 1989 – 2002) and international programs (1959-2002) were compiled and compared. Out of 746 turtles tagged in Cuba from fishing areas, nesting beaches and head-start facilities, 5.5% were recaptured, mostly outside of Cuban waters

and with a majority of these (76.9%) off the coast of Nicaragua. Green turtles tagged elsewhere and recaptured in Cuba included a large number of size classes and originated in Grand Cayman, Tortuguero, Costa Rica, the Bahamas, Bermuda, Florida Quintana Roo, México, Aves Island, Venezuela and the U.S. Virgin Islands, in that order. Recaptures of Tortuguero tags were concentrated in the SE and westward regions of Cuba, while Grand Cayman and the Bahamas recaptures were concentrated in the SE and NE regions, respectively. The insight gained on the migratory patterns for green turtles in the region underscores the value of prolonged and intensive tagging programs and the need for close international collaboration.

THE DEVELOPMENT OF CONDITIONING TECHNIQUES FOR STUDYING THE SENSORY ABILITIES OF SEA TURTLES

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Conditioning techniques have often been used to study the sensory abilities of animals. We have adapted a conditioned choice discrimination method to study vision and magnetic field perception in juvenile loggerhead sea turtles (*Caretta caretta*). To conduct these studies, we designed and constructed a fully automated, computerized conditioning arena. Our technique requires turtles to discriminate between two slightly different sensory stimuli and to press one of two available paddles, depending on the stimulus present. Correct choices are rewarded with food and incorrect choices result in a time penalty. The technique has been used successfully in initial experiments, which have demonstrated perception of simple visual and magnetic stimuli and set the stage for more detailed analyses of the sensory ability of turtles. The methodology developed provides a new and powerful behavioral assay for investigating the ability of turtles to perceive any sensory stimulus of interest, including visual, chemical, auditory and magnetic cues.

DO SEA TURTLES USE ACOUSTIC CUES WHEN NESTING?

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Olive ridley turtles nesting on Guatemala's Pacific shores appear to show preference for places and times of nesting. There is clear evidence from observations of this species nesting in Costa Rica that they can wait for many days in a gravid state seaward of the breakers for the optimum hour to come ashore. In Guatemala this beaching is precise, with females coming ashore around high tide and moving directly up-beach to the nest site; false crawls are rare. Little attention has been paid to the mechanism the turtles might use to determine their preferred time and place of nesting. Our intuition is that they may be using acoustic cues. From the little information available, there is a clear match between the tonal emissions of the surf zone and the range of turtle hearing. It is feasible that turtle embryos could become imprinted with acoustic signals during their fifty days of incubation in the nest. Along-beach variation in gradient and sand-size will cause variation in surf sound quality that could be sensed by turtles. Similar across-beach variations could permit sensitivity to the state of the tide. This year we began a simple project involving both a review of the literature and the making of initial sound recordings in upper beach locations as a first step in investigating this phenomenon. Our results are consistent with the hypothesis that sea turtles could be using acoustic cues to control their nesting behaviour.

DO GREEN SEA TURTLES (*CHELONIA MYDAS*) EXHIBIT PLAY BEHAVIOR? A CLOSER LOOK USING PLAY OBJECT ANALYSES

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In this study we examined the behavior of green sea turtles (*Chelonia mydas*) when presented with potential play objects. In these experiments, eight month old green sea turtles were selected at random from a large population maintained at the Parque Xcaret, México. Three different experiments were designed to obtain a more thorough description of the turtles' activity with the absence and presence of play objects. Three different play objects were used (an elongated yellow ball, a medium-sized blue ball and an orange disc). We hypothesized that green sea turtles would initially experience neophobia towards the objects, avoiding their vicinity, but through more exposure, they would be more inquisitive and interact with the objects. Fisher's Exact Probability Tests were used to determine whether turtles spent more or less time in the target quadrant in the presence of play objects than expected based on time spent in the target quadrants in the absence of play objects. Then, the amount of time the turtles spent with a particular play object was analyzed. We found that green sea turtles were neophobic initially, then very curious about the play objects. A clear preference emerged for the orange play object. Given the complex nature of defining exactly what play is, it is difficult to say that the turtles were, in fact, playing. Alternatively, the turtles may have been attempting to groom themselves. Further research is needed to evaluate this question in this species.

COMPARISON OF BEHAVIOUR OF THREE LOGGERHEAD TURTLES TRACKED BY SATELLITE IN AND FROM AMVRAKIKOS BAY, NW GREECE

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Three subadult to adult sized turtles were equipped with Sirtrack, Kiwisat 101 satellite transmitters in Amvrakikos Bay (NW Greece) in May 2003. The Bay is an important foraging area for loggerhead turtles with many large areas of shallow sea and lagoons. It is a Ramsar site and a proposed NATURA 2000 site in the context of the European Union's Habitats Directive. The telemetry actions were part of EU co-funded LIFE Nature projects. The transmitters functioned for 71 to 555 days and the three individual turtles displayed clear differences in behaviour. Turtle A was shown to utilise two separate areas of the Bay for foraging with short distance migrations between the two and did not leave the Bay during transmitter operation (71 days). Turtle B was shown to remain in a restricted region of the Bay close to the capture site for almost the entire duration (555 days) of its transmissions. Finally, turtle C, after spending its initial seven weeks near its capture site, departed the bay and migrated to the coast of Syria then it moved north and west along the coast of Turkey. It finally settled from November 2003 until July 2004 in a restricted area of Turkey, south west of Antalya. It is not known whether this turtle nested during the summer nesting season of June and July during which time the transmitter was functioning (423 days). This study confirms the international nature of turtle conservation and the need for improved regional cooperation in conservation and management efforts.

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MOVEMENTS OF A JUVENILE KEMP'S RIDLEY ALONG THE UPPER TEXAS COAST

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Incidental capture of Kemp's ridley sea turtles (*Lepidochelys kempii*) on recreational hook-and-line gear represents a relatively untapped source of life history information. The modal size of ridleys caught on hook-and-line along the Texas coast during 1980–1992 (30.1–40.0 cm CCL, N=112) (Cannon et al., 1994) mirrors that reported by entanglement netting surveys along the upper Texas coast (Landry et al., 2005; Metz, 2004). As such, these ridleys constitute a cost-effective means of updating information on population structure and distribution, while providing an opportunity for hooked individuals to be examined, x-rayed, rehabilitated (if necessary) and characterized as to their post-release behavior.

Eight Kemp's ridleys, one green turtle (*Chelonia mydas*) and one loggerhead (*Caretta caretta*) were retrieved after being caught on recreational hook-and-line gear along the upper Texas coast during March–September 2004. The ridleys ranged from 30.1–44.6 cm SCL (mean=35.6 cm, SD=4.4 cm) while the green and loggerhead turtles were 33.1 and 64.2 cm SCL, respectively. Seven ridleys were hooked in the mouth or flipper and the green was hooked in the neck. The loggerhead and one ridley swallowed hooks, both of which were successfully removed at the Houston Zoo. A 34.9 cm SCL ridley was outfitted with a platform terminal transmitter and released near Sabine Pass on 21 September. Transmissions were received through 18 November 2004; however, none were received during 26 October–15 November. Movements occurred along 75 km of the upper Texas coast and the turtle spent at least 25 days within 10 km of its initial capture location (Gilchrist, Texas). Approximately 99% of the 22–30 September and 73% of the 1–20 October temperature readings were in the 25.1–30.0º C bin, whereas 75% of the 10–17 November readings were in the 15.1–20.0º C bin.

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TAG RETURNS OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) FROM WASSAW NATIONAL WILDLIFE REFUGE, GEORGIA, USA

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Much of what is known about sea turtle biology is attributed to research conducted on nesting females, due to the accessibility of these animals when on the beach. Long-range tag return data obtained from individual loggerheads may be helpful when determining population estimates, nesting ranges, seasonal dispersal patterns and possible foraging areas. The Caretta Research Project has run a saturation-tagging project on Wassaw National Wildlife Refuge, GA since 1973. Here we present 32 years of tag returns from loggerhead sea turtles tagged on Wassaw National Wildlife Refuge, GA.

THE BEHAVIOR OF LOGGERHEAD SEA TURTLES ENCOUNTERING BARRIERS ON THEIR NESTING BEACH: A MEASURE OF EFFECTS FROM COASTAL ARMORING

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We experimentally studied the nesting behavior and nest-site placement of loggerhead sea turtles that emerged to nest at night on a beach in south Brevard County, Florida, USA. Emerging turtles were divided between two paired treatments: wall and control. Intercepted turtles in the wall treatment were presented a portable wall that blocked their ascent of the beach. The position of the portable wall was shore-parallel and midway between the recent wrack line and the dune toe. Intercepted turtles in the control treatment ascended the beach and did not encounter a wall. We observed 44 female loggerheads (22 paired samples) in both treatments and measured their nesting behavior. In the control treatment, 15 of 22 turtles completed a nest and in the wall treatment, 14 of 22 turtles completed a nest. There was no significant difference in nesting success (nests/attempts) between treatments. However, effects from the wall resulted in wall-treatment nests being 3.5 m closer to the surf than control nests, on average. Egg survivorship did not differ significantly between treatments; however, the sample size was not large enough to detect biologically significant differences in hatching success amidst the high variation in the data. An additional factor that made our test of hatching success less rigorous was the absence of significant beach erosion during the study period. Erosion is the principal cause of mortality to nests low on the beach and has been observed to cause 100% mortality in the region of beach where the wall-treatment nests were located.

ECOLOGY

GROWTH RATES OF *CARETTA CARETTA* IN THE MEDITERRANEAN SEA

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Growth rate is a fundamental parameter to understanding population dynamics. It is necessary to calculate growth rates in different areas and populations because it can be influenced by both environmental and genetic factors. Unfortunately, the growth rate of *Caretta caretta* is not available for the Mediterranean. We provide for the first time growth rate estimations for two different size classes using two different approaches. Size distribution of 76 turtles ranging from 8 to 20 cm curved carapace length (CCL) was used to provide indication of growth rate pattern in this range, under the assumption that the turtles were 0-2 years old and considering arbitrary hatching date and size on the basis of data from the region. The resulting mean growth rate was 9.3 cm/yr, but great variability appears to occur in the first months of life, certainly in part due to the arbitrary hatching date assigned to all the specimens but possibly also a consequence of environmental variability to which post-hatching turtles may be particularly sensible. However, in older specimens growth rates appear much less variable and decrease linearly with increasing size and especially with presumed age. For comparison, growth rate calculated from six turtles stranded in the Azores ranging in size from 9.1-10.8 cm CCL (corresponding to a mean size of about 7 cm) was 12.0 cm/yr (Bjorndal et al., 2000).

For the larger size class, capture-mark-recapture data of 34 turtles ranging from 37 to 82 cm CCL at first release and re-encountered after 1.0-10.9 years were used.

Growth rates of these specimens show great variability without an evident trend, with a mean of 2.5 cm/yr. For comparison, growth rate calculated in the Atlantic from capture-mark-recapture data of 10 turtles ranging from 19.3-78.4 cm CCL at the first release (Bjorndal et al., 2000) was 4.5 cm/yr. Mediterranean nesting females are known to be smaller than those from other areas (Margaritoulis et al., 2003). This raises the question of whether turtles in the Mediterranean attain maturity at a younger age (with a growth rate similar to other areas) or at the same age (with a lower growth rate). Naturally, both age and growth factors could be involved. Taking this into account, the present preliminary analysis and comparison appear to support the second pattern.

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DOES EXPERIENCE EQUATE TO BETTER PRODUCTION IN ST. CROIX LEATHERBACKS?

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Sandy Point National Wildlife Refuge (SPNWR), St. Croix, USVI is the site of the largest leatherback (*Dermochelys coriacea*) rookery in the U.S. and its surrounding territories. This rookery has been monitored for over twenty years and is the site of a growing leatherback population. As a result of this project, SPNWR has accumulated one of the most extensive databases on nesting leatherbacks in the Atlantic Ocean. A subsample of 40 individual females, 20 neophytes and 20 remigrants, were selected based on certain criteria. Turtles were chosen if they nested consistently (9-10 days) (Pritchard, 1971; Tock, 1988) without skipping any intervals and if every nest location was known for excavation. Data utilized for this study included nest location, clutch size and hatchling and emergence success. The objective of this study was to better understand nesting production in this population. To accomplish this we looked at the potential role experience plays in hatchling production. Production was defined as the total number of hatchlings to successfully emerge to the beach surface. The impact of experience on production was determined by comparing clutch sizes, number of clutches laid for each individual per season and the number of hatchlings produced by neophytes versus remigrants. An evaluation of these parameters will help to determine whether the more experienced remigrants show greater productivity than the less experienced neophytes.

THE BIG CHILL: COLD-STUNNING OF HATCHLINGS DURING THE FLORIDA SUMMER MONTHS

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Historically, cold-stun events in Florida have occurred during winter in two enclosed, estuarine areas: Mosquito Lagoon on the central Atlantic Coast of Florida and St. Joseph Bay on the northwest Gulf Coast of Florida. However, in the summer of 2003 during the nesting and hatching season, a prolonged coldwater upwelling offshore of the south and central Atlantic coast of Florida resulted in the cold-stunning of 12,847 loggerhead turtle hatchlings, 11 green turtle hatchlings and 7 leatherback turtle hatchlings along approximately 338 km of beach. Water temperatures were measured as low as 9º Celsius. Brevard County, which includes a portion of the Archie Carr National Wildlife Refuge, accounted for 11,000 (85.5%) of the cold-stunned hatchlings. In all, the upwelling affected seven counties and lasted approximately three months. Although mild, sporadic upwelling has been documented during the summer, no records could be found documenting water this cold for so prolonged a time during summer in Florida. A protocol was established between Florida Fish and Wildlife Conservation Commission (FWC), local volunteer organizations, rehabilitation centers, federal agencies and academic research groups dealing with this unusual situation. The cooperative efforts of thirteen sea turtle conservation groups, private companies and concerned citizens all contributed to helping over 12,000 sea turtle hatchlings get back out to the ocean.

FORAGING GROUNDS FOR SEA TURTLES IN INSHORE PERUVIAN WATERS

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Sea turtles in Peru face several threats including both direct and incidental capture, use of their meat for human consumption and habitat degradation. Although there is information on bycatch levels, no studies to date have identified and assessed marine habitats used by sea turtles as foraging grounds. During the present study surveys were conducted at inshore waters to identify critical foraging grounds for sea turtles and to generate data on species composition and size frequency of species occurring in these areas. Baseline information was obtained from previous reports and interviews with fishermen; according to these sources three of the five species of sea turtles in Peru, the black turtle (*Chelonia mydas agassizii*), olive ridley (*Lepidochelys olivacea*) and leatherback turtle (*Dermochelys coriacea*), were present in shallow bays within the 2 km of coastal waters. Study sites were the Paracas (13º 50' LS) and the Sechura Bays (05°.50' LS), on the central and northern coasts, respectively. The methodology involved a collaborative effort between fisherman and researchers for capturing sea turtles using gillnets. Biological and ecological data were recorded. Species captured were juvenile and adult black turtles and adult olive ridley turtles. Threats identified for the studied areas were trawling, direct harvest, fishing, scallops farming and extraction of algae. We stress the need of systematic studies on the critical areas identified, with close collaboration of stakeholders to ensure the development of a long term conservation program if threats to sea turtles are expected to be mitigated.

JUVENILE GREEN TURTLE (*CHELONIA MYDAS*) FORAGING ECOLOGY: FEEDING SELECTIVITY AND FORAGE NUTRIENT ANALSIS

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The green turtle (*Chelonia mydas*) is an endangered species with respect to which a fundamental component of its recovery and conservation is to understand its foraging ecology. Foraging optimality models suggest that animals will select resources of high quality over those of low quality. For green turtles this behavior is important, as sufficient quantities of nutritionally adequate prey items are necessary for growth and reproduction. Therefore, an intrinsic element to understanding green turtle foraging ecology is to identify and document the availability and quality of resources selected by green turtles.

The objectives of this study were (1) to determine whether juvenile green turtles showed a feeding preference by comparing prey items in the diet to the availability of those items in the habitat, (2) to identify species for which there was positive or negative selection, (3) to identify potential nutritional factors determining selection or avoidance of prey items and (4) to evaluate the nutritional content of the diet. This research was conducted by comparing lavage samples from juvenile green turtles to benthic surveys within the habitat. To determine feeding preference Ivlev's Electivity Index was used to compare ingested species of algae to that available in the habitat. Nutritional analysis of forage was conducted to identify possible nutrients affecting feeding preference.

Juvenile green turtles selectively foraged on chlorophytic and rhodophytic algae. Results suggest that diet selection was based on nutritional content. Both the composite diet and the main diet item, *Hypnea* spp, had a higher gross energy count, were higher in protein and were lower in fiber than prey items that were avoided. Species conservation requires effective habitat management, which must be informed by an understanding and evaluation of the habitat. For juvenile green turtles, this study indicates that habitats dominated by rhodophytic algae may be more important for the health of green turtle populations than habitats dominated by other algal divisions.

THE EVIDENT DESTRUCTION OF OLIVE RIDLEY SEA TURTLE EGGS (*LEPIDOCHELYS OLIVACEA*) BY THE BEETLE *OMORGUS SUBEROSUS* (FABRICIUS, 1775) AT ESCOBILLA BEACH, OAXACA: A PROPOSAL OF A BIOLOGICAL CONTROL

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The olive ridley sea turtle (*Lepidochelys olivacea*) population is increasing, to the satisfaction of the people who are working to protect them. A serious new threat has appeared whose control and eradication is essential: the beetle *Omorgus suberosus* (Fabricius, 1775). This arthropod, both as larvae and as adults, eats olive ridley eggs, embryos and hatchlings. Two studies were carried out. In both studies, nests were placed in plastic pots and incubated with sand free of beetle contamination. In the first study, a known quantity of beetles was introduced into each pot, from 1 to 105 beetles, increasing by 15 in each treatment. Three attempts to treat each beetle treatment were made. After the hatching period the nests were examined to calculate the percentage of eggs destroyed by beetles. The percentage destroyed was proportional to the number of beetles. In a second study the eggs were separated into two plastic pots with 40 eggs in each. One pot of each pair contained no beetles as a control. There was apparent destruction of eggs; in some pots with beetles only 37 or 38 eggs were found instead of 40. This problem requires a non-chemical alternative method of control in order to safeguard human health and that of the turtles and of the environment, rather than subject them to the hazards of chemical pesticides. It has been demonstrated in agriculture that the use of seeds of superior plants for combating insects is economically sound and does not harm the environment.

JAGUAR PREDATION OF GREEN TURTLES (*CHELONIA MYDAS*) AT TORTUGUERO, COSTA RICA – CURRENT TRENDS AND CONSERVATION IMPLICATIONS

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Although jaguars (*Panthera onca*) have been observed on the beach at Tortuguero since the 1950's, the incidence of green turtle predation remained negligible until relatively recently, with just two documented cases in the 1980's. In the late 1990's, however, a substantial increase in jaguar predation was noted, from four in 1997 to at least 22 in 1999. This presentation describes jaguar feeding behavior, presents data on jaguar predation of green turtles from 2000 – 2004 and reviews the impacts of jaguar predation on the Tortuguero green turtle population. A remote video camera-trap was used to record jaguars feeding on recently predated turtles. One hour of close-up footage was subsequently analyzed to elucidate aspects of jaguar feeding behavior. Data on the number of turtles killed by jaguars were collected opportunistically during track surveys of the 30 km of nesting beach. A minimum of 28-97 green turtles were killed annually, suggesting a continuing increase in jaguar predation from previous years. Incidental jaguar sightings on the beach were also recorded and the frequency of jaguar observations increased over the study period. Although the data indicate an increase in jaguar predation on green turtles in the last 5 years, if it remains at current levels it is unlikely to have a great impact on the green turtle population. However, this study highlights the need for a more comprehensive investigation of this intriguing interaction between two endangered species at Tortuguero.

EXTREME VARIATION IN ANNUAL SEA TURTLE STRANDINGS ON VIRGINIA'S EASTERN SHORE, USA

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From 2001 through 2004, sea turtle strandings were recorded in high numbers on the eastern shore of Virginia (ESVA), USA from May 1 through July 31. In Virginia it is well established that sea turtle strandings increase as Chesapeake Bay surface water temperature (CBSWT) rises in the spring. Strandings begin when CBSWT approaches 16.5˚ C and peaks when CBSWT is approximately 21˚ C. In the past four years ESVA strandings ranged from 72 to 191 in 2002 and 2003, respectively. The date of first stranding varied from May 1 in 2002 to May 25 in 2003. The peak in strandings occurred during the first week of June in 2001, 2002 and 2004 but did not peak until the third week of June in 2003. In high stranding years (2001 n=163, 2003 n=191), more turtles were reported on the Chesapeake Bay side of ESVA. Conversely, when strandings were lower (2002 n=72, 2004 n=91) more strandings were reported on the ESVA ocean side.

These differences in stranding number and distribution could be related to fishery interactions, turtle health and/or environmental factors. We found no correlation between annual CBSWT and ESVA stranding number; however, the timing of strandings did appear to be related to CBSWT. In 2003, when CBSWT increased slowly, strandings started and peaked approximately three weeks later than other years. Future research will focus on subsurface water temperatures and other environmental and health factors.

SIGHTINGS OF JUVENILE AND SUBADULT GREEN SEA TURTLES (*CHELONIA MYDAS*) OVER A TWO YEAR PERIOD IN MANGROVE TIDAL CREEKS OF THE BIG SABLE CREEK COMPLEX, EVERGLADES NATIONAL PARK, FLORIDA, USA

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In the course of ongoing research in the Big Sable Creek (BSC) complex in Everglades National Park (November 2001 – November 2003), we consistently sighted at least 25 juvenile and subadult green sea turtles (*Chelonia mydas*) in mangrove tidal creeks. Estimated carapace lengths were 10-60 cm and some animals (N = 4) showed signs of fibropapillomatosis. The predominance of green sea turtle sightings (25 in 5 trips) have been in clear water in the shallow headwater reaches of creeks that contain an abundance of submerged algal-covered logs and groundwater seeps. We postulate that these difficult to access areas may provide previously unknown foraging and possibly nursery grounds for this endangered species. We present sightings location data for a two year time period during which we conducted five visits to the site. We have recently secured funding from US Fish and Wildlife Service to initiate a green sea turtle tagging study in the BSC complex to determine whether these turtles are resident in BSC or if they use the area only as a stopover point in their migration routes. We will also establish activity and habitat use patterns through the combined use of mark-recapture, satellite tracking and molecular genetic techniques. We plan to collect stomach contents to perform diet analysis and record evidence of disease for all animals captured.

INDIVIDUAL VARIATION IN FEEDING HABITAT USE BY ADULT FEMALE GREEN TURTLES

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Adult female green turtles have been thought to inhabit neritic areas and feed mainly on algae and sea grasses during post-nesting seasons. However, recent results of satellite telemetry conducted in Japan revealed that, after the nesting season, female green turtles also inhabit oceanic areas. In these oceanic habitats they presumably feed on planktonic animals, as do immature turtles. This suggests the presence of life-history polymorphism in female green turtles as has been found in female loggerheads. In this study we quantified what percentage of green turtles nesting on Ogasawara Islands, Japan used neritic or oceanic habitats by measuring stable carbon and nitrogen isotope ratios (d13C and d15N) in their egg-yolks. A total of 89 females were examined in 2003–2004. Comparisons between both isotope ratios in green turtle egg-yolks and prey items indicated that 70% of the females used neritic habitats and 30% of them used oceanic habitats.

There were no relationships between body size and the isotope ratios, indicating a lack of size-related differences in feeding habitat use for adult female green turtles, which is in contrast with female loggerheads. In addition, four females were tracked by satellite to verify the inferences from stable isotope analyses.

GREEN TURTLES USING NEARSHORE REEFS IN BREVARD COUNTY, FLORIDA AS DEVELOPMENTAL HABITAT: A PRELIMINARY INVESTIGATION

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Our study focused on characterizing the marine turtles using nearshore reefs as developmental feeding grounds in Brevard County, Florida. One of the major goals of the Green Turtle (*Chelonia mydas*) Recovery Plan is to determine the distribution and seasonal movements for all life stages of the green turtle. We know little about the origin of juvenile and subadult turtles or their behavior patterns and foraging ranges. Due to limited access and the cost of inwater research we lack important information on habitat usage. An increasing number of beach nourishment projects in Florida warrant focusing research efforts on marine turtles using nearshore reefs. In Brevard County, the densest reef structures form a narrow band that extends from the immediate shoreline approximately 100 m seaward in shallow water (less than 4 meters deep). Visual transects were conducted to establish the presence and locations of sea turtles in the area. Turtles were captured using tangle nets set east of the reef formations. We captured 21 juvenile *C. mydas* during the first year. We photographed portions of the reef and recorded the predominant vegetation. An esophageal flushing technique was used to collect a foraging sample. *Chelonia mydas* consumed a diversity of marine algae including: *Gelidium* spp., *Gracilaria mammillaris*, *Ceramium* spp., *Jania adhaerens*, *Ulva* spp., *Chaetomorpha* spp. and marine invertebrates including: snails, jellyfish, hydroids and tunicates. The average straight carapace length was 37.0 cm with a size distribution that ranged from 26.4 cm to 64.6 cm.

A STUDY ON DIETARY COMPONENTS OF LOGGERHEAD TURTLES, *CARETTA CARETTA*, FOUND NEAR JAPAN

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Loggerhead turtles are circumglobal reptiles that inhabit temperate, subtropical and tropical waters. In the North Pacific they lay eggs only in Japan. The population of loggerhead turtles is decreasing dramatically for reasons such as marine pollution, seashore destruction, incidental capture, by-catch, etc. The progress of research on the ecology and life cycle of loggerhead turtles (*Caretta caretta*) in the North Pacific is especially remarkable. However, in the study of the turtles' ecology there are few studies on feeding ecology. This must be remedied in the near future. We have acquired the stomachs of six individuals stranded ashore on the coast of Chubu, Japan and three individuals captured as by-catch and analyzed the major faunal components. The loggerhead turtles used for this study had mean SCL 839 mm (max 926 mm, min 734 mm). In the stomach content analysis squid, seaweed, fishes, etc. were found. The feeding habits of loggerhead turtles that this study reveals differ from previously known ocean feeding habits.

FEEDING ECOLOGY OF "PELAGIC" LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN THE NORTHERN ADRIATIC SEA: PROOF OF AN EARLY ONTOGENETIC HABITAT SHIFT

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The life history of loggerhead sea turtles may be seen as a series of ecological and geographic shifts. The ontogenetic habitat shift from the oceanic to the neritic zone is certainly the most important one, affecting the population's demography. The size-at-recruitment of the neritic zone differs between loggerhead populations worldwide. Although size class analysis of several studies suggested an early recruitment in the northern Adriatic of small juveniles, size at ontogenetic habitat transition and diet of early juvenile stages remained unknown. In order to gain insight into the ontogenetic habitat shift from the perspective of the feeding ecology of these early stages, we focused our study on the smallest loggerheads that recruit in the northern Adriatic, with CCLn-t < 40 cm.

We analyzed diet composition of 17 small juvenile loggerheads (CCLn-t: 25.0 – 39.2 cm, mean: 33.9 cm, SD: 4.5), captured dead by coastal gill net fishery in Slovenian waters, northern Adriatic, in 2002-2004. Food items were classified into 15 taxa plus unidentified digested remains, anthropogenic debris and pebble/stone fragments and wet weighted (w.w.). In order to quantify the abundance of pelagic vs. benthic prey in the diet, we classified these taxa into two groups: benthic prey and pelagic prey. The benthic group included 12 taxa (Foraminifera, Porifera, Anthozoa, Mollusca, Polychaeta, Crustacea, Bryozoa, Brachiopoda, Ophiuroidea, Echinoidea, Algae and Angiospermae) and pebbles, while in the pelagic group we classified Cephalopoda, Osteichthyes and Insecta; decomposed unidentifiable organic remains and anthropogenic debris were conservatively classified into the pelagic group.

The three highest ranked prey groups included anemones (39.9%), crustaceans (23.4%) and molluscs (14.3%). Anthropogenic debris (remains of plastic and rope fragments) were found in 58.8% specimens. Though according to size loggerheads in this study should still be in the pelagic (oceanic) stage, the benthic taxa were dominant in the diet. They were found in all samples, with an average of 87.6% w.w. and a range of values for individual turtles between 19.2 and 97.2%.

The results showed that loggerheads with CCLn-t as small as 25 cm already recruit into the north Adriatic neritic zone, suggesting that these waters host transitional habitat for juveniles, most likely belonging to the Greek management unit. A shallow continental shelf with easily available benthic communities seems to cause the ontogenetic habitat shift in loggerheads of smaller size when compared with most other populations worldwide.

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DARWIN INITIATIVE ASSESSMENT OF THE COASTAL BIODIVERSITY OF ANEGADA, BRITISH VIRGIN ISLANDS

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Anegada is a small island in the Caribbean and is part of the British Virgin Islands archipelago. It is one of the largest unspoilt islands in the Caribbean and is under extreme development pressure. It hosts a globally important coral reef system and is a regionally important area for nesting and foraging sea turtles. Hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*), turtles are known to nest on Anegada but the knowledge relating to the status and ecology of these populations is lacking. Here we provide an overview of a multidisciplinary project which, in addition to monitoring marine turtle nesting and foraging populations, will also assess the status of birds and plants integrated within an extensive campaign to raise environmental awareness, promote community participation and contribute to institutional strengthening.

DIET OF THE OCEANIC GREEN TURTLE, *CHELONIA MYDAS*, IN THE NORTH PACIFIC

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Green sea turtles (*Chelonia mydas*) occur worldwide in tropical to sub-tropical habitats. Knowledge of *C. mydas* feeding ecology comes mainly from studies of near-shore benthic foraging habitats (Mortimer 1982, Seminoff et al. 2002, Balazs and Chaloupka 2004). Studying the foraging ecology of oceanic turtles is a developing research; however, wild *C. mydas* are rarely encountered in the open ocean so little is known about them during this stage. A total of 10 oceanic stage green turtles were obtained as by-catch mortalities in pelagic fisheries. Four of these were collected during 1990-1992 in the high seas driftnet fishery and six others were collected during 2000-2004 in the Hawaii-based longline fishery. The distribution of these turtles ranged in area between 5.6° N to 33° N latitude and 159° E to 154° W longitude. One dead stranded turtle was collected in Alaska by the NOAA-NMFS Auke Bay Laboratory (58.4° N, 134.7° W). The size distribution for the green turtles ranged from 30-70 cm curved carapace length. Out of the eleven *C. mydas* specimens, haplotypes were determined for a total of four turtles, five could not be determined and two specimens are under analysis. One of four driftnet-captured turtles had a common Hawaiian haplotype (LeRoux et al. 2003), while two of six longline-captured turtles had Eastern Pacific haplotypes (Dutton et al. 2000). A third turtle of six longline-captured specimens had a haplotype shared between Hawaii and the Eastern Pacific with morphological characteristics similar to Eastern Pacific green turtles. For samples where DNA amplification was not possible, two turtles (including the Alaskan turtle) had morphological characteristics similar to Eastern Pacific greens and two had Hawaiian-type morphology.

Diet analysis of gastro-intestinal contents found that oceanic green turtles are mainly omnivorous tending toward being carnivorous, consuming prey items by feeding at or near the surface. The most frequent prey items identified in samples were Coelenterates - Pyrosomas, Salps, Ctenophores, Cnidarians and associated amphipods. *Lepas* spp., *Cavolina* spp. and *Carinaria* spp. also frequently occurred in stomach samples. *Janthina* spp., a prey item that was identified as common in oceanic loggerhead diets, was found in few green turtle stomachs. *Velella velella*, prey commonly found in loggerhead stomachs, was absent in all green turtle stomach samples. Plastic debris was commonly found, but in very small quantities and was not the cause of death in any case.

DISTRIBUTION PATTERNS OF EPIBIOTA INHABITING THE CARAPACE OF NESTING LOGGERHEAD TURTLES ON WASSAW ISLAND, GEORGIA

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The spatial distribution of epibiota inhabiting the carapace of sea turtles may be influenced by the behavior of the host, such as mating, cleaning, or resting position, or by environmental factors, such as patterns of water flow over the carapace. In this study, attachment patterns of 17 epibiotic taxa on the carapace of nesting loggerhead turtles (*Caretta caretta*) were described. Distribution patterns of epibiota were recorded on 18 individual turtles on Wassaw Island, GA, throughout the 2004 nesting season. Turtles were tagged for individual recognition. The carapace was divided into six proportional zones and the occurrence of the 17 epibiotic taxa was recorded for each zone. The presence or absence of epibiotic species within the zones allowed for an evaluation of behavioral and environmental factors of the host that may affect the distribution patterns of epibionts over the carapace.

FACTORS AFFECTING NESTING SUCCESS IN GREEN (*CHELONIA MYDAS*) AND LEATHERBACK (*DERMOCHELYS CORIACEA*) TURTLES IN TORTUGUERO, COSTA RICA

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Leatherbacks nesting in Tortuguero have a significantly lower nesting success compared to green turtles nesting in the same location. To determine the causes of this difference, we evaluated the effects of spatial position, rainfall, air and sand temperature on hatching and emergence success, incubation time and fate of nests. Nests were monitored daily from March to December 2001. Nests were classified in zones based on sunlight exposure (open, partial exposure and closed canopy). Distance from the nest to high-tide was also measured.

Hatching and emergence success was determined from excavated nests. Incubation time was longer in vegetation than in open-zone in green turtle nests. The fate of nests also varied, with a slightly higher number of depredated and inundated nests in border-vegetation and washed over nests in the open zone. Leatherbacks only nested in the open; 33 and 39% of the nests were washed out and over, respectively. The number of undisturbed nests was low compared to green turtles (18.75% vs. 54.87%). The distance to high-tide and vegetation varied between species; leatherbacks nested closer to the water and greens closer to vegetation. Leatherback nests close to high-tide had lower nesting success; however, green nesting success was not affected by proximity to the water. Incubation time decreased with higher sand temperatures in both species and hatching success decreased with longer incubation periods in leatherbacks. Nesting success was higher in deeply buried nests in both species. It seems likely that the low nesting success of leatherbacks is due to nesting zone selection with respect to proximity to the high-tide and vegetation line.

REPERCUSSIONS OF ABIOTIC FACTORS ON THE NESTING PROCESS OF *CHELONIA MYDAS* IN NESTING AREAS IN WESTERN CUBA

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We studied the effect of abiotic factors such as temperature, precipitation, relative humidity and geomorphology of the beach, among others, on the nesting process of green turtles (*Chelonia mydas*) in the Peninsula of Guanahacabibes, located in the western region of Cuba. Performing one comparison at a time, significant differences were found when comparing time and space of emergences and nestings**.** Nesting and emergences reached the highest frequency in the month of July, although it varied between beaches. No relationship was found between total emergence and the ambient temperature, but there was a relationship between precipitation and relative humidity. As for the geomorphology of the beach, it was found that nesting occurred mostly at the level of the vegetation) and in areas of the beach free of obstacles, like big rocks on the shore. Another factor that seems to influence nesting is marine currents, due to their effect on the nesting frequency per beach and the trajectory of entrance of the turtles onto the beach.

REPRODUCTIVE SUCCESS INDICATORS FOR GREEN TURTLES (*CHELONIA MYDAS*) IN GUANAHACABIBES PENINSULA, PINAR DEL RÍO, CUBA

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An analysis of the quantitative indicators of the final phase of green turtle (*Chelonia mydas*) incubation was carried out at three beaches located in the Biosphere Reserve and National Park on the Peninsula of Guanahacabibes, Cuba. Seven indicators of reproductive success were compared among the beaches and among three zones (defined as a function of the proximity to the high tide or the vegetation lines) per beach. There were significant differences between zones for percentage survival and for eggs without embryos; among beaches there were differences for predation levels. The incubation period did not show significant differences except for zone A in Perjuicio beach, where sample size problems could have been the cause. The mean values and confidence intervals for egg number, anomalies and embryo death were presented, with no differences found among treatments. There were significant differences among zones for some indicators of survival, with the A zone having the lowest survival rate and the highest percentage of eggs without embryos. Together with the fact that the smallest number of nests occurred in the A zone, this indicates that green turtles, as a species, have developed toward the selection of those areas that guarantee the most appropriate conditions for reproductive success when choosing a nesting spot.

A NEW APPROACH TO EVALUATING NEST DISTRIBUTION PATTERNS ON BEACHES: THE MID-DOMAIN EFFECT MODEL

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Many environmental factors have been suggested to explain observed spatial and temporal nest distribution patterns on beaches. In this study, we investigate the role of geometric constraints on spatial and temporal nest distribution patterns using the mid-domain effect (MDE) model, which was originally developed to evaluate patterns of species richness. Using spatial and temporal nesting data from Tortuguero, Costa Rica, we develop simulation models and demonstrate that intraspecific spatial and temporal nest distribution patterns within well-defined spatial and temporal boundaries can be evaluated within the context of the MDE model. Deviations from the model may be attributed to overriding environmental factors. The model also provides an estimate of the mean spatial nesting range of individual green turtles at Tortuguero.

ESTIMATING NEARSHORE PREDATION RATES ON HATCHLING LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) FROM SOUTH FLORIDA BEACHES

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Few studies quantify mortality in hatchling sea turtles during their offshore migration. Predation is assumed to be highest nearshore, but few studies have supported this. Gyuris (1994) found 0-85% predation rates (mean = 31%) on *Chelonia mydas* hatchlings as they migrated over a reef crest and into deep water at Heron Island, Australia. Stewart and Wyneken (2004) found a 5% predation rate off a high-density loggerhead (*Caretta caretta)* nesting beach in Florida, USA. Our study quantifies and compares nearshore predation rates on loggerhead hatchlings at several locations in Florida to determine if there are spatial or temporal differences in predation. Observers in kayaks followed hatchlings during the first 15 min of migration at three sites: Boca Raton (N26°22′01.5″ W080°04′04.6″) and Hutchinson Island (N27°20′18.6″ W080°13′59.4″) on the east coast and Naples (N26°06′31.5″ W081°48′11.3″) on the west coast. Each site was sampled three times across the hatching season; early, middle and late sub-seasonal categories (based on densities of hatchling emergences) were compared. Thirty hatchlings were sampled each sub-season (n = 90 hatchlings/location). Hatchlings were followed individually as they swam away from the beach, each towing a Witherington float on a 2 m tether from which we could site the turtles. This method was previously used successfully to track hatchlings (Wyneken and Salmon 1997, Stewart and Wyneken 2004). No predation was observed at any sampling site during the early sub-season. Boca Raton was the only beach where predation changed temporally (Fisher exact test, $p = 0.012$), with higher predation (20%) during late sub-season. Wyneken and Salmon (1997) noted predator assemblages changed throughout the hatching season. Such shifts may explain the sharp increase in predation from the early to the late sub-season in Boca Raton. Due to hurricane damage to Hutchinson Island beaches, no data were collected during the late sub-season there. We found an overall predation rate of 4.6%; it did not differ significantly from Stewart and Wyneken's 5% predation rate; however, specific beaches differed in predation risk. The two east coast sites had similar predation rates; predation was higher on the east coast than on the west coast. Predation for the entire sampling period differed significantly between Boca Raton and Naples (Boca Raton: 8.9%, Naples: 1.1%; $\chi 2 = 5.731$; $p = 0.017$). These differences may be due to alternative patterns of predator movement, different fish and macro invertebrate assemblages and/or different physical and environmental conditions. Our results suggest that currently, hatchling mortality rates are low in shallow nearshore waters off Florida's coastline. Rates at later life history stages may be very different.

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FISHERIES

LONGLINES AND SEA TURTLE BYCATCH IN PERU

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As sea turtle nesting beaches have become increasingly protected, one of the greatest conservation priorities is addressing bycatch in fisheries. Worldwide assessments on turtle bycatch in longlines have been limited due to gaps of information on turtles CPUE in some regions, including the southeast Pacific. Through a shore based observer program in 2001-2003, we estimated there were 2025 turtles captured at eight ports sampled in Peru. However, due to the clandestine nature of the use of captured turtles, an accurate estimate of turtle CPUE was difficult to achieve. Therefore, in 2003 we established an onboard observer program based in Ilo, home to the largest artisanal longline fleet in Peru, targeting mahi mahi and sharks. During the first ten months of the program, ten greens, one hawksbill, 16 olive ridleys, two leatherbacks and 108 loggerheads were recorded. Of these, 72% were entangled in the line while 23% were usually hooked. Fisheries are the second largest economic sector of Peru. However, endangered marine fauna are being affected by fishing practices. Sea turtles in Peru are legally protected but due to poor socio-economic conditions in the country, political instability and insufficient resources, enforcement of this legislation is very limited. In the case of longline fisheries in Peru, we recommend the implementation of mitigation measures (i.e. de-hookers, circle hooks) together with improved basic education in coastal communities.

CAPTURE OF SEA TURTLES IN THE FISHERIES AROUND TANGIER, MOROCCO

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Moroccan waters support a large fishing industry. This study evaluated the interaction between fisheries and sea turtles in the marine fishing zone around Tangier, Morocco. Data sheets and measuring tapes were distributed to fishermen willing to collect information on turtles caught in their fishing gear. Between June 2003 and September 2004, fishermen reported 21 accidental captures. Except for one leatherback, all captured turtles were loggerheads, consistent with other studies on bycatch in the area. The mean size of the captured loggerheads was 55.2cm CCL, suggesting that most were likely juveniles or sub-adults, although loggerheads with <60cm CCL have been observed nesting in Cape Verde. More in-depth studies are planned to evaluate the impact of fisheries along the Atlantic coast of Morocco.

EVIDENCE OF HUMAN-INDUCED MORTALITY AMONG TURTLES STRANDED ALONG ITALIAN COASTS

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Sea turtles may strand on the coast for different reasons, natural and not. The proportion of turtles stranded because of anthropogenic factors can give useful indication on the importance of these factors for the populations. Finding dead or ill turtles on the beach or floating at sea is relatively common near important foraging areas. Italy is in the center of the Mediterranean and borders some of the most important areas for sea turtles, like the Adriatic Sea, the Ionian Sea and the Sicily Channel. In Italy, several independent teams continuously monitor sea turtle strandings along most of the coast, with the main purpose of rescuing live specimens. During this activity data are usually collected for each turtle, including evidence of interaction with fishing gear or of other anthropogenic factors. Data from most of these teams are pooled together and presented here in order to provide insights on the impact of human activities on turtles at sea.

2135 records of *Caretta caretta* were assembled from the databases of five different programs: University of Rome/WWF Italy (1981-2000; n=788), WWF Italy (2001-2004; n=362), Fondazione Cetacea (1986- 2003; n=518), University of Bari (n=410) and ARCHE (2003-2004; n=57). 1569 turtles were found dead or alive on the beach and 566 were found floating at sea. Data were not originally collected with the goal of providing evidence of anthropogenic impact, so these records may be incomplete and often only very clear evidence was recorded. For these reasons, the percentages presented here should be considered as an underestimation. Because of the methodological limitations, evidence of anthropogenic impact were grouped into three categories: a) evidence of capture by longline (presence of hook or branchline from cloaca or mouth), b) entanglement in pieces of nets or lines, or c) wounds indicating a collision with a boat/propeller.

When all specimens are considered, a higher proportion of turtles showing evidence of anthropogenic impact are found among turtles gathered at sea than among those stranded. However, most stranded turtles are found already dead while most gathered ones are still alive. In fact, if only live turtles are considered, evidence of anthropogenic impacts increases among stranded specimens and is very similar to gathered specimens. This difference may be due to several factors; generally, greater attention is given to live specimens in need of veterinary treatment. Additionally, some mortality factors leaving no external evidence (like capture in trawl nets) could kill a turtle in the very short term, leaving no or few live turtles to strand on the beach. On the other hand, boat impact produces visible external evidence and the higher proportion among dead turtles is indicative of the high mortality rate of such an impact. Considering the above, as well as evidence of boat strike being found in low proportion, statistics from live specimens would be the most reliable ones and stranded and gathered specimens can be considered a homogeneous group. About 19% of these turtles (n=1022) showed clear evidence of anthropogenic impact. Evidence of interaction with longlines was recorded in 9.4% of specimens and entanglement in 6.9%, totaling 17.0% of turtles with evidence of interaction with fisheries. Given the probable underestimation of these cases, the proportion of turtles stranded because of anthropogenic factors in general, is certainly much higher.

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MAPPING POTENTIAL THREATS BY CANADIAN ATLANTIC FISHERIES ACTIVITY TO THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*)

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The leatherback turtle (*Dermochelys coriacea*) is legally protected under the SARA (Species at Risk Act of Canada) which came into force on June 1, 2004. Canadian commercial fisheries operating in Atlantic Canadian waters are known to incidentally capture leatherback turtles, although the threats are not well understood. This project was undertaken in order to synthesize existing data on commercial fishing activities to aid in the assessment of this potential threat. Commercial fisheries data were extracted from existing databases of the Department of Fisheries and Oceans Canada for fixed gear fisheries that have been identified as having high risks for potential interaction with leatherback turtles. A database containing the positional and effort data for these fisheries was created in MS Access. ESRI ArcGIS 8.3 software was then used to create maps of fishing gear distribution during May to November, when leatherback turtles are present in migratory and feeding habitat in Atlantic Canadian waters. Maps of leatherback turtle occurrence were also available. These spatial and temporal distribution maps will enhance the ability of managers to assess and evaluate the threat of incidental interactions between leatherback turtles and commercial fishing gear and to work toward the development of appropriate mitigation measures.

REDUCTION OF LOGGERHEAD (*CARETTA CARETTA*) SEA TURTLE BY-CATCH IN THE VIRGINIA (USA) WHELK POT FISHERY

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The Chesapeake Bay and the coastal waters of Virginia serve as an important foraging ground for an estimated 5,000 to 10,000 sea turtles each summer. Sea turtles migrate in to these waters each spring when sea temperatures reach approximately 18º C and migrate out in the fall as temperatures decrease. Each year between 200 and 400 sea turtle stranding deaths are recorded within Virginia's waters, the peak of this stranding period occurring during the spring migration in late May and early June. Several fisheries are operating during this spring migration period, including the whelk pot fishery. The whelk pot fishery is a relatively new fishery to Virginia's waters and may pose a threat to the seasonal population of loggerheads in the Chesapeake Bay and the coastal waters. Loggerhead turtles appear to be attracted to whelk pots by horseshoe crabs used as bait and targeted whelk species (*Busycotypus canaliculitus*). Upon interactions, these turtles may become entangled in the bridle and subsequently suffer serious injury or death. The purpose of this research was to determine which type of whelk pot and bridle attachment method reduces loggerhead sea turtle entanglements while still fishing efficiently. Several voluntary observer trips were conducted with a whelk pot fisherman setting pots in the lower Chesapeake Bay and coastal waters. Catch data for each hauled pot and pot type were recorded. Preliminary results indicate that three of the whelk pots resulted in similar CPUEs for whelks. Evidence of sea turtle interactions was also documented at this time. There were no incidences of sea turtles caught as by-catch during these trips. However, evidence of sea turtle interactions was present including: missing bait bags, chewed shells, frayed bungee cords and mangled crab pot wire. Eight more voluntary observer trips will be conducted to obtain additional catch data. In spring 2005 tank experiments will be conducted at the NMFS Laboratory in Galveston, Texas using captive-reared loggerhead sea turtles. Turtle interactions with each type of whelk pot will be examined. The bridle configuration will then be modified to discern any changes during turtle interactions. Results for this portion of the experiment are forthcoming.

INFLUENCE OF ENVIRONMENTAL AND FISHERY PARAMETERS ON THE CAPTURE OF LOGGERHEAD SEA TURTLES IN THE LONGLINE FISHERY OF THE AZORES

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It is common knowledge that oceanic sea turtles suffer several impacts on their habitat, longline fisheries being a world concern. In the Pacific it is accused of decreasing the loggerhead sea turtle (*Caretta caretta*) population on 80% in 20 years, of leading the leatherback sea turtle (*Dermochelys coriacea*) to extinction and of overfishing pelagic sharks. In the Azorean waters, mainly used by the oceanic juveniles of loggerheads, these fisheries target swordfish (*Xiphias gladius*) and blue shark (*Prionace glauca*). The loggerhead bycatch rates differ according to which of these species are targeted. The data were recorded during a longline gear modification experiment conducted in the Azores in the year 2000. Of 232 loggerhead turtles recorded on 93 longline sets, two were dead by drowning and 31 were put back in the sea with the hook still inside; their mortality is high. The size classes of loggerheads being impacted (24-72 cm curved carapace length) constitutes the largest size class of loggerheads occurring in the Azores and are considered very important for the survivorship of the North Atlantic population. The results show that the captures are not uniformly distributed around the fishing effort; 81% of the sets captured 1/3 of the total loggerheads, with a high capture rate around the oriental group of islands and in the summer months, coinciding with the presence of the thermohaline front in the area.

To find the parameters - mean depth, minimum depth, sea surface temperature (SST), soak area, soak time, moon phase and wind velocity - that best predict the variations in turtle capture rates we used the General Linear Model. This was also applied to the target species because of the apparent relation found between the capture of turtles and the capture of the two fish species. Results from a descriptive analysis performed on the parameters revealed from the model were as follows: mean depth and SST to the turtles, minimum depth to the swordfish; mean depth, SST, Beaufort value and soak time to blue shark. Higher turtle bycatch rates were associated with higher blue shark captures, observed in sets released in deeper waters and in sets with longer day hauling time. The opposite association, in relation to SST, of blue sharks and turtles is of significance for the capture variations by time, but it is buffered by the strong correlation found between capture rates and mean depth. Also, the higher SST related to higher loggerhead sea turtle capture is expected because of the association with the front. The high capture rate observed in the oriental area of Azores can be explained by the mesoscale eddies trapped in that area, reported as normally present and induced by the bathymetric features. The relationship of the swordfish with the minimum depth is expected, since sets deployed in shallow water and/or near banks are targeting swordfish while sets deployed over deeper bottom depths are mainly targeting blue shark.

Fishing gear agitation induced by wind and waves increase the attraction of blue sharks. Juvenile loggerhead sea turtles present an aggregate distribution around very specific ocean areas that are variable in time and space and the distribution of the turtles can be predicted by monitoring those areas in relation to a few parameters. Impact of the longline fishing on sea turtles could be quickly diminished by the awareness of fishermen for sea turtle conservation, including onboard handling methods and one or more of the following measures: after a high capture of turtles the fishing area should be changed; monitor the oceanographic parameters by remote sensing and then provide instructions to the fleet; prohibit longline fishing in specific areas during a fixed period. Experimental results show that gear modification has potential to reduce bycatch, but the implementation of obligatory gear alterations must be done with extreme caution. For instance, in the Azores circle hooks might increase the effort towards the unregulated blue shark fishery, leading to an unsuspected increase in loggerhead-fishing interactions. Therefore it is important that bycatch research continues, including at the local and social level, but the implementations of mitigation measures are of high priority if we want to keep Atlantic turtles and shark stocks safe.

SEA TURTLE ON BOARD: STRUGGLE TO SURVIVE

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The WWF Sea Turtle Rescue Center has worked in Lampedusa since 2000, focusing its activities on two aspects: one involving volunteers and visitors learning about the care and study of sea turtle biology, the other one involving the sensibilization of fishing boats working around the island. Since 2000 more than 100 trawling boats and ten boulers have caught almost 1500 sea turtles; around 20% of the animals needed surgery and their convalescence was between 2 and 60 days. We analysed the relationship between fishing and rescue activities and what kind of advantage sea turtles can gain from such a collaboration in the Mediterranean Sea. Captured sea turtles have a lot of problems: first, being caught, but once on board, for them it is a real struggle to survive. The cold temperature, loss of seawater, injuries and fright reduce their ability to survive. Some die. Travel conditions are poor and unnatural. Few boats accept or realize the need for tanks or special places for turtles; often onboard space is insufficient and the men are totally crushed by tasks, but it is only with a collaboration with fishermen, who live on the sea 27 days/month, that we can pick up data to help turtle conservation.

Fishermen are the major threat to the survival of endangered sea turtles in the Mediterranean Sea. That many thousands are caught or entangled in fishing gear each year seems a realistic number. We really agree with all authors in thinking that interaction with fishermen is the most significant factor in sea turtle survival, so we employed all of our energy in develoing relationships with the fishermen. In Lampedusa, local fishing traditions are disappearing: the economy is based more and more on tourism and few local fishers still work with little boats near the coast, often leaving for just one night. A strong Sicilian fleet is working between Lampedusa and the African coast and every 3-4 days they come in to port and unload fish for 1-2 hours, then go back out to the open sea. They fish from the Lampedusa port almost 9 months/year, stopping in April, May and August. Each month they work 27 days straight. In recent years we have tried to build a strong relationship with the fishermen and now we can count on their precious collaboration with our conservation effort. There are more than 100 trawling boats with almost 700 fishermen working, most of them coming from Mazara del Vallo, Sicily, and fishing between the African and Sicilian coasts. We also collaborate with almost ten long-lines boats where approximately 30 men work. The shark fishing season lasts 50 days during the summer.

Acknowledgements: I'd like to thank all the friends that, with determination and patience, help the rescue center in its activities, but first of all my family! To my colleague Paolo Casale all my gratitude to share with me each adventure and event! A special thanks to the Fishermen that made the idea to protect sea turtles part of their sea life, often carrying out my loneliness and weariness: always they managed to put a smile on my face. Thanks to Captain Calogero Raptis for sharing with me lot of nights at the port involving fishermen; Captain Pietro Russo and Pino Asaro and their families for their friendship and the same for all Captains, fishermen and especially Mr. Nino Maltese, for his affection. For their support thanks to Mr. Salvatore Barreca, all the volunteers, Prof. Zizzo and Prof. Di Bello of Bari University. Et tout l'amour eternal à ma maman, qui m'a appris à aimer la vie et la mer.

A STRATEGY FOR SEA TURTLE CONSERVATION AND RECOVERY IN RELATION TO ATLANTIC OCEAN AND GULF OF MÉXICO FISHERIES

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All species of sea turtles inhabiting the Atlantic Ocean and Gulf of México are listed as either endangered or threatened under the Endangered Species Act (ESA). Incidental capture in fisheries is a major limiting factor in the recovery of sea turtles in these areas. NOAA Fisheries, the agency responsible for protecting sea turtles in the marine environment, continues to implement conservation and monitoring programs, regulations and other actions under the ESA to recover these species. To further help meet ESA recovery goals for sea turtles, NOAA Fisheries is implementing the Strategy for Sea Turtle Conservation and Recovery in Relation to Atlantic Ocean and Gulf of México Fisheries (Strategy). The Strategy is a new approach to reducing incidental capture of sea turtles in U.S. commercial and recreational fisheries based on evaluating sea turtle bycatch across gear types and relying heavily upon involvement of stakeholders (e.g., fishing industry, non-governmental organizations and the interested public). A strategic approach evaluating fishery impacts by gear types across state, federal and regional boundaries will increase management effectiveness. The primary objectives of the Strategy are to: (1) conserve and recover sea turtles; (2) evaluate sea turtle bycatch across gear types; (3) develop and implement measures to reduce bycatch; and (4) authorize fishery takes consistent with ESA mandates. Conservation measures will be developed using all elements of the Strategy - information gathering, research and analysis and stakeholder involvement.

NEW REPORTS OF METALLIC TAGS IN SEA TURTLES RECOVERED IN THE HIGH GUAJIRA, BORDER COLOMBIA – VENEZUELA

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Marking of sea turtles is carried out in most cases to obtain information on their reproductive biology, movements, stranding, distribution and rate of growth. The Gulf of Venezuela is considered a feeding area for sea turtles, but it is also an area of great human fishing activity where these reptiles are constantly caught to be marketed and consumed. During April to June, 2004, we visited the fishing establishments of the ethnos Wayúu and the coasts of the Gulf of Venezuela. During that time, we obtained the following information from tags:

ID, Tag locality, recapture location, recapture year, species
P4787 ---------- Guajira, 1990, *Eretmochelys imbricata*,
0103, Cuba, Guajira, 1996, *E. imbricate*
MM400, Bermudas Edo. Zulia, 1997 *Chelonia mydas*
98083, 98084 Tortuguero Costa Rica, Golfo de Venezuela, 2004, *Chelonia mydas*

These data are of great importance for the development of projects pursuing female nesting areas in different countries of the Americas. This demonstrates that the Gulf of Venezuela and the High Guajira coasts constitute an are a of temporary residence with wealthy alimentary resources for these reptiles.

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MODIFICATION OF LONGLINE FISHING GEAR INCORPORATING SHARK CHARACTERISTICS

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The by-catch of sea turtles in the pelagic tuna and swordfish longline fisheries is an international problem that has resulted in the closure of some U.S. domestic fisheries. Solutions for preventing the incidental take of sea turtles need to be identified, developed and implemented. It is not known by what mechanisms pelagic loggerheads find longline gear and become captured through entanglement with the lines or the ingestion of baited hooks. Turtles of all sizes and ages fall prey to sharks. It is not known whether sea turtles actively avoid sharks through some form of recognition and avoidance or whether turtle/shark encounters are simply random acts and the fate of the turtle rests with the shark. If sea turtles can recognize the threat of a shark and then actively avoid sharks in the wild, then maybe some attributes of the "shark" shape can be incorporated into/onto longline gear to deter sea turtles. Preliminary field studies indicate captive reared juvenile loggerheads displayed an avoidance behavior when exposed to fiberglass shark replicas. In this study, we quantify the innate response of captive reared loggerhead sea turtles to shark decoys and attempt to identify the shark characteristics most repulsive to sea turtles.

INTERACTIONS BETWEEN SEA TURTLES AND FISHERIES IN PERU: DATA FROM ONBOARD OBSERVATIONS DURING 2003 AND 2004

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Grupo de Tortugas Marinas - Peru / APECO, Perú

Five species of sea turtles inhabit the Pacific Ocean near Peru. Green, hawksbill, leatherback, loggerhead and olive ridley turtles cross the ocean looking for food. Some of these species interact with different fishing activities. During the seasons for the common dolphinfish and shark longline fisheries in 2003 and 2004 and during the season for the anchovy and mackerel purse seine fisheries, on board observers collected data about incidental sea turtle capture. The onboard observers were specially qualified to conduct the data collection. Information about the fishing gear and fishing activity was also collected. The species most commonly captured during the longline activities was the loggerhead turtle, but green and olive ridley turtles were also captured. The loggerhead turtle was more injured during the longline activities than other turtles due to the fact that it commonly bit the hook and the tools for hook removal were not available. The information about capture rates and areas of capture, with other results, will be presented in the poster.

AN INTEGRATED APPROACH TO LONG LINE FISHERY MANAGEMENT AND TURTLE CONSERVATION IN THE PACIFIC

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Management objectives for the Hawaii-based pelagic longline fishery managed by the Western Pacific Regional Fishery Management Council are to achieve optimum target yield without jeopardizing the long-term existence of sea turtles and other protected species, while at the same time operating a "best practice" or environmentally responsible fishery. Measures to promote the reestablishment of the swordfish fishery in the Pacific have been identified following four years of experimental and collaborative research in the Atlantic. These new regulatory measures have helped to establish a "model" shallow-set swordfish fishery using circle hooks with mackerel bait and a limited number of sets (2,120 sets or 50% of the 1994-1999 annual average). As an additional safeguard, a 'hard' limit on the number of leatherback (16) and loggerhead (17) turtles that could be taken by the swordfish fishery has been implemented which results in immediate closure if the limit is reached. The Council strategy recognizes that turtle population recovery is contingent on mitigating threats across the full spectrum of a turtle's life history. Consequently, a number of conservation projects at nesting beaches and coastal foraging habitats have also been implemented in Indonesia, Papua New Guinea, Japan and Baja California, México. This approach, which melds both fishery mitigation and conservation activities at nesting and foraging grounds, will be shared with the major international longline fishing nations (Japan, Taiwan, China and others) during the third International Fishers Forum in Japan in 2005.

SEA TURTLE INTERACTIONS WITH THE COMMERCIAL FISHING INDUSTRY OF THE U.S. VIRGIN ISLANDS

Kemit-Amon Lewis

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Sea turtles were historically important to many countries and cultures and were hunted for consumption of their meat and eggs. Also, their bones, carapaces, skulls, fats, oils and blood were used for culturally medicinal practices that include black magic or voodoo. In addition to being hunted, accidental captures also played an integral role in the drastic decline of global populations. The purpose of this study was to assess the interactions between sea turtles and the commercial fishing industry of the US Virgin Islands, particularly with fishing gear. I interviewed 70 fishermen on St. Croix and 45 on St. Thomas to analyze sea turtle-to-fishing gear interaction frequency and to further analyze interaction as associated with fishing gear, sea turtle species and location. Also, ten years (1994-2003) of what was considered "fishery-related" stranding data were analyzed. 56% of the fishers interviewed on St. Croix and 47% of those interviewed on St. Thomas reported never having any sea turtles interact with their fishing gear. Only 11% and 18% of the surveyed fishers on St. Croix and St. Thomas, respectively, reported frequent interactions (two or more per year). For both islands, all but one of the net fishers had interactions between sea turtles and their gear. Between 1994 and 2003, there were 64 fishery-related sea turtle strandings reported. More fishery-related strandings were reported for St. Croix than for any other island (36). Boat related injuries accounted for 31 of those strandings reported.

REPORT OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) IN THE NORTHERN GULF OF VENEZUELA, HIGH VENEZUELAN GUAJIRA

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The olive ridley (*Lepidochelys olivacea*) is considered the most numerous sea turtle due to their enormous synchronous nesting (arribadas). Some towns where it happens are along the Pacific coasts of Costa Rica and México and the north of India. In Venezuela their nesting is not known. Recaptures of tagged turtles in the east of the country indicated they are coming from nesting areas in Surinam. We journeyed to fishing establishments of the ethnos Wayúu for interviews, observation and revision of fishing. In May 2004 a *Lepidochelys olivacea* was captured to the northern region of the Gulf of Venezuela by fishermen of the ethnos Wayúu and taken to fishing establishments in the High Guajira. The olive ridley's measurements were: 66.5cm curved carapace width and 64.7cm curved carapace length. It presented eight costal keels, green olive color, dehydration and wounded fins from ropes. *Lepidochelys olivacea* observation in the Gulf of Venezuela has been inconsistent with three reports for the study area. Pritchard and Trebbau (1984) established the first registration of *L. olivacea* in the northern Gulf of Venezuela, virtually to the Colombian border. Sideregts et al. presented the second report in 1987. By 2002, Parra reported a jaw of *L. olivacea* for the third report. This study report adds the fourth known incidence of this infrequent species on the coasts of the Gulf of Venezuela. Finally, we thought the sea turtle was taken to the market Los Filuos (Venezuela) or Maicao (Colombia) where it was sold for human consumption.

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A PRELIMINARY LOOK AT THE HAWAI'IAN SWORDFISH REGULATIONS AT REDUCING SEA TURTLE BY-CATCH

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The first year of the reopening of the Hawaii swordfish longline industry terminates on December 31, 2004. A moratorium had been placed on swordfish longlining in Hawaii due to excessive leatherback and loggerhead by-catch. The fishery was reopened this year under the following conditions: replacing j-hooks and squid bait with circle hooks and mackerel bait, 100% observer coverage on every swordfish vessel, a quota on the number of sets fishermen can make (half of the historical effort) and a cap on the number of interactions permitted with loggerheads and leatherbacks (17 and 16, respectively). We have a grant to study this experiment for the first year and will present preliminary results at the conference. With access to the observer data for every vessel, we will know where, when and how many sea turtle interactions occur and how many swordfish are caught. This will allow us to analyze how these new regulations will impact the swordfish industry and how effective they are at reducing turtle by-catch. Additionally, certificates will be distributed for 2005 in November, so we will also report new developments with the experiment, as well as discuss how success can be measured in such experiments. Even though the Hawaii swordfish longlining fleet is small and they are severely restricted in the number of sea turtles they can interact with, the results of this experiment could play a large role in shaping future policy decisions about the compatibility of longlining and sea turtle population recovery.

TESTING THE ATTRACTIVENESS OF BAIT HAVING AN OLFACTORY COMPONENT

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Long-line fisheries are known to have an impact on loggerhead sea turtles all over the Mediterranean. This negative effect is particularly strong in the waters surrounding the islands of Lampedusa and Lampione (SCI code ITA040002) and the island of Linosa (SCI code ITA040001) in southern Italy. We tested captive immature loggerheads to assess the importance of olfactory stimuli in prey selection. To test mackerel-smell effect, turtles were offered either odorous (mackerel inside a sheath, invisible from the outside) or odorless "bait" (identical sheath but without mackerel). Each experimental set was composed of three sheaths set at a 10 cm distance from one another. For each turtle we considered eight behavioral categories, from no interest to identification of the sheath as prey.

The bait's smell was demonstrated to be an important component for attack by turtles. Smell-less bait, in fact, is generally unattractive to turtles. The turtles' behavioral responses highlighted the importance of chemical clues in eliciting approaching or biting behaviours (19 with scomber / 10 without scomber: X2=4.32; d. f. = 1; P=0.038). This study was carried out within the framework of the EU-Life Project "Urgent conservation measures for *Caretta caretta* in the Pelagie islands" (LIFE99 NAT/IT/006271).

FIRST REPORT OF LEATHERBACK (*DERMOCHELYS CORIACEA*) ENTANGLEMENT IN TRAP LINES IN THE URUGUAYAN CONTINENTAL SHELF, SOUTHWESTERN ATLANTIC OCEAN

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Leatherback turtle (*Dermochelys coriacea*) populations have experienced drastic declines over the last decades and are currently critically endangered. Little is known about the life cycle of leatherback turtles and the threats they face while in the sea. Understanding the distribution and occurrence of sea turtles has been recognized as an essential element for the successful recovery of the endangered sea turtle populations. Fisheries are an important sampling and data collecting tool for sea turtle research and conservation, but at the same time represent a threat for sea turtles. Incidental catch in fisheries is recognized as a major mortality factor for leatherback turtles, but little is known about the magnitude of this problem in the southwestern Atlantic Ocean (ASO). Leatherback turtles have been reported to interact with the lines of crab or lobster traps, mainly in the US (Cape Cod) and in Great Britain (Cornish coast). In this work, we present the first report of leatherback entanglement in trap lines in the ASO. A scientific onboard observer reported the incidental capture of three leatherback turtles in the Uruguayan continental shelf, entangled in the mainline (polyamide, diameter=24 mm, length=1500 m) of a snail trap fishing vessel during a one month (May 18th to June 17th 2004) fishing trip. The first two turtles were released alive, but the last one was already dead when the hauling occurred. The fishing zone exceeded 60 m in depth. Further research and monitoring of this fishery is recommended in order to better understand this problem.

INVOLVEMENT OF ARTISANAL FISHERMEN IN GREEN TURTLES MANAGEMENT: INITIATIVE FOR RESEARCH AND CONSERVATION IN SOUTHERN BRAZIL

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Three out of five Brazilian sea turtle species are commonly found in southern waters: *Caretta caretta*, *Chelonia mydas* and *Dermochelys coriacea*. Their main nesting beaches, located along the southeast and northeast coast, have been monitored and protected by the Sea Turtle National Program over the last 23 years. However, sea turtles have been killed or seriously injured in fishing gear located hundreds of kilometres southward. Santa Catarina Island, part of Florianópolis City (SC), shows a great fishing effort with industrial and artisanal boats involved in sea turtle bycatch. We present the first steps in an attempt to estimate the local impact of fishing activities. Florianópolis' artisanal communities were visited, resulting in 37 interviews with fishermen also in the location and characterisation of 24 artisanal floating-weirs following criterion of the National Plan for Reduction of Sea Turtle Bycatch. Local beaches and five floating-weirs (20.8%) were monitored daily from September 2003 to March 2004 in order to quantify strandings and captures. Fourteen fishermen were authorised by the Brazilian Environmental Institute to transport turtles incidentally caught, allowing the researcher to take measurements, attach flipper tags and assess the turtles' health conditions. Under special permit of the Genetic Heritage Management Council we were able to collect biological samples for future genetic studies with the aim of identifying the origin of turtles that inhabit the region.

We recorded 72 captures of *C. mydas* (CCL med =39.75 cm; 27.5 - 61.5; n=32) in the 5 floating-weirs (CPUE= 0.08) and a low mortality rate of 2.8%. Nineteen green turtles were found dead on the beaches, most of them suggestive of negative interaction with other kinds of fishing gear. No green turtles were found to have fibropapillomas. The most common epibiont was *Chelonibia testudinaria*, but we found *Balanus improvisus* and *Planes cyaneus* as well. This is the first record of the crab *P. cyaneus* on *C. mydas* in the southwestern Atlantic. A total of 40 tissue samples were obtained from 35 *C. mydas*, two *C. caretta*, two *D. coriacea* and one *L. olivacea*. Despite several records related to incidental capture in pelagic longline and drift-net fisheries in southern waters, *D. coriacea* has been captured at low frequency by artisanal coastal fishery and sighted near local small islands. Since 1999, we recorded seven inshore captures, four nesting activities and at least three strandings of leatherbacks on Santa Catarina Island. Finally, we compared our results with other published studies regarding TAMAR stations on feeding grounds, concluding that Florianópolis stands out at the national level in relation to the implantation of a permanent community-based sea turtle research and conservation program.

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DISTRIBUTION PATTERNS OF SEA TURTLES CAUGHT DURING AN EXPERIMENTAL LONGLINE FISHERY

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Information about the distribution and abundance of oceanic-stage loggerhead sea turtles in the Azores archipelago is scarce. ArcGis software can be a useful tool to study distribution patterns of sea turtles. The objectives of this study were: a) to evaluate relative influence of several temporal and spatial parameters in the distribution patterns of loggerhead sea turtles and b) to determine if GIS can be used to estimate distribution patterns. Data from 343 sets collected during five longline fishing experiments (2000-2004) carried out within EEZ of the Azores archipelago were used. Caught loggerheads (n=491) were plotted by time of day and month to determine the influence of these temporal factors on the bycatch pattern. Spatial analyses by ArcGIS 8.3 (ESRI) were applied to examine the relative influence of bathymetry and slope on the distribution of sea turtles.

For spatial analyses, the study region was divided into 1 minute squares. In each square, a CPUE for loggerheads was assigned (calculated as the number of animals caught per km of gear). Bathymetry data were obtained from GEBCO Digital Atlas. Maximum, minimum and mean values of depth and slope were calculated for each square. For each loggerhead, position, depth and slope were determined, considering its geographical location. CPUE of each square was associated with respective mean values of depth and slope, using Spearman correlations.

Analyses found that loggerhead catch increases with the advance of the daylight time, indicating that loggerhead interaction with longline gear may be related to time of day. Loggerhead catch is higher during the summer season than in the autumn. This shows that operational modification in the swordfish fishery may reduce the bycatch of loggerheads significantly. Spearman correlations did not demonstrate a significant relation between loggerheads CPUE and mean, minimal and maximal depth. Chi-square analysis showed that the turtles were not uniformly distributed in relation to bathymetry, showing preference for areas with depths between 2500 m and 3000 m (Chi-square=77.33). Slope was the variable with the strongest influence on the loggerheads CPUE. There was a significant positive relation between mean slope and turtle distribution. The turtles were more numerous in areas with a steeper slope (e.g.: 15º-18º; Chi-square=20.42) and less abundant at lower slope categories (e.g.: 0º-3º; Chi-square=12.07). Turtles were more abundant where the slope was steeper. Apparently the turtles are foraging in these areas with a higher primary production. Geostatistical analysis can be a powerful tool for elucidating habitat preference and the ecology of oceanic-stage juvenile loggerheads in the North Atlantic and for highlighting the importance of certain fishery areas for conservation where turtle populations are endangered by longline fisheries.

INNOVATIVE TOOLS AND TECHNIQUES FOR RELEASING SEA TURTLES INCIDENTALLY CAPTURED IN FISHING GEAR

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Innovative tools and techniques for releasing sea turtles that were incidentally captured in fishing gear have been developed as a result of an ongoing partnership among NOAA Fisheries, representatives from the pelagic longline fishing industry and gear technology specialists. Careful release protocols synthesizing the use of these gear removal devices and methods evolved from scientific research conducted in the western Atlantic Ocean in 2001-2003. The goals of the research were to develop methods to reduce post-hooking mortality by safely removing as much gear as possible and to investigate various hook and bait combinations in an effort to reduce incidental sea turtle capture. The benefits of removing gear from animals before release have been clearly demonstrated in reducing mortality and the techniques outlined in these protocols have proven highly effective in gear removal. Participating captains and observers were provided with gear removal devices, trained in their proper use and interviewed after each trip to discuss the efficacy of the tools and methods under various conditions. The devices included dipnets, line cutters to remove monofilament line, long and short-handled dehookers to remove external and internal hooks, a long-handled device to assist in disentanglement, tethers, long-nose pliers, bolt cutters and mouth opening and gagging tools. Based on field-testing and user feedback from these experiments the gear removal prototype tools were revised and equipment design standards and use protocols were updated. These tools and release protocols now must be carried and used onboard all U.S. pelagic longline vessels with a Federal Highly Migratory Species permit. Details can be found at: http://www.sefsc.noaa.gov/PDFdocs/TM_524_Epperly_etal.pdf.

DIRECT TESTS OF THE EFFICACY OF BAIT AND GEAR MODIFICATIONS FOR REDUCING INTERACTIONS OF SEA TURTLES WITH LONGLINE FISHING GEAR IN COSTA RICA

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The objective of the proposed research was to determine the efficacy of a bait or gear modification that could significantly reduce the incidental capture of marine turtles in longline fishing gear. Specifically, we tested the effectiveness of blue-dyed bait in reducing sea turtle bycatch. An analysis of data made after 22 sets suggest that blue dye is not an effective sea turtle deterrent for longline fishing operations. The research was also designed to understand survivorship and behavior of sea turtles post-capture by placing pop-up satellite archival tags on turtles released from longline fishing gear. Results of this are more fully described in the PFRP Progress report entitled "Survivorship, migrations and diving patterns of sea turtles released from commercial longline fishing gear, determined with pop-up satellite archival transmitters".

GENETICS

GENETIC DIVERSITY IN THE NESTING GREEN TURTLES, *CHELONIA MYDAS* AT RAS AL-HADD RESERVE-SULTANATE OF OMAN

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The green turtles at Ras Al-Hadd nest year round and therefore one would expect that the nesting turtles represent different subpopulations probably originating from the western section of the Arabian Sea, the Persian Gulf and the western region of the Indian Ocean. The nesting season has a peak period, where a large number of turtles nest between May and October and a smaller number of turtles nest between November and April. The seasonal genetic diversity was investigated by sequencing a mtDNA control region for 54 hatchlings and 44 adults. The samplings were taken at random during peak and non-peak periods from nests or beaches of over 12 miles of shoreline. One hatchling or adult was sampled from each examined nest. The results indicate that there are eight novel haplotypes, suggesting different subpopulations at the Reserve. Two of the eight are dominant haplotypes. This is only a preliminary study and more extensive data analysis is needed to make a definitive conclusion. The results of this study will be of value to the conservation program at the reserve in Oman.

DISTRIBUTION OF GREEN TURTLES (*CHELONIA MYDAS*) POPULATIONS ACROSS NORTH AUSTRALIAN FEEDING GROUNDS

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Australasian coastal waters contain large areas of seagrass and reef habitat that provide suitable feeding habitat for large aggregations of adult and juvenile green turtles (*Chelonia mydas*). Recaptures of tagged turtles on these feeding grounds provide evidence that at least a proportion of green turtle populations migrate over geographically large distances between nesting and feeding habitat (e.g,. Dizon and Balazs 1982; Limpus et al. 1992; Limpus et al. 2003). Although tag-return data suggest that green turtles typically show a strong fidelity to their preferred feeding grounds, it is generally not known how many genetically distinct breeding stocks are represented at a feeding ground. Previous studies identified 17 genetically distinct breeding stocks or Management Units (MUs) in Australasia (East Indian Ocean, SE Asia and West Pacific; Moritz et al. 2002, Dethmers et al. submitted). These MUs provide the necessary baseline information for analyses of mixed stocks such as occur at feeding grounds. Information on which MUs are represented at a feeding ground is necessary to predict the consequences of disturbance and/or management in that area and to estimate the impact of harvests in the region and adjacent nations. In this study we present the results of genetic analyses of tissue samples taken from green turtles feeding in the coastal waters across the north Australian coast and Aru, Indonesia.

DNA was extracted from 468 skin tissue samples collected at seven feeding grounds in the East Indian Ocean and the Timor and Arafura seas including: Cocos (Keeling) Islands, Ashmore Reef, Fog Bay, Field Island, Cobourg Peninsula, Sir Edward Pellew Islands (SEP) and the Aru Archipelago. A 384 bp segment of mitochondrial (mt)DNA control region (bounded by primers TCR5 and TCR6) was our genetic marker. Haplotypes were identified through denaturing gradient gel electrophoresis (DGGE) and sequencing. Proportional stock contributions of the foraging populations were estimated using maximum likelihood algorithms implemented in the program SPAM (Statistics Program for Analysing Mixtures, version 3.7; Alaska Department of Fish and Game).

Among the samples, 95.3% were haplotypes previously identified among nesting populations and 4.7% were new haplotypes. Haplotype diversity and frequencies varied among the feeding grounds (FG). The estimated proportional contributions of MUs at the FGs ranged from 2 to 5 MUs. Cocos Keeling, Ashmore Reef, Aru and SEP each supported a feeding population of which 50% or more consisted of a single (dominant) MU. Fog Bay and Cobourg Peninsula supported the highest diversity of MUs, with five each. At the SEP, 88% of the foraging population consisted of turtles nesting within the Gulf of Carpentaria. This dominance of a single MU in the Gulf of Carpentaria (GOC) suggests that possible population declines in the Gulf (e.g. as a result of intensive harvesting or in fisheries by-catch) will be poorly compensated for by minimal recruitment from other stocks. The Ashmore Reef foraging population was dominated by turtles from the North West Cape (58%) and Scott Reef (20%) MUs, but there was no representation from the Ashmore MU. This suggests that turtles nesting at Ashmore Reef migrate to distant FGs, rather remaining in the proximity. Conversely, in Aru, turtles appear not to migrate far but remain in the proximity of the nesting area. No other FGs supported the Aru MU, suggesting that the Aru turtles form a relatively closed population. Representation from 'international' stocks on the north Australian FGs was estimated to be relatively small.

MICROSATELLITES PROVIDE INSIGHT INTO CONTRASTING MATING PATTERNS IN ARRIBADA VS. NON-ARRIBADA OLIVE RIDLEY ROOKERIES

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In the last decade a number of studies on sea turtle mating behaviour have shown us that multiple copulations by males may result in multiple paternity (MP) of clutches. The potential for multiple mating could be influenced by a variety of factors such as behaviour, reproductive cycle, the time a female is receptive, male ability to inseminate non-receptive females, population size and the sex ratio in the mating area (Fitzsimmons 1996). This study uses nuclear microsatellite markers to compare the incidence of MP in two olive ridley rookeries on the Pacific coast of Costa Rica with contrasting nesting behaviours - the "arribada" population nesting at Ostional and the solitary nesters of Playa Hermosa. DNA from 13 mothers and their offspring (20-29 per nest except for two nests with low hatching success) was collected at each of the two rookeries. We also sampled females from Ostional (N= 100) and from P. Hermosa (N=27) and 58 males from the Ostional breeding ground to assess allele frequency distributions for the used loci. Paternity of clutches was assessed using three micro-satellite loci: Cm84, Ei8 (Fitzsimmons et al. 1995) and Or1 (Aggarwal et al. 2004). Our results document the highest level of multiple paternity (MP) in any marine turtle nesting population found to date. The high level of MP combined with the high number of fathers per clutch suggests that females nesting at Ostional are under intense mating pressure.

The fact that the level of MP varies between populations of the same species could suggest that the basis for the differences is really "situational" (extrinsic) rather than biological (intrinsic). If high density breeding produces high MP we would expect the dominating factors to be the abundance of mature individuals. Other factors may operate as well, such as a highly skewed sex-ratio. However, no study has been conducted on sex ratio in the reproductive patch off Ostional. Also, we did not find any genetic differentiation between the arribada and non-arribada neighboring colonies based on six microsatellite markers (unpublished results), suggesting that MP is not a genetic phenomenon. With that in mind our comparison of MP levels for an arribada rookery compared to a neighboring non-arribada rookery could provide important comparative results on the effects that abundance of individuals have on multiple paternity.

NUCLEAR MICROSATELLITE VARIATION OF OLIVE RIDLEYS FROM ESCOBILLA, OAXACA, MÉXICO

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In México, olive ridley populations, after decades of official protection, are now demonstrating a trend towards recovery, all the more significant in Escobilla, Oaxaca where the number of nests per year has increased steadily from the early 90's. For this reason, there is a latent possibility of allowed exploitation of this particular rookery. This emphasizes the necessity of research that can provide a scientific basis for management plans. In this sense advances in molecular genetics have provided tools that help the conservation of biological resources. With the objective to identify molecular markers useful for the study of olive ridley mating systems, the nuclear microsatellite loci Cm72, Cm84, Cc117, Ei8, LB107, LB121, LB142 and LB143 were analyzed in the Escobilla rookery using polymerase chain reaction (PCR). The variation found in these loci ranged from monomorphism (LB121 and LB142) to high polymorphism (e.g., Ei8 with 29 alleles and an observed heterozygosity of 0.96). With regards to the Hardy-Weinberg equilibrium test (P = 0.05), LB143 showed deviations while Cm72, Cm84 and Ei8 were within expectations. There was no evidence of linkage disequilibrium (P = 0.05) between the latter group of loci. The analysis of their usefulness for paternity testing indicated that Cm72 is barely informative, whereas Cm84 and Ei8 together provide a high probability of detecting multiple paternity (D = 0.98).

STOCK STRUCTURE OF HAWKSBILL TURTLES, *ERETMOCHELYS IMBRICATA*, IN THE CARIBBEAN: RE-EXAMINATION WITH ADDITIONAL MTDNA SEQUENCES

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Previous molecular research on hawksbill stock structure in the Caribbean has provided insight into the understanding of the genetic make-up of several major nesting beaches and foraging areas in the region (e.g. Bass et al. 1999 and Diaz-Fernandez et al. 1999). However, many rookeries remain to be sampled before reliable stock assignments can be made on foraging grounds. Here we present new and updated haplotype frequency data for two key rookeries and explore how inclusion of these new data in mixed stock analysis changes our understanding of stock composition from previously published studies. Mitochondrial DNA (mtDNA) haplotypes from the St. Croix (updated) and Costa Rica (newly published in Troëng et al. 2005) nesting population were amplified using new primers designed by Alberto Abreu-Grobois to amplify a larger base pair region than previously reported in Bass et al. 1999. Re-amplification with the new primers allows for two of the haplotypes reported by Bass (F and Q) to be further broken down into several haplotypes, revising the population sub-structuring results presented in earlier mixed stock analysis. Bayesian mixed stock analysis for the México, Cuba, Puerto Rico and USVI foraging stocks were analyzed using previously published data from Bass et al. 1999, Diaz-Fernandez et al. 1999 and the new data described above. Results were then compared with previously published data in order to determine changes in the relative contribution rates with the addition of potential source stocks. Pairwise comparisons testing for homogeneity among nesting sites were also performed.

Preliminary results indicate genetically distinct nesting stocks, reinforcing the notion of nest site fidelity and regionalized sub-structuring among a majority of the hawksbill rookeries in the Caribbean. It is important to note that even aggregations at areas in close geographic proximity are distinct and should be treated as unique management units until all potential rookeries can be included in the analysis (Bass et al. 1999). Preliminary Bayesian mixed stock analysis indicates that inclusion of the updated USVI data, along with the new Costa Rica data, changes estimates of composition and provides a finer scale resolution of regional patterns. The Costa Rica rookery contributed to both the Puerto Rico and Cuban foraging aggregations. However, the USVI rookery continues to be the main source of animals at the Puerto Rico foraging area, which is consistent with Bass et al. (1999). In order to accurately characterize regional stock boundaries, large scale efforts to collect samples from all potential rookeries for genetic analysis are needed. This should also include increasing the sample size from several of the previously sampled nesting sites. Further studies using both mtDNA and nuclear markers are needed to better understand the nesting and foraging ecology and address the management issues concerning the Caribbean hawksbill.

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CONSERVATION GENETICS OF WESTERN SOUTH ATLANTIC GREEN SEA TURTLE (*CHELONIA MYDAS*) FORAGING POPULATIONS

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The present research characterizes endangered green sea turtle foraging groups in the Western South Atlantic region (WSA) employing population genetic methods. One major objective is to determine relationships between the study groups and other green turtle breeding and foraging populations. Notably, aspects of intra-population genetic structure will also be examined. The research focuses on population structure as revealed by nuclear microsatellites and the mitochondrial DNA control region. The significance of the study derives from unique insight into dispersal and migration, temporal and spatial patterns of genetic variation, relationships between genetic composition and key demographic factors and conservation priorities. This information enhances basic biological knowledge of marine vertebrate population structure with applications to marine species worldwide.

ASSESSING THE IMPORTANCE OF OLFACTION IN THE LIFE OF A SEA TURTLE: A MOLECULAR PERSPECTIVE

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Little is known about the role olfaction plays in the life of a sea turtle. Increased understanding of this role might serve to improve management of these animals. For this purpose, as well as to better understand the evolution of olfactory receptor genes in vertebrates, we investigated the sea turtle olfactory receptor gene family. For turtles odors might be important for locating feeding sites, nesting beaches and in social/ mating interactions. Odorants are detected in the olfactory system by odor receptors (ORs) embedded in nasal tissue. OR genes code for these receptors. The structure of OR genes is highly conserved from fish to humans and have no introns, making them excellent candidates for a non-invasive molecular investigation of olfaction. Blood was obtained from three species of sea turtle and two species each of freshwater and terrestrial turtles for comparison. DNA was isolated, olfactory genes were cloned and sequenced and comparisons were made between turtle sequences and known fish and mammal sequences. Results show two OR genes that are highly conserved across the three sea turtle species and an increased number of pseudogenes (presumed unexpressed) in the sea and freshwater turtles. An allelic variation study was then conducted using several of the turtle OR genes found. A comparison between loggerheads from the Mediterranean Sea and Pacific, Atlantic and Indian Oceans was made and a very high degree of gene conservation was seen across populations. These allelic variation studies are being continued in leatherback and green sea turtles.

MANAGEMENT

THE IRONY OF THE WILDLIFE CONSERVATION ACT IN THE TURTLE ISLANDS, PHILIPPINES

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The Turtle Islands harbour ASEAN's remaining major nesting grounds for green turtles. In 1996, the Philippine and Malaysian governments established the Turtle Islands Heritage Protected Area (TIHPA), the world's first trans-frontier protected area for marine turtles. Recognising that turtle egg collection was a traditional source of livelihood for communities in the Philippine Turtle Islands, a formal system of regulation was set up by the Philippine government in the 1980s which allowed 60% of eggs to be harvested and 40% set aside for conservation. However, in 2001 the Philippine Congress enacted the Wildlife Conservation Act, which prohibited harvest of endangered wildlife. Under this law, turtle egg collection is banned and sustainable use outlawed. Upon its enactment the local government of the Turtle Islands and the community vehemently reacted, citing lack of consultations, alternatives and social preparation. This eventually led to non-compliance to the new law and eventual collapse of the permit and turtle egg allocation systems. The application of the law effectively undermined not just a system acceptable to all major stakeholders but a working system that was actually able to curb the decline of the nesting population in the area. This paper presents the social dynamics in the Turtle Islands and the processes that led to breakdown in management and the steps undertaken to resolve these conflicts. It also highlights the importance of resource agreements, monitoring and the lessons learned in implementing conservation programs with local communities.

SEA TURTLE RELOCATION TRAWLING: IS IT EFFECTIVE?

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The Army Corp of Engineers (ACOE) coastal dredging program has included sea turtle relocation trawling for selected projects since the early 1980s. Relocation trawling has been successful at temporarily displacing turtles in channels in both the Atlantic and Gulf of México during periods when hopper dredging was imminent or ongoing (NMFS NE Biological Opinion F/NER/2003/00302). Net design, protocols and trawling techniques were developed by the ACOE after considerable research and development efforts. These methods have become standard for ACOE dredging projects where project managers need to reduce the potential for incidental takes of sea turtles during the dredging project. Towing two specially designed, 60-foot trawl nets, the trawlers operate in the same vicinity as the dredge on either a twelve- or twenty-four hour schedule. Captured turtles are measured, photographed and scanned for PIT tags and overall health. Turtles are tagged and released 3-5 miles away from the channel. Since September 2001, REMSA, Inc. personnel have completed thirteen trawling projects capturing and safely relocating 232 sea turtles. During the same period, a total of 13 turtles were taken by dredges involved in these projects. Because levels of effort on relocation trawling projects vary greatly, REMSA has developed a series of "levels" to distinguish between the amounts of effort applied. Results indicate that effectiveness of the trawling project itself varies widely with the level of trawling effort applied. The results are encouraging, demonstrating that Sea Turtle Relocation trawling may be effective in minimizing the impact of dredging on sea turtle populations.

EFFECTIVE OPERATION OF SEA TURTLE HATCHERIES ON THE PACIFIC COAST OF GUATEMALA

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The history of sea turtle conservation in Guatemala is based almost entirely on the use of hatcheries. Since the establishment of the first hatchery in 1971, the number of hatcheries in the country has fluctuated annually between 16 and 24. These hatcheries necessarily have a community focus based on the fact that the majority of the eggs collected are the result of voluntary donations on the part of local egg collectors. Hatcheries are typically managed by local personnel who lack formal scientific training. The performance of the hatcheries, in terms of eggs collected per kilometer of beach and hatchling success, varies substantially. NGOs ARCAS and AMBIOS have collaborated to study the adequacy of current sea turtle hatchery management in Guatemala. The first (two year) phase of this project has focused on developing simple, sustainable, yet effective methodologies for monitoring controlling factors (climate, geography, infrastructure, management practices), micro-climate within hatchery nests (temperature and humidity) and hatchling success. The second phase involves an outreach programme to encourage sustainable development and capacity building at other hatcheries in the country and where necessary the development of new hatcheries. This programme will involve collaboration with other Guatemalan NGOs within the overall guidance of the government's National Council of Protected Areas (CONAP) and financial support provided through a system of international volunteers.

MARINE TURTLE NESTING AND FEEDING AREAS ALONG VENEZUELA'S CENTRAL COAST

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I confirmed and evaluated nesting and feeding areas for marine turtles in the states of Aragua, Carabobo and Vargas in Venezuela. This is one of the priorities for marine turtle research and conservation in Venezuela. Beach walks and underwater inspections, in conjunction with data from published reports and information from fishermen and local settlers, allowed for the description of the biotic and abiotic components of the principal nesting and feeding areas. I confirmed and described more than 20 nesting beaches for *Dermochelys coriacea*, *Caretta caretta*, *Chelonia mydas* and *Eretmochelys imbricata*. Most beaches are spacious, with less than a 10º slope and relatively little urban and tourist development. The main factors limiting turtle survival are nest poaching and habitat degradation. Feeding areas are located on coral reefs, on the edges of rocky substrates, near algal and sea grass beds and over sandy substrates. On average, coral reef communities are located at a maximum depth of 16 m with massive corals and a high abundance of octocorals and tubular sponges, principally *Aplysina* sp. and *Xetonpongia* sp. Algal communities are dominated by patches of *Sirigodium* sp., *Halophila* sp., *Sargasum* sp. and *Dictiota* sp. The main threat to turtles in feeding areas is incidental catch with nets and long lines. This study highlights the need to develop conservation plans for the conservation of sea turtle nesting and feeding areas along the Venezuelan coast.

ATLANTIC LEATHERBACK STRATEGY RETREAT AT ST. CATHERINES ISLAND

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A group of 18 Atlantic leatherback researchers and conservationists met at St Catherines Island, Georgia, USA, January 15-18, 2005. The objectives of the meeting were to: 1) assess the level of knowledge about Atlantic leatherback turtles and 2) identify nesting beaches and in-water conservation and research priorities for Atlantic leatherback turtles. Presentations given at the event and additional background information are available at http://www.cccturtle.org/leatherbacks. The meeting recommendations are reported below.

For nesting beaches, conservation and research priorities are:
1) In Atlantic Africa, to conduct detailed surveys of nesting distribution from Mauritania to Angola, with special priority given to Cote d'Ivoire, Equatorial Guinea (Bioko Island), Sierra Leone, Liberia and Angola; to determine the importance of the Gabon and Congo nesting aggregations; to support and/or initiate local conservation efforts at significant nesting locations; to strengthen and implement legislation that regulates conservation and use of sea turtles; and to assess human impact on nesting aggregations.
2) In Trinidad/Guianas, to conduct a collaborative effort to assess overall distribution, size and trend of the regional population and to standardize PIT tag use and instrumentation, phase in same brand of tags at all beaches.
3) To reduce killing of female turtles on nesting beaches, priority should be given to Tiger and Gwennie beaches in Guyana, Sixaola and San San beaches in Panama, Tobago beaches and beaches in Atlantic Africa (for example, in Congo and Angola).
4) To reduce or eliminate egg collection, priorities are to eliminate commercial egg collection and to initiate long-term relationships with local communities to identify joint conservation actions.
5) To determine relationships among life-history, oceanic and climatic conditions and human interventions for Atlantic and Pacific nesting aggregations, priorities are to convene multi-disciplinary conferences including oceanographers, physiologists, sea turtle biologists and statisticians/modelers and to determine mechanisms for testing the efficacy of sea turtle conservation actions.
6) To complete the determination of the genetic structure of Atlantic populations, priority should be given to collecting additional genetic samples from

Caribbean Islands and Atlantic Africa nesting aggregations.

For in-water research and conservation, priorities should be:
1) Establish a regional research program to define habitat utilization, especially in the east and south Atlantic where there is significant exposure to fisheries. Once these key regions are identified, there should be two immediate goals: the first is to reduce mortality resulting from fisheries interactions by increasing fishermen awareness on handling/release protocols and conservation awareness; the second goal is to reduce fisheries interactions through the development of new gear technologies and fishing practices.
2) Implement new and/or enhance existing observer programs onboard fishing vessels operating in the Atlantic to support a comprehensive assessment of fishery effort and sea turtle interactions.
3) Given that we are trying to learn about the interactions of specific nesting colonies with particular fisheries, it is recommended that the research on the suitability of color coded external tags (Floy tags) be undertaken to aid in recognition of recaptured turtles that may or may not have been pit tagged.
4) Establishment of a system of regular and open communication, such as a specific listserve and an annual gathering, to support greater collaboration, information sharing and technical assistance among Atlantic leatherback researchers and conservationists.
5) Encourage the FAO to expedite the adoption of means to reduce leatherback-fisheries interactions (including new gear technologies) and the reporting of leatherback status (in accordance with recent outcomes of the FAO Technical Consultation Bangkok, 2004).
6) Encourage all trawl fisheries operating in the Atlantic where leatherback turtles are impacted to adopt the use of TEDs that exclude leatherback turtles.
7) Encourage all states in the Atlantic that are not signatories to the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) or the Memorandum of Understanding for Atlantic Africa formulated at Abidjan in 1999 to sign and ratify those instruments.

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EFFECTS OF A SHORE PROTECTION PROJECT ON LOGGERHEAD AND GREEN TURTLE NESTING ACTIVITY AND REPRODUCTION IN BREVARD COUNTY, FLORIDA

Kelly Brock and Llewellyn Ehrhart

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The impacts of beach nourishment along 5 km of the largest nesting area for loggerhead turtles (*Caretta caretta*) in the western hemisphere and for green turtles (*Chelonia mydas*) in the United States were investigated. Previous studies and generalizations concerning beach nourishment projects have been based on loggerhead turtles. This study compared data among nourished and non-nourished areas and between loggerhead and green turtles to establish that beach nourishment, one season post-nourishment, has statistically similar negative effects on nesting success and no significant effect on reproductive success. Physical attributes of the fill sand did not physically impede turtles in their attempts to nest as seen in previous studies; instead, the absences of factors that cue nesting behavior potentially had the greatest impact. Nest placement on the nourished profile was significantly further from the water for both species. Green turtles nested near the foredune while loggerheads nested on the gradient or the seaward crest of the berm. More loggerhead than green turtle nests were "washed out" by erosion which illustrates the importance of nest placement and the detrimental effects of the equilibration of the nourished profile to the reproductive success of loggerheads. A decrease in reproductive output during the first season post-nourishment indicates that a reduction occurred in the estimated total number of hatchlings produced regardless of similar reproductive success rates. These results demonstrate the impacts of decreased nesting success and illustrate the importance of future studies that would focus on minimizing the occurrence of non-nesting emergences associated with beach nourishment.

LOGGERHEAD NESTING AND REPRODUCTIVE SUCCESS ON ADJACENT NOURISED BEACHES WITH DIFFERENTLY CONSTRUCTED SEAWARD BERM SLOPES: BREVARD, FLORIDA

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The Brevard County Shore Protection Project, located within the largest nesting area for loggerhead turtles (*Caretta caretta*) in the western hemisphere, was the first known shore protection project in Florida to purposely slope the berm seaward at a specified grade. The project was constructed in two segments, one constructed in 2002 with a zero meter seaward berm slope and an adjacent segment in 2003 with modifications to the berm so that a 1/3 meter slope existed over the berm width. The purposes of this berm modification were to mimic natural beach profiles and to reduce the amount of berm inundation during spring tides, which presents the potential for seawater inundation of eggs. The area encompassing the two nourished and adjacent non-nourished beaches have been systematically studied since 1989. A sizeable database of pre-nourishment data has been established regarding marine turtle nesting and reproduction. As a result, an adequate assessment is provided discerning the effects of the differently constructed slopes during the first and second seasons post-nourishment that allow for temporal fluctuations and natural trends. Our results indicate that a 1/3 meter seaward slope of the berm significantly reduces impacts to marine turtle nesting success. However, an increase in non-nesting emergences was still exhibited. Preliminary data suggest that there was no significant reduction in the occurrence of nests being washed out during erosion of the berm caused by strong surf. We recommend that future beach nourishment projects implement alternative construction templates with greater berm slope to minimize impacts to marine turtles.

A TOOL TO CONTROL THE ILLEGAL TRADE OF CARAPACE PRODUCTS; THE CASE OF THE HAWKSBILL SEA TURTLE (*ERETMOCHELYS IMBRICATA*)

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One of the main problems for the endangered hawksbill turtle is mortality due to poaching by people who use the shell to make jewelry and crafts. In Central America, domestic trade continues to occur at a significant level, causing the loss of many individuals from already reduced populations. Local authorities, from environmental ministers to customs agents, have little or no training in distinguishing between genuine sea turtle products and imitations. The tool presented in this poster helps to clarify the procedure to be used during inspections and the characteristics of hawksbill products that should be noted. The field revision protocol and the laboratory tests that are described will help authorities proceed appropriately in the case of illegal trade. The guide for identifying hawksbill articles could potentially help various government agencies in improving the control of illegal trade of a variety of hawksbill derived products, being applicable for use by street vendor investigators as well as customs agents. The morphological description, the coloration, the form in which keratin is deposited in the shell scutes, the release of sulfur during combustion and infrared ray analysis are elements of this guide. Similar analyses for cosmetic products, such as oil derivatives and for making clearer descriptions in cases of sea turtle meat trade, are necessary. They are also very useful for immediate testing at the moment of confiscation.

EVALUATION OF THE EFFECT OF DEPTH ON HATCHING SUCCESS OF EGGS OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*, ESCHSCHOLTZ, 1829: CHELONIDAE) UNDER CONTROLLED CONDITIONS IN THE MONTERRICO MULTIPLE USE NATURAL RESERVE, TAXISCO, SANTA ROSA, GUATEMALA

Ana Beatriz Rivas Chacón

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The following work took place during September to November, 2000 in the hatchery of the Reserva Natural de Usos Multiples Monterrico. This is a natural area for the conservation of flora and fauna on the Pacific coast of Guatemala in the region of Santa Rosa. The objective of the study was to determine the effect of depth and shading on the hatching success of olive ridley turtles by comparing two shade treatments (67.4% shade and no shading) and three depths (25, 35 and 45 cm). During this period, 72 nests of 15 eggs were located in the hatchery and distributed in 36 nests for each treatment. The incubation temperature was monitored to estimate the proportion of each sex. From the 1,080 eggs incubated, 496 hatched: 458 from the shade treatment and 38 from the no shade treatment. There was no significant difference in the hatching success between the three depths ($p=0.9564$). Under the conditions of the study, the temperature was above the pivotal temperature (29.1°C) which would suggest the production of females. For these conditions and in the hatchery of Monterrico, shading has an effect on hatching success. It will be necessary to study a complete season to observe the behavior of the temperature in order to know the tendency of sex production at the beginning.

A NEW LIGHT FOR TURTLES AT TORTUGUERO

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As part of the master plan to reduce luminary contamination along the coastal zones of Costa Rica, the "Instituto Costarricence de Electricidad" (I.C.E) is initiating tests to determine the efficiency of various public area lighting systems in the town of Tortuguero. With the collaboration of the firm M.S. Electrotecnica, S.A., I.C.E has substituted four traditional fixtures located at various problem points in the town for low pressure sodium lamps and aluminum shades. It is expected that the positive results of this test will help to secure funding for the execution of the master plan. The plan includes changing the coastal lighting system, giving priority to beaches, on both the Pacific and Atlantic coasts where marine turtle nesting activity is highest.

SEA TURTLES AND THE CARIBBEAN HOTEL INDUSTRY: THE DEVELOPMENT OF A BEST PRACTICES MANUAL

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The tourism industry generates 20% of the gross domestic product of the wider Caribbean region. Although the Caribbean tourism industry thrives on a coastal/ocean aesthetic and recreational product, it is often criticized for its poor environmental record. Sea turtles may serve as an educational tool to help promote local biodiversity and ecosystem health while encouraging changes in corporate and tourist behavior. The Wider Caribbean Sea Turtle Conservation Network (WIDECAST) and the Caribbean Alliance for Sustainable Tourism (CAST) co-sponsored the development of a best practices manual in regards to sea turtles for beachfront properties. Based on recommendations made at an industry meeting in Barbados, the manual will provide a Sea Turtle Policy Statement as well as standard guidelines and criteria for implementing the policy statement. These guidelines will assist hotel management and staff to implement sea turtle protection policies throughout the region.

MARINE TURTLE CONSERVATION IN GUYANA

Romeo De Freitas and Aliesha Narain

Guyana Marine Turtle Conservation Society, Guyana

Turtle patrols were initiated in Guyana by Peter Pritchard and Audley James in 1988 in response to uncontrolled killing of nesting females of four turtle species (green, leatherback, olive ridley and hawksbill). Today leatherbacks predominate. More turtles were slaughtered than were tagged in 1988. Only 30 were tagged in 1999, but over 200 were tagged in 1992. Nesting occurs on various beaches within the remote “Shell Beach” coast in northwestern Guyana. Beaches – and turtles – shift annually following cycles of erosion and accretion of both shell and mud. In 2000, efforts were shifted to Kamwatta Beach, a “recovered” major nesting site. With seven wardens, we found an incredible average of 40 turtles per night during the peak weeks. Sadly, poachers swarmed other beaches (Tiger and Gwennie beaches) and over 150 leatherbacks were killed. In April 2000 we started the Guyana Marine Turtle Conservation Society (GMTCS), a new NGO, to handle grants, establish no-fishing zones and continue education programs started by Pritchard years earlier. Greens had an excellent early nesting season in 2004, with over 300 nests between March 16-30, but many nests were raided by poachers. By midseason over 40 hunters in 12 camps were encamped on Tiger Beach, killing turtles and taking eggs. Currently, Guyana is developing a Shell Beach Protected Area, with the EPA responsible for oversight and GMTCS the lead agency for planning. With five thematic areas of operation, GMTCS has been working with targeted communities building awareness and capacity for informed decisions and management of resources within the forthcoming protected area.

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

Tomas Diagne[1] and Arona Soumare[2]

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Six species of sea turtles have been confirmed in the waters of WAMER (West Africa Marine Eco-Region): loggerhead, hawksbill, leatherback, green, olive ridley and Kemp’s ridley. Five costal states are involved (Senegal, Cap Vert, Mauritania, Gambia, Guinee Bissau and Guinee Conakry). This ecoregion is biologically very rich in marine animal life and is characterized by: (1) zones of world importance for sea turtle nesting (green turtle and loggerhead); (2) significant sea turtle feeding and developmental areas; and (3) the convergence of significant migration corridors, particularly for loggerheads, green turtles and leatherbacks. However, in spite of the richness of the region the marine turtles of the area are in danger of extinction due to the destruction of breeding areas and the capture of individuals for consumption and traditional uses by the local population. Since 2002 a vast conservation plan for the marine turtles of the area was initiated by WWF, UICN and the FIBA in accordance with the agreement for conservation of marine turtles of the Atlantic coast in Africa (CMS, Abidjan 1999) encouraging the installation of regional programs. The major objective of this plan is to improve the state of conservation of the marine turtles of the Atlantic coast of Africa. Since its launching, several activities have been undertaken or are underway, including following turtle migration patterns, raising awareness among fishermen and reinforcing the capacities of the conservation actors in the field (NGOs and official organizations qualified on these issues). The activities of this plan are planned for five years (2002 –2007).

PEYU PROJECT SEA TURTLES OF ARGENTINA REPUBLIC, ACTIVITIES SUMMARY 2004-2005

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Since 2001, Argentina has been conducting a project dedicated exclusively to the research and conservation of sea turtles in the offshore waters. The project is called "PEYU," the Araucanos aborigine name for turtles. The Peyu Project is conducted by graduates and advanced students of the Universities of La Plata, Buenos Aires and El Salvador. The work is multidisciplinary and the participants work pro bono. The project has two lines of work: one dedicated to research into thematic areas like ethology, feeding, parasitology, genetics and fisheries; and another dedicated to educating and promoting conservation consciousness through exposure to appropriate information. This poster exhibits the result of the work done during 2004 and shows the proposal of activities to be done during 2005.

The behavioral objectives included studying the behaviour of sea turtles in captivity and creating a partial ethogram. The objectives of the feeding study included determining if the Mar Argentino constitutes a feeding area for the three species of sea turtles that inhabit it, identifying preference areas, determining the diet of the three species, establishing the role of sea turtles in the Argentinian sea ecosystem and investigating if there are strange components in their diet as a result of human contamination and determine how they affect them. For molecular biology, objectives included determining the population of sea turtles in Argentina and relating the results of the genetic studies to other similar projects. In parasitology the objectives included determining the helminth fauna in three species of sea turtles of Argentina and complimenting the rehabilitation work with the parasitological study of living and dead samples.

In order to fulfill the objectives of each area the group made trips to the coast of the Province of Buenos Aires. The animals beached there were rehabilitated in the aquariums of San Clemente del Tuyú and Buenos Aires. Samples of tissue, blood, parasites and stomach contents were taken.

In the area of education, objectives included: implementing an educational programme for the knowledge, handling and conservation of sea turtles; implementing workshops and educational debates, puppet shows, plays and games in general related to sea turtles and marine ecosystems at schools; training fishermen through talks and workshops on what to do to help sea turtles which are trapped in nets or which swallow fishhooks; training biologists, foresters and workers in protected areas to give them knowledge on the three species of sea turtles that live in the area and on how to handle them; and to give basic information about Argentinian sea turtles in stalls placed in the principal tourist centres of the protected areas in question. To do this, the group has given numerous talks, workshops and classes adapting the ludic activities and didactic resources to the ages of students and their levels of education. The group has worked with approximately three hundred people, all of them inhabitants of urban areas and coastal communities that have direct contact with sea turtles owing to their fishing activities.

Project Peyu participated in the Juvenile Environmental Exhibition 2004 organized by the Direction of Development and Environmental Promotion on November 3-4. As members of the PRICTMA, the group has taken part in the organization of the second meeting of specialists on Sea Turtles of the Occidental South Atlantic, where approximately fifty investigators of Uruguay, Brazil and Argentina assisted. Peyu project made a presentation at the Department of Herpetology of the National University of La Plata, on "Las tortugas marinas lejos de los tropicos: que importancia tienen?" delivered by Jack Frazier.

Thanks to the consolidation and unification of criteria in the working style of the different groups in Argentina, the members of Proyect Peyu have worked as guests in the Monitoring Sea Turtles Programme, financed by Wildlife Conservation Society, with the objective of collecting data about the status and health of sea turtles in the area and the impact of fisheries. Thanks to the Peyu Project, this year one green turtle (*Chelonia mydas*) was reported in the interior of the Río de La Plata estuary. The turtle is in rehabilitation at the Buenos Aires Aquarium. For this reason we will have major contact with the fishermen of this region to analyze the situation in the Río de La Plata.

During the year 2005, Proyect Peyu will continue developing activities and working strategies according to each area and theme. Two new areas of work are expected to be created, history and contamination. As regards to the area of education, material will be developed according to the ages of students. The group will travel to Bahia Blanca to carry out investigation and education activities to generate awareness of the need for conservation among the inhabitants of that area.

NESTING AND CONSERVATION OF CRITICALLY ENDANGERED PACIFIC LEATHERBACKS AT PLAYA CALETAS, COSTA RICA AND THE CREATION OF THE PLAYA CALETAS / ARIO NATIONAL WILDLIFE REFUGE

Alexander R. Gaos, Randall M. Arauz and Ingrid L. Yañez

PRETOMA, San José, Costa Rica

Monitoring and conservation of sea turtles at Playa Caletas, Costa Rica, has been conducted by PRETOMA (Programa Restauración de Tortugas Marinas) since November 1st, 2002. During the first three seasons of monitoring (2002 – 2005), critically endangered Pacific leatherback sea turtles (*Dermochelys coriacea*) were recorded visiting the beach 81 times. When considering that there are as few as 1,690 adult nesting females left in the eastern Pacific Ocean, down from 91,000 in 1980 (Spotila, 2002), the nesting numbers at Playa Caletas make it one of the most important nesting sites for the leatherback in the eastern Pacific Ocean.

Locals from the area that were interviewed reported that in 1993 approximately 20 leatherbacks would emerge a night. It is probable that Playa Caletas was once a major leatherback nesting beach, but with a 95% drop in the eastern Pacific population, now only a remnant nesting population remains. The majority of leatherbacks observed at Playa Caletas are often observed several times each season, indicating that Playa Caletas is not a beach that receives the occasional wandering leatherback, but actually hosts a colony of leatherbacks that use the beach to nest time and time again. An important part of the efforts that need to be taken to protect and restore Pacific leatherback populations is the permanent protection of beaches that host even low numbers of nesting leatherbacks. During the 2004 – 2005 nesting season PRETOMA spearheaded efforts to create the "Playa Caletas / Ario National Wildlife Refuge" by bringing together local conservation organizations and government representatives, as well as local land owners and community members, at several workshops to discuss plans, objectives and strategies regarding the creation of the Refuge. The Refuge will include a Marine Protected Area (MPA) where large scale industrial fishing operations will be banned and responsible fishing practices will be fostered among local artisanal fishermen.

Playa Caletas is also an intensive nesting site for olive ridley (*Lepidochelys olivacea*) sea turtles. Pacific green (*Chelonia mydas agassizii*) and hawksbill (*Eretmochelys imbricata*) sea turtles are also known to nest on Playa Caletas and the neighboring beach of Ario. Between November 1st, 2002 and February 25th, 2005, 1,400 sea turtle nests have been registered at Playa Caletas. The combination of a new base camp location, a larger team of researchers and what appears to be a higher than average nesting season has led to a significant increase in the number of turtles encountered and nests protected this season (2004-2005). The number of sea turtles encountered and tagged rose for each consecutive year at Playa Caletas; the increase is particularly evident for the 2004-2005 season. Similarly, protection of sea turtle nests from natural predators, poachers and abiotic factors such as inundation also increased in each of the project's three years of existence. To date (February 25th, 2004), 47,289 eggs have been protected in the Playa Caletas hatchery, leading to the production of 30,513 hatchlings (64.68% hatching success).

ASSESSMENT OF "TURTLE-FRIENDLY" LIGHTS: METHODS AND UNDERLYING PRINCIPLES

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Artificial lighting disrupts the ability of hatchlings to locate the sea from their nest. Disruption occurs because artificial light sources show greater "directivity" (contrast with background) and often contain spectra that are especially attractive to the turtles. In Florida alone, lighting kills thousands of hatchlings annually. Can luminaries be designed that are less attractive? We used a T-maze to determine how strongly the turtles were attracted to six "turtle friendly" luminaries (magnaray fluorescent, bug light, standard red, Beeman red, H&H Twistee and Filtered HPS) compared to a HPS light that is strongly attractive. Intensity was eliminated as a variable so that responses were based upon spectral composition. All of the lights were less attractive to loggerhead hatchlings than the HPS. Luminaries that emitted the longest wavelengths were the least attractive. The Beeman Red was the least attractive luminaire, either when presented alone or when paired with other lights.

MONITORING OLIVE RIDLEY SEA TURTLES (*LEPIDOCHELYS OLIVACEA*) ON THE PACIFIC COAST OF NICARAGUA

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There are two major (Playa La Flor and Chacocente) and two minor (Isla Juan Venado and Peninsula de Cosiguina) nesting beaches on the Pacific coast of Nicaragua used by olive ridley sea turtles. Playa La Flor is the primary beach, where the number of nesting turtles can reach 100,000 in a nesting season (104,846 in 2002). At Chacocente, 10,000 to 20,000 turtles nest for the whole nesting season, whereas Juan Venado and Peninsula de Cosiguina may receive a few thousand for the season. The threats to the olive ridley sea turtle population in Nicaragua currently include incidental death in fisheries by-catch, illegal fishing and beachfront development. Moreover, egg poaching at these sites continues to be a serious threat, at times saturating the entire national market and driving prices as low as 25 cents U.S. per dozen, down from normal prices of $2.50 per dozen. In addition to poaching there is a legal " harvest" program, whereby local communities are supposed to receive about 10% of all eggs laid on the beach; however, the eggs are additionally used as direct payment for local "volunteer" laborers, increasing the total take. Ultimately, only 6% of all eggs laid at Playa La Flor survive to hatch (2002). Additionally, there are problems with the methodology used to monitor olive ridley populations at these beaches (number of nesting turtles and hatchling numbers). The lack of funding and science-based management has resulted in both missing data and poor data analysis for any of these beaches.

SEA TURTLE CONSERVATION IN SOUTH CAROLINA: THREE DECADES

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South Carolina has been in the forefront of sea turtle conservation since the late 1970s. This poster chronicles three decades of effort involving research, management, monitoring and public outreach.

1939: William Baldwin and John Lofton conducted the first sea turtle research in North America on Cape Island, Cape Romain National Wildlife Refuge.

Late 1970s: Tom Murphy became the first person to successfully track a sea turtle's movements using sonic telemetry. High use of near-shore waters by adult female loggerheads during the nesting season showed the potential for interactions with commercial shrimping activities. Telemetry research, continuing into the nineties, documented effects of disturbance and relocation on behavior of nesting females. Results showed: 1) adult females will move to other beaches if disturbed, 2) they will also home to a preferred beach if relocated and 3) females do not use the earth's geomagnetic field to find their way back. The first Marine Turtle Recovery Team included South Carolina members Sally Hopkins (co-leader), Glenn Ulrich and Tom Murphy.

1980s: The Sea Turtle Stranding and Salvage Network (STSSN) was organized to document the spatial and temporal distribution of sea turtle carcasses. South Carolina closed the gill net fishery for Atlantic sturgeon in the Georgetown coastal area. April and May strandings in that area dropped from over 60 to zero. South Carolina became the first state to require TEDs. After several legal challenges, shrimpers now accept TEDs as a necessary piece of equipment on their boats. Research on beaches determined that less than 10% of nests hatched. Raccoon trapping, nest relocation and nest screening resulted in nest success of over 80%. Volunteer projects began implementing this management protocol. In 2004, there were 19 projects including over 500 individuals managing over 70% of the nesting effort. A standardized aerial survey methodology to index the statewide nesting population was developed. Twelve flights per season provided a 17% sample of the nesting effort. Three consecutive flight years covered 83% of the nesting population. Nesting has declined 3% per year since 1980. Local ordinances require beachfront lights to be out by 10 PM from May through October to protect nesting females and hatchlings. South Carolina passed the Beachfront Management Act. This prohibited "any new hard structures on the beach." Sand fences were re-designed so that nesting turtles would not become trapped behind them.

1990s: South Carolina became the first state to challenge and stop the U.S. Army Corps of Engineers from using hopper dredges during sea turtle season. Winter dredging windows are now a Corps policy in South Carolina. Standardized aerial surveys were begun each spring to document the spatial and temporal distribution of leatherbacks in nearshore waters. These surveys became part of the Leatherback Contingency Plan in 1995.

2000 and beyond: Data on nesting loggerhead morphometrics, provided to NOAA Fisheries, led to larger TED openings to accommodate adult turtles. Satellite telemetry research documented that most nesting females in South Carolina utilize the mid-Atlantic region as foraging habitat. Protection from fisheries-related mortality in that region is needed.

A MANAGEMENT PLAN FOR NESTING SEA TURTLES ON PUERTO RICO'S UNDEVELOPED BEACHES

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The Northeastern Ecological Corridor (NEC) and western Vieques, Puerto Rico are critical nesting sites for leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*) sea turtles and serve as study sites for this project. The NEC consists of the remaining undeveloped and unprotected beaches in Puerto Rico, between the towns of Luquillo and Fajardo. However, proposed large-scale development threatens these nesting beaches where the turtle population is beginning to increase. The major nesting beaches of western Vieques, an island ten miles off the eastern coast of mainland Puerto Rico, adjoin the Vieques National Wildlife Refuge, guaranteeing protection from development. The management plan includes an assessment of current monitoring techniques, stakeholder interests and local threats to sea turtles for the undeveloped beaches of Puerto Rico, both protected and unprotected. This management plan also includes data analysis materials, as well as detailed recommendations for future management and research. The management plan includes field monitoring sheets and a database for analysis of results. Also, the current status of the species and recommendations for future monitoring and research are discussed in depth.

LEATHERBACK TURTLE CONSERVATION AND RESEARCH BY COASTAL COMMUNITIES IN THE MELANESIAN COUNTRIES OF THE WESTERN PACIFIC

Kenneth T. MacKay

Coordinator, Canada-South Pacific Ocean Development Program

The Pacific Island Countries of Papua New Guinea (PNG), the Solomon Islands and Vanuatu are important leatherback nesting areas. Here the indigenous peoples have traditionally consumed adult turtles and eggs. Recent efforts by the coastal communities in these countries, supported by both local and international NGOs, are contributing to both conservation efforts and the collection of data on nesting populations. In Vanuatu the use of environmental drama followed by community discussion and the nomination of community turtle monitors has had dramatic effects in increasing conservation for all species of turtles. In the case of leatherbacks this has resulted in the identification of nesting beaches not previously reported, a survey of the most important nesting beach, tagging of nesting turtles and increased conservation of nests. In the Solomon Islands on the isolated coast of Western Province, the coastal communities have traditionally killed and consumed all the nesting leatherbacks and collected most of the eggs. These communities are now actively conserving the turtles, involved in beach monitoring, relocating of nests and recording hatching success. In PNG on the Huon Coast, community efforts in close cooperation with US NMFS researchers are successfully carrying out conservation and research efforts including beach surveys and tagging using metal and pit tags. Recently efforts have expanded to encompassing all communities along a 120 km section of coast, the most important nesting area in PNG.

THE HAWKSBILL SEA TURTLE (*ERETMOCHELYS IMBRICATA*) IN BRAZIL

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The Brazilian coast holds both foraging and nesting areas for the hawksbill sea turtle (*Eretmochelys imbricata*). Projeto TAMAR-IBAMA, the Brazilian sea turtle conservation program, has been working on nesting beaches since 1982 and on foraging grounds since 1992. Here we present an overview of the hawksbill turtle in Brazil. In the 2002/2003 nesting season about 83% of the hawksbill nests found in Brazil were on the northern coast of Bahia State, where 800 clutches are estimated to have been laid. Regarding the population nesting in that state, we present data on the number of clutches per season, clutch size, percentage of clutches by management strategy, emergence success, incubation period, curved carapace length of nesting females and remigration intervals. The main known feeding areas are located around Fernando de Noronha Archipelago and Rocas Atoll. Data on juvenile and adult hawksbills found at sea or stranded on the Brazilian coast are presented. Finally, we report the long distance movements of two hawksbills tagged in Brazil and later found in Africa.

THE STATUS OF SEA TURTLES IN ERITREA

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Turtles are significant components of the Eritrean marine environment. Five species of turtles have been reported. Both *Chelonia mydas* and *Eretmochelys imbricata* are relatively common and make the bulk of the record. The available information regarding the status of turtle populations in the Eritrean Red Sea (ERS) is very scant. From the limited investigations conducted, community knowledge suggests that the populations are declining. However, there are no past records with which to compare present levels. It is clear that surveys are required to establish present population levels and lay baseline information with which future management strategies could be compared. There are extensive potential foraging and nesting habitats on both the mainland coast and on the islands, but little is known owing to the very low human population density and no documented baseline studies. Basic inventories of nesting and foraging habitats are needed to fill gaps in knowledge of population status, distribution, reproductive potential and level of exploitation. Traditional use of marine turtles and their products by the local communities is largely subsistence harvesting for meat and eggs. Shells are discarded at fishing camps along the beach and used only as containers for other products being processed (shark products and beche de mer). Even though most of the required legislation, regulatory and enforcement procedures and accessions to the requisite international conventions are in place, the operating mechanisms have not yet been established with respect to turtles and other endangered species which require protection.

NOAA'S COMMUNITY-BASED RESTORATION PROGRAM: SEA TURTLE HABITAT RESTORATION FUNDS AVAILABLE

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The NOAA Restoration Center's Community-based Restoration Program (CRP) helps catalyze local efforts to restore degraded marine, estuarine and riparian habitat. The Program's collaborative approach has proven to be a successful model for replacing, revitalizing and repairing key environments and vital resources nationwide. Sea turtles are a NOAA trust resource and have been protected under the Endangered Species Act. The six species found in the United States (green, hawksbill, Kemp's ridley, loggerhead, leatherback and olive ridley) require a variety of habitats for survival, such as sand beaches, sea grass beds and coral reefs. Restoration of sea turtle habitats can be achieved by removing non-native beach vegetation, planting native beach vegetation, removing hardened shorelines, re-establishing dune systems, eliminating marine debris and a variety of other methods. Since the Program's inception in 1996 it has funded over 850 restoration projects, some of which have benefited sea turtle species. NOAA's CRP serves an important role in facilitating restoration and conservation of sea turtle habitat by supporting local habitat restoration efforts through grants and partnerships. Community-based organizations such as local governments, non-profit organizations and academic institutions submit project proposals to the Restoration Center or to one of its numerous partners several times each year. Proposals undergo a competitive review and projects are selected based on their technical merit, ecological benefits to marine species and their habitats, cost-effectiveness and the level of community involvement and partnership opportunities. In 2003, $10 million was available to support community-based habitat restoration projects and partnerships.

MARINE TURTLES TRADE AND USE: RECENT FINDINGS, PROJECTS AND PLANS

Adrian Reuter

TRAFFIC

The TRAFFIC Network has undertaken several projects to better understand marine turtle trade, management and use in diverse parts of the world. The network used data from studies in over 37 countries and territories from the Caribbean to key locations of Asia and Africa such as Vietnam, Indonesia and Tanzania. TRAFFIC's marine turtle related work has also involved collaboration with governments and enforcement agencies through information sharing and technical assistance, with recent focus on the Caribbean, Vietnam, Japan, Indonesia, Indochina, East Africa and Oceania, as well as multilateral instruments such as CITES, the IAC, or IOSEA. Reports from this work have been made available to and used as strategic tools by different key actors including decision makers and managers. TRAFFIC feels that making this information known and available to a broader spectrum of institutions, researchers and conservationists is key so it may be considered and used for ongoing and future projects globally. Findings so far have helped TRAFFIC identify gaps and needs and set sound baselines for our ongoing and planned work, aimed at addressing critical problems such as insufficient or inefficient regulation governing trade and use of marine turtle products, stockpile management and lack of regional cooperation in monitoring and enforcement. The ISTS offers the ideal forum to present an overview of our projects, research, reports and plans; provide links to available materials as well as contact information of TRAFFIC staff working on these issues; encourage communication; and create synergies where possible towards effective management and conservation of marine turtles.

COMMUNITY CONSERVATION AGREEMENTS FOR SEA TURTLE PROTECTION IN THE WESTERN PACIFIC

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Direct protection of strategic nesting aggregations is critical to arresting the decline of sea turtle populations worldwide. In many areas, nesting beach protection will depend on long-term agreements with local communities. While creating endowed funds to support such agreements and associated beach protection is a sensible strategy to ensure sustainability, in practice few community agreements with long-term funding exist. One important reason for this is a lack of information on the cost and structure of such arrangements. Conservation International (CI), NOAA Fisheries and other partners are leading a two-pronged approach to address this issue by: 1) examining the cost and structure of existing and potential community agreements at three sites (the Arnavons Marine Conservation Area (AMCA) in the Solomon Islands, the Kamiali Wildlife Management Area in PNG and the Jamursba Medi beach in Papua, Indonesia); and 2) joining with the NOAA Fisheries Pacific Islands Regional Office, the Norbert Hardner Foundation and TNC to establish an endowment for the long-term protection of the AMCA.

Initial examination of the three sites suggests that costs should not be an obstacle to funding long-term management. Site level costs, which vary from $11,000 to $31,000 per year, seem particularly affordable, especially given the global importance of these sites. Jamursba Medi, for example, is one of the last remaining large nesting aggregations for the leatherback turtle in the Western Pacific. Conservation managers at present often rely heavily on short-term grants as a funding strategy, forcing them to focus on fundraising over protection and to favor activities that can be funded rather than those that should be funded. This in turn can lead to multiple, conflicting priorities and a lack of coordination among different donors. Short-term funding also virtually eliminates consideration of long-term community conservation agreements as a central component of conservation at sea turtle nesting sites – even though long-term community support in these areas may be an unavoidable necessity. Lack of stable funding for annual recurrent costs is therefore a fundamental threat to sustainable and effective conservation of strategic nesting sites.

In order to encourage the broader use of endowed funding and long-term community agreements, this project is supporting the establishment of a series of pilot projects at key nesting sites in the western Pacific. To begin, TNC, the Norbert Hardner Foundation, the NOAA Fisheries Pacific Island Regional Office and others are joining to establish a long-term trust to support on-going protection at the Arnavon Marine Conservation Area. This collaboration will make the Arnavons the first endowed conservation project in the Pacific. Plans are currently in the works to extend this effort to a series of additional sites.

BEHAVIOR OF THE HATCHING IN THREE YEARS OF STUDY IN NESTS OF OLIVE RIDLEY, *LEPIDOCHELYS OLIVACEA*, INSIDE HATCHERIES AT CAMP "LA GLORIA" IN THE SANTUARIO PLAYON DE MISMALOY, JALISCO, MÉXICO

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The objective of protecting eggs at the nesting beach is to produce hatchlings and have them later recruit into the natural population. The present study was conducted inside the protected area of Camp "La Gloria" (Sanctuary Playón de Mismaloya, Jal. Méx.). The hatchings from 2001-2003 was analyzed. Two variables were included: the incubation area perpendicular to the beach (spatial) and time in the season (temporal). The number of hatchlings were compared weekly. Analyses of variance (ANOVA) was done to determine if there existed significant differences in spatial and temporal effects. The analysis indicates that the first three weeks had the lowest hatching rates, while the rest of the season had more homogeneous behavior. The most hatchlings survived in 2003, while 2001 and 2002 had similar survival rates. The location of the nest within the hatchery also had some effect on the hatching rates. An ANOVA and Tukey test indicates that zone A is not different from either B or C, but Zones B and C are different from each other.

SEA TURTLE/DREDGE INTERACTIONS IN VIRGINIA, USA: A DIAGNOSTIC VIEW OF OBSERVED TAKES VS. STRANDINGS

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In 2001, the Virginia Aquarium Stranding Team began to notice stranded turtles with traumatic and unusual crushing injuries in Virginia, USA. There were major dredging projects taking place in Virginia at that time. Since then, a number of turtles have stranded with injuries similar to known dredge takes. Hopper dredging takes place yearly in Virginia in order to keep shipping channels deep and beaches replenished. When dredging takes place in the warmer months, interactions between sea turtles and hopper dredges occur and are known to be fatal. The Virginia Aquarium Stranding Program developed a diagnostic checklist to determine whether trauma in stranded turtles is consistent with observed dredge takes. We examined ten observed dredge takes from Virginia waters and then compared them to stranded turtles with similar characteristics. From this comparison, we developed a list of five criteria consistent with turtle/dredge interaction. The five criteria are: 1) relatively fresh condition; 2) traumatic carapace injury; 3) organs torn or mangled; 4) scutes peeling or missing at injury sight; and 5) mud entrained in tissue. Stranded turtles meeting all five criteria are considered positive for dredge interaction. Those turtles meeting four criteria are scored as possible dredge interaction. By consistently analyzing stranded turtles for dredge interaction, we will be able to provide valuable information to NOAA Fisheries and the Army Corps of Engineers for future management of turtle/dredge interactions.

SPREP'S REGIONAL MARINE TURTLE CONSERVATION PROGRAMME IN THE PACIFIC

Anne Patricia Trevor

Secretariat of the Pacific Regional Environment Programme

The Secretariat of the Pacific Regional Environment Programme's Regional Marine Turtle Conservation Programme (RMTCP) addresses issues regarding marine turtle survival across all 21 of its Pacific island member countries and territories. The vision of the programme is; "We see a future where generations of Pacific Island people will have choices about how they use and interact with sea turtles. This dream will come true if we take action now to ensure that sea turtle populations recover to become healthy, robust and stable. Sea turtles will be fulfilling their ecological role and being harvested by Pacific Island people on a sustainable basis to meet their cultural and nutritional needs." In order to enable this vision the programme coordinates the activities of a network of governments, NGOs and local communities through the RMTCP Network to enable them to work together to promote conservation and sustainable management of marine turtles in the Pacific. As well as coordinating the network, activities include: exchange of information and technical expertise within the network, in-country support for turtle conservation and sustainable use initiatives, producing and disseminating resource materials to member countries and monitoring and reviewing progress every three to four years. Some examples of the RMTCP Network programmes that are on-going in the Pacific region are the Kamiali Leatherback Tagging and Monitoring Programme in Papua New Guinea and the Vanua-tai Monitors Community-based Turtle Conservation Programme.

THE EFFECTS OF DELAYING THE RELEASE OF *CHELONIA MYDAS* HATCHLINGS THAT EMERGE FROM HATCHERY NESTS IN MALAYSIA

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Sea turtle hatchlings emerge in a state of energetic frenzy and with a finite supply of energy in the residual yolk sac to fuel off shore dispersal. In peninsular Malaysian hatcheries, emerging hatchlings are restrained from running directly to the ocean by nest nets and rely on hatchery staff for their release. We sought to determine whether effects of short-term restraint for 1, 3, or 6 hours affected running speed or mass:length ratios, an indicator of hatchling residual yolk mass reserves and hydration. Twenty-five hatchlings were collected from each of ten nests as they emerged. Immediately following emergence, ten hatchlings were subjected to a running test and had their mass and straight carapace length measured. Subsequently, five hatchlings were subjected to the same tests at intervals of 1, 3 and 6 hours after emergence. Running speed of hatchlings decreased significantly over each time period. Hatchlings tested 6 hours after emergence ran 50% slower than hatchlings tested when they first emerged. Mass:length ratio did not decrease after the first hour but significantly decreased after 3 hours and 6 hours of restraint. A decreased running speed would increase the exposure of hatchlings to nearshore predators and may indicate a reduction in activity and energetic status. Decreased mass: length ratio over the 6 hours indicated increased absorption of the residual yolk sac and dehydration, which could compromise the vigor and duration of offshore dispersal. Therefore, we recommended that hatcheries be checked at least every hour to release all emerged hatchlings immediately and maximise the speed and duration of hatchling dispersal.

NESTING BEACHES

AN ASSESSMENT OF LONG-TERM FECUNDITY, PHILOPATRY and THE “LUCK-OF-THE-DRAW” OF LOGGERHEAD TURTLES (*CARETTA CARETTA*) ON A NESTING BEACH IN SOUTHWEST FLORIDA, U.S.A.

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Data were collected from a 7.2 km section of beach on southern Keewaydin Island, Florida. Some tag returns were also recorded from turtles that nested on the northern 4.8 km of the island. In all, 68 individual remigrant turtles laid 571 nests (mean 105 eggs/nest). The mean distance between nests for each nesting cycle of individual turtles was 2329 m while the mean distance between nests for all seasonal nesting cycles by individual turtles was 4198 m. Analysis of the clutch size of re-migrants on Keewaydin Island suggests that there is no significant correlation between mean clutch size and re-migration events. This suggests several analytical complications; the period of time covered by this monitoring project is too short and, since there is no ability to determine age or the state an individual's reproductive life, trends become even more difficult to detect. Turtles may also constantly deposit large numbers of eggs throughout their reproductive lives, particularly since the rigors of migration from foraging areas likely select for only the healthiest females. Anthropogenic impacts such as drift nets and long-line fisheries on nesting populations may also impact population structure.

Site fidelity varied among individuals from season to season and within single nesting seasons. Some turtles were remarkably faithful to the area of the beach where they nested while others were less site-specific and, periodically, nested on adjacent beaches within the same season. Individuals that nest on nearby beaches or in locales miles distant from the beach they once frequented are likely "bet-hedgers" that spread their reproductive effort in the event that a once prime nesting beach becomes unsuitable for nesting. It was evident that some individual turtles were more fortunate than others in their reproductive efforts. For example, turtle QQV490 laid 19 nests between 1991 and 2001. Of the 1,239 eggs laid, only 556 hatched. The insight offered by these data highlights the reproductive effort required by female loggerheads to sustain the species. To illustrate, PPJ739 was first tagged in 1988 and last seen in 2003. During those years she laid 21 nests that contained 2,106 eggs. Of these, 3 nests were washed away (no egg count). Fourteen non-nesting emergences were also recorded. There were 5 events that, because of their timing between documented nesting, were probably nests. Including the 3 uncounted nests and the 5 possible additional nests (mean 105 eggs/nest), it is possible that this female produced at least 2,946 eggs. Data from long-term tagging underscores the significance of premature death of adult female sea turtles.

Acknowledgements: Thanks to the many individuals for their efforts work on Keewaydin Island to collect the data used in this presentation.

A BRIEF OVERVIEW OF THE EFFECTS OF HURRICANES CHARLEY, FRANCES, IVAN AND JEANNE ON SEA TURTLE NESTING SUCCESS IN SOUTHWEST FLORIDA, USA

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In southwest Florida, loggerhead turtle nesting begins in May and ends in October. Coincident with the nesting season is the Atlantic hurricane season, which officially begins on May 1 and ends on November 1. When tropical weather systems make landfall or even pass well offshore, storm surges, repeated flooding of nests and the effects of beach erosion and/or accretion can have devastating effects on nest hatching success. The effects of hurricanes Charley, Frances, Ivan and Jeanne on sea turtle nesting success in southwest Florida are assessed here. These storms passed offshore and/or made landfall between August 13 and September 25, 2004. Data from beaches in Collier, Lee, Charlotte, Sarasota, Manatee and Pinellas Counties were used in this report. Fewer nests were laid in 2004 than in 2003. The lower number of nests in 2004 coupled with hurricane impacts dramatically reduced hatchling recruitment. The data revealed that the extent of the impacts varied along the coast from storm-to-storm. Charley was more destructive in Collier and Lee Counties and less so in the others. Though Frances and Ivan washed away 25 nests in Collier County, they destroyed significantly more nests in Charlotte, Sarasota and Manatee Counties. Pinellas County was least impacted by the storms. During the 2003 season, the mean percentage of nests washed out over the entire west coast was 6.9% as opposed to a mean of 26.8% in 2004. In 2003 133,188 hatchlings entered the Gulf of

México as opposed to 72,299 in 2004. Even considering the fewer number of nests that were evaluated in 2004 (1,881) compared to 2003 (2,176), the impact of the storms on hatchling recruitment was dramatic.

The extent of the storm damage on individual beaches was clearly illustrated on Keewaydin Island (KI). In 2003, 15,383 hatchlings entered the Gulf compared to 2,450 in 2004. The 11-year mean for hatchling recruitment from KI is 10,242. Recruitment in 2004 decreased by 41.8%.

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SEA TURTLE HATCHLING PRODUCTION ON FLORIDA BEACHES 2002-2004: EFFECTS OF MULTIPLE HURRICANES IN 2004

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Florida has the highest density of loggerhead nesting in the Western Hemisphere and significant numbers of nesting green turtles. The Fish and Wildlife Research Institute (FWRI) coordinates statewide nesting beach surveys that are carried out by a network of researchers who hold permits from Florida Fish and Wildlife Conservation Commission. This survey network allows researchers to study the factors that affect sea turtle hatchling production in Florida and to estimate total hatchling production statewide. We measured loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*) hatchling production at ten sites on beaches throughout the state between 2002 and 2004. Researchers at each site conducted season-long nesting surveys and inventoried a representative sampling of the nests. In our analysis, we focused on three questions. (1) How many hatchlings leave Florida beaches annually? (2) What are the sources of egg and hatchling mortality on Florida beaches? (3) How did four hurricanes affect hatchling production in 2004? Our results indicated that the annual hatchling emergence success from loggerhead nests (n=784, n=1173, n=897) ranged 48–68% and from green turtle nests (n=108, n=78, n=102) ranged 13–61% during this period. The principal disturbances to nests that were observed to affect hatchling/egg mortality were predation predominantly by raccoons (*Procyon lotor)* and ghost crabs (*Ocypode quadrata*) and beach erosion from storms. The effects of beach erosion on sea turtle nesting were profound in 2004 because four major hurricanes eroded, inundated and accreted almost every nesting beach in Florida near the peak of nest incubation. These storm effects were greatest for green turtles, which have their peak in nesting activity approximately one month after the peak in loggerhead nesting. In addition, a 2-factor ANOVA on transformed loggerhead hatchling emergence percentages showed that both year ($F = 58.4$, $df = 2$) and beach location ($F = 16.3$, $df = 9$) significantly affected hatchling emergence success.

THE EFFECT OF BEACH NOURISHMENT ON NESTING LOGGERHEADS IN SOUTH CAROLINA, USA

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Loggerhead sea turtles, *Caretta caretta*, nest on South Carolina beaches. Many of these beaches are periodically nourished as a temporary solution to fight beach erosion. This study determined nourishment's effect on nesting loggerheads in SC using two methods: 1) examined historical nesting data from three SC beaches: Debordieu Beach, Hilton Head Island and Kiawah Island, SC, USA to determine if nourishment affected nest to total crawl ratio densities; and 2) determined if a partial nourishment project on Hunting Island, SC, USA altered physical properties of the beach. Based on the historical analysis, I found generalizations cannot be made about nourishment's impact on turtle nesting because results differed among the two nourished beaches. On Debordieu, the nest to total crawl ratio increased after nourishment to levels comparable or above control sections of the beach. On Hilton Head, the nest to total crawl ratio decreased after nourishment and was not comparable to the control beach until three years after nourishment. In the beach characteristic study, significant differences were found in sand temperature and compaction between the nourished and control beaches on Hunting Island, SC with the nourished sand being warmer and more compact. These differences may have the potential to affect turtle nesting success and the nest environment.

MONITORING OF ISOLATED AND ARRIBADA NESTS OF OLIVE RIDLEY, *LEPIDOCHELYS OLIVACEA*, IN CHACOCENTE BEACH, RIO ESCALANTE-CHACOCENTE, WILDLIFE REFUGE, PACIFIC COAST OF NICARAGUA (2002-2004)

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Since 1992, MARENA (Environmental and Natural Resources Ministry of Nicaragua) has conducted olive ridley monitoring and protection activities at Chacocente beach, Rio Escalante Chacocente Wildlife Refuge between 1 July and 31 January. This is one of the two beaches where arribadas (massive nesting events) occur in Nicaragua. Each night 1.5 kilometers of beach, where nesting activities are concentrated, are patrolled by MARENA's rangers and local communities' volunteers. Both solitary and arribada nests are counted by 100 meter sectors along the beach. Nests lost by natural causes and illegal poaching are recorded. Eggs are given as compensation to local people for beach protection work. On average, 10% of the nests occurring during an arribada are extracted and distributed between the communities near the beach. This presentation aims to show monitoring and management results reported for 2001/02, 2002/03 and 2003/04 seasons.

NATURAL AND HUMAN INDUCED VARIATIONS ON BEACH DYNAMICS AND THEIR EFFECTS ON LEATHERBACK SEA TURTLE CONSERVATION

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This investigation was designed to compare the physical and chemical properties of the sand at nest depth between the developed and undeveloped areas along the leatherback (*Dermochelys coriacea*) nesting beach at Playa Grande, Costa Rica and relate these factors to leatherback nest site selection and hatching success. Differences in the sand characteristics such as water content, bulk density, particle density, particle size, porosity, air-filled pore space, pH, electrical conductivity, salinity, organic content and calcium carbonate content may be affected by natural processes and human development but have never been analyzed on a leatherback nesting beach.

The leatherback nesting beach at Playa Grande, serves as an ideal location to study the effects of human development on nesting beaches. This beach has sustained substantial development along the northern and southern ends which has lead to the removal of the natural beach vegetation. Subsequently, this has lead to increased erosion in these areas and to the increase in other environmental damage associated with human development.

In the 2003-2004 nesting season, we performed a thorough analysis of these sand characteristics at nest depth, for the 37 one-hundred meter sections along Playa Grande. These sections were then grouped into eight groups, numbered 1-8; each containing five sections except for the last group which contains only two sections. Groups 1, 2, 7 and 8 represent areas of the beach with the most substantial levels of development and groups 3, 4, 5 and 6 are areas of little to no development. Significant differences in the elevation, water content, bulk density, particle size, pH, electrical conductivity, salinity, organic content and calcium carbonate content were found for the analyzed sand characteristics. Differences were most significant between areas with high levels of human development (Groups 1, 2 and 7) where nesting frequency was low verses areas with little to no development and high nesting frequencies (Groups 3, 4, 5 and 6).

Overall, areas where development has occurred differ from undeveloped areas in several of the parameters measured. The affects that these alterations might have on the overall hatching success of nests and nest site selection by nesting females requires further research. In addition, implementing an ongoing monitoring project in these areas with adjacent development would be beneficial to the future success of the local ecosystem through improved understanding of impacts of human development on the beach environment.

LEATHERBACK (*DERMOCHELYS CORIACEA*) NESTING AND SURVIVAL THREATS ON THE BEACHES OF SAN-SAN POND-SACK WETLANDS RESERVE IN BOCAS DEL TORO PROVINCE, PANAMA

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Historically, Bocas del Toro Province has been well known for the consumption of sea turtles, especially green and hawksbill turtles but leatherback turtles are also killed for egg consumption. The San-San Pond-Sack Wetland Reserve comprises three black sand beaches, Sixaola (3.5 km), San-San (4 km) and Soropta (12 km), all of which host important levels of leatherback nesting. In 2004, monitoring and conservation efforts were concentrated along 5 km of the Soropta beach. Along this beach section, the killing of nesting females was reduced by 100%, in comparison with previous years. Two female leatherback turtles were killed along 7 km of unprotected beach at Soropta. A nest survey along the Sixaola and San-San beaches, conducted in April, revealed twelve and three dead leatherback females respectively. These turtles were most likely killed for their eggs and ovaries. The efforts of the National Environmental Authority (ANAM) and local communities on the two beaches were insufficient to deter the killing of nesting females. Observations of tagged individuals show that leatherbacks from other nesting beaches in the region emerge to nest in the San-San Pond-Sack Wetland Reserve. Therefore, the continued killing of nesting leatherback turtles at the Sixaola, San-San and other unprotected beaches in Bocas del Toro Province threatens to undermine leatherback conservation efforts in the Caribbean Panama and Costa Rica.

PRELIMINARY ASSESSMENT OF NESTING SITE FIDELITY OF LOGGERHEAD TURTLES IN GEORGIA, 2004

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Nesting site fidelity of loggerhead turtles in the south-eastern U.S. has been described using conventional flipper tagging data (Miller et al. 2003). For example, Bell and Richardson (1978) reported that 51% of tagged loggerhead turtles returned to within 16.6 km of their original nesting site on Little Cumberland Island. However, most tagging studies are limited in spatial scale (5-15 km) and often provide an incomplete picture of nesting habitat use. An alternative method for assessing loggerhead nesting site fidelity is to monitor the movements of nesting females with satellite telemetry. During the spring of 2004, we examined nesting site fidelity of loggerhead turtles in Georgia using satellite telemetry. We instrumented 10 nesting females with satellite and acoustic transmitters from May 25 through July 8 on Cumberland and Jekyll Islands. Movements of instrumented turtles were monitored throughout the intra-nesting period and nesting events were recorded. Nesting site fidelity varied among individuals. Nesting females used an average of 26 linear km of beach for nesting with a range of 4.2 to 87.7 km. There was no correlation between female carapace length and the length of nesting beach utilized.

MARINE TURTLE NESTING IN THE ARCHIE CARR NATIONAL WILDLIFE REFUGE IN 2004: SMALLEST NEST PRODUCTION ON RECORD AND HURRICANE-INDUCED LOW REPRODUCTIVE SUCCESS

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In a season that produced the smallest number of loggerhead nests (7600) since the beginning of record-keeping in the Carr Refuge (1982), marine turtle reproductive success was significantly diminished by the impacts of four Florida hurricanes. Green turtle nest numbers were also lower than expected (930). We believe that the smaller nest numbers may have been due to lower water temperatures in foraging areas prior to the onset of the nesting season. We estimate that the storms and related high winds and water washed out 44% of the loggerhead nests and 85% of the green turtle nests deposited during the 2004.season. Leatherbacks were unaffected by the lower water temperatures, laid a total of 12 nests and emerged prior to the hurricanes.

HATCHLING SEX RATIOS OF HAWKSBILL SEA TURTLES FROM A CARIBBEAN ROOKERY, A MULTI-YEAR EVALUATION

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The hawksbill sea turtle possesses temperature-dependent sex determination (TSD), which has the potential of producing a wide variety of sex ratios. Therefore, the sex ratios are of ecological, evolutionary and conservational interest. Buck Island Reef National Monument (located approximately 2 km north of St. Croix) represents a natural and undeveloped nesting beach for endangered hawksbill sea turtles in the Caribbean. The purpose of the current study was to monitor hatchling sex ratios of hawksbill sea turtles produced on Buck Island during the 1995-1999 and 2002 nesting seasons. Temperature data loggers were placed into the center of the egg mass in each nest. Data loggers were also placed in beach locations at midnest depth to monitor beach temperatures. Sex ratio predictions were based on the average temperature during the middle third of incubation. The results suggest that a variety of sex ratios were produced on Buck Island (ranging from all female to all male), but overall, a significant female bias was predicted in each of the six seasons examined. The results also suggest that some male-biased clutches were produced in response to temperature decreases associated with tropical weather systems passing through the study area and by nest location.

USE OF HISTOLOGICAL TECHNIQUES TO EVALUATE SEX RATIOS PRODUCED IN THE KEMP'S RIDLEY CONSERVATION PROGRAM DURING THE 2003 NESTING SEASON

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The Kemp's ridley is the subject of an intense international conservation effort that includes the protection of nesting females and their eggs on the nesting beach. This program includes the translocation of most nests to "egg corrals" in order to protect the nests from poaching and predators. Moving the nests to egg corrals places these nests into the same thermal environment and Kemp's ridleys have been shown to have temperature-dependent sex determination. Therefore, it is important to monitor sex ratios. Over the past few years, incubation temperatures have been monitored in a subset of nests in the egg corrals during each nesting season and those data suggest an overall female-biased sex ratio. In the current study, an alternative method was used to determine the sex of hatchlings from Kemp's ridley nests. Histological analysis of gonadal tissue was used to determine the sex of hatchlings that were found dead in nests during the 2003 nesting season. This included nests from the egg corrals as well as from in situ nests left in their original location on the natural nesting beach. One to six dead hatchlings were collected from 63 nests which were laid throughout the 2003 nesting season. Gonadal tissue was examined histologically to determine sex. The results were consistent with those of the temperature data, indicating that a significant female bias was produced in both the egg corrals and in the in situ nests during the 2003 nesting season.

A COMPARATIVE ANALYSIS OF SEA TURTLE CONSERVATION EFFORTS AT CENTRO ECOLóGICO AKUMAL FROM 1993 TO 2004

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Centro Ecológico Akumal (CEA) is a non-profit conservation organization that has been working for the past 11 years to protect the marine ecosystem along the Caribbean coast of México. Among the several programs operated by CEA, is the Marine Turtle Program, which works on the protection, conservation and research of marine turtles. Since 1993, this program has carried out efforts to protect nesting turtles and hatchlings under the Ministry of the Environment permit number CONV-DGVS/CPCTM-038-QROO-001. This includes managing the beaches of Half Moon, Akumal bay, Beach Jade and south Akumal. The objective of the current project is to present results from 10 years of marine turtle protection, along with a comparative study of past seasons with the 2004 season. There was a drastic decline of the green turtle nesting population during the 2004 season. Statistical analysis from past seasons shows a constant increase in the number of nesting females, but this year, preliminary results demonstrate an absence of a large number of green turtles. Therefore, it has become a priority to study external factors on turtle populations which may present a risk to the conservation of the species and in this way increase efforts in evaluating environmental impacts on populations.

EVALUATION OF THE OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) SIZE WITH FECUNDITY AND HATCH SUCCESS PERCENTAGE FROM THEIR EGGS TRANSFERRED TO A PROTECTION CORRAL ON ESCOBILLA, BEACH, OAXACA

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In nesting female olive ridley sea turtles, *Lepidochelys olivacea*, the most common size is 60 to 70 cm. However, a few studies have examined the reproduction of females outside of this range. The present study compares the reproduction of females less than 60 cm to those greater than 70 cm. In this study we compare the number of eggs, hatch success and the incubation results (i.e. mortality) in the three different phases of the embryonic development. Nests from 50 large and 50 small olive ridleys were transferred to a protected place for incubation. Nests hatch between the 44th and 59th day of incubation. There were a total of 4,771 eggs from the small females (average 95.4 eggs/nest), which produced a total of 3,706 fry (74% hatching success). The large females' had an average of 104.7 eggs/nest for a total of 5,234 eggs, but had a lower hatching success (66%). A total of 924 eggs from the large females died during development (18%, 15% during phase III of development), while in the smaller females the percentage was 9%. The larger females had the highest percentage of eggs without apparent embryonic development, considered infertile, with an equivalent total of 762 eggs (15%), against 5% for the smaller females.

BEACHES COME AND BEACHES GO: COASTAL DYNAMICS IN SURINAME ARE AFFECTING IMPORTANT SEA TURTLE ROOKERIES

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The Surinam coast is part of the extensive mud coast between the mouths of the Amazon and the Orinoco rivers. Due to the westward-oriented Guyana Current and north-easterly trade winds, the coastline is highly dynamic and unpredictable and is subject to successive phases of beach erosion and accretion. The coastline is dominated by extensive mudflats. Sandy beaches that are suitable for sea turtle nesting are found mostly in East Suriname and have a total length of 30-40 km.

Suriname hosts one of largest leatherback nesting colonies in the world, with a peak of >30,000 nests estimated in 2001. In addition, there is a large and stable green turtle nesting population (5,000-10,000 nests/year), but also a now almost extinct olive ridley population (150-200 nests/year). Hawksbills nest in low numbers on Matapica. Sea turtle monitoring started in 1964 and it was discovered that the location of nesting beaches changed every year – even within a single nesting season, not only with significant consequences for sea turtle nesting, but also for conservation and for monitoring and research activities. For example, green turtles nest mainly in the Galibi Nature Reserve (GNR) and at Matapica. Although generally exhibiting great nesting site fidelity, they show flexibility in moving along steadily westward-moving beaches, e.g. from Bigisanti to Matapica (at about 0.5 – 1.5 km/year). Leatherbacks nest in the GNR and at Matapica, but they are also the first ones to utilize new beaches in the area west of the mouth of the Marowijne River, such as Samsambo and Kolukumbo. Olive ridleys use to nest in small arribadas on the former Eilanti Beach in the GNR, but due to excessive harvesting (e.g. '60s and '70s) and later almost 100% poaching of eggs, the population has collapsed dramatically. They now nest in only low numbers at Matapica, eastern Samsambo and the GNR. Beach erosion sometimes destroys sea turtle nests, especially on the eastern side of westward moving beaches like Matapica. Further, newly formed mudflats sometimes block sea turtle access to existing (and often relatively new) nesting beaches, e.g., Samsambo in 2000 and Kolukumbo in 2004.

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MARINE TURTLES OF MONTSERRAT

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We present an attractive, highly graphical account of the work that has been carried out over the last few years to elaborate the status of marine turtles. This includes results of beach census work and the more recent online tracking of "Montserrat" the green turtle as part of UK Government OTEP funded initiative. We show that Montserrat hosts small yet regionally important nesting populations of green and hawksbill turtles.

THE CURRENT STATUS OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) IN GRENADA, W. I.

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The 2004 nesting season marked the 5th consecutive year of the leatherback nesting monitoring programme in Grenada. Focused primarily on the North Eastern tip of Grenada, the research programme was established in 2000 to identify the existing status of this population. Initial findings in the first year of research highlighted Grenada as host to a regionally significant nesting leatherback population. Track surveys have been consistently recorded on 2 beaches since then, showing a rise to over 700 nests in 2003. Due to the physical profile and size of Levera beach (700m index site), it was feasible to conduct a saturation tagging programme from 2002; 57 females were tagged increasing to 183 in 2003. Tag returns were recorded in 2004 with sightings of turtles from Trinidad, Panama and Grenada's sister isle, Carriacou. Turtles tagged in Grenada were also recorded on beaches in St. Vincent, Carriacou, Trinidad & Tobago. Hatched and unhatched nests were excavated over 3 years for both nests laid in situ and those that were relocated. However, the physical properties of the beach have been drastically altered by the development of an 18 hole golf course situated 1m from the beach. This may have played a significant role in the reduction of hatching success along certain zones of the beach. Illegal egg poaching activities remain problematic, initial observations recorded a high rate of poaching (91%) during peak season. Although poaching has decreased as a result of research efforts and beach presence, the local demand for the eggs remains high.

TOTAL DISSOLVED SOLIDS IN RENOURISHED SAND DETERS SEA TURTLE NESTING: FORGET THE PENETROMETER

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Recently renourished beaches seem undesirable to nesting sea turtles. It has been observed that the nesting season following a renourishment project usually sees a sharp decline in the number of nests for the affected area. Consequentially, neighboring beaches that were not renourished see an increase in the number of nests. The number of nests in both renourished and non-renourished areas usually returns to normal for the following year's nesting season. Thus, the undesirable quantity in renourished beaches is temporary. One possibility for this undesirable quantity is the high dissolved solids content of the dredged sand. Since renourishment projects occur in dry season of the Florida climate, the sand's content is relatively unchanged after being pumped onto the beach. The massive rainfall characteristic of the summer months in Florida may dilute the sand dissolved solids. This study will investigate the relationship between high total dissolved solids (TDS) in the sand and decrease of sea turtle nesting in a given area.

This study examined a 1.5-mile central span within the 5 miles of beach in Boca Raton, Florida. The renourishment for central Boca Raton occurred primarily in zones F, G and H. During late February of 2004, 747,000 cubic yards was placed in these zones to increase the beach width. Rainfall was measured every day from seven rain gages spaced evenly throughout the project area. Two additional rain gages were placed to the north of the project area in zones E and D to serve as controls. All rain gages were placed in the dune of the beach to minimize interference and vandalism from beachgoers. Sand samples were collected from crawls both in and outside of the project area. Sand samples were taken from the westernmost point of the tracks or nest in undisturbed sand. Each sand sample was dried in an oven for sixty minutes at 300^{o} F. The dried sand was then sifted through a 0.5mm mesh. A 60-gram portion was then measured from the remaining sample. Using the United States Department of Agriculture's guidelines for soil quality measurement, a 1:1 ratio of sand sample and distilled water was used to make a paste. This mixture of sand and water was well stirred. Finally, a TDS meter was used to measure the sample's electrical conductivity.

The following trends can be observed in the data. First, the Total Dissolved Solvents (TDS) is higher in the project area than in the control area. Second, the TDS values decreased with increased rainfall. Third, loggerhead sea turtles largely preferred to nest in areas with lower TDS values. Overall, nesting success approached a normal value of 1 to 1 in the project area as the rainfall increased over 8 inches. The shunning of the renourished beach as a suitable nesting site can be interpreted from by the low nest success, which approached 1 nest for 3 false crawls. After July 4 these ratios returned to near 1 to 1 following nearly 8 inches of rainfall. The average total dissolved solids measured for false crawls in the renourished area was 1.2 parts per thousand (PPT) whereas the average salinity at nest sites in the project area was significantly lower at 0.3 PPT.

This project is a continuation of a small study conducted during the summer of 2003. In the previous study salinity level were examined for a small renourishment project in front of a single condominium. The project area for this study was 1.5 miles of beach in central Boca Raton, Florida. The sand was tested for total dissolved solids (TDS), instead of exclusively for salinity. Sand was also collected randomly from turtle crawls. Approximately 75 sand samples were collected from false crawls and nests in the project area. Most of the false crawls occurred in the middle of the beach. Many nests were laid closer to the dune. This can be seen in the GIS mapping of the turtle crawls for 2004.

Testing conducted on samples from false crawls showed higher TDS levels than samples collected near the dune. This may be indicative of the varied volume of sand placed on the beach. The majority of the sand is pumped in the middle section of the beach and eastward to establish a new profile. The dune area comparatively receives less pumped sand. Thus it seems reasonable that the total dissolved solids in the station samples would match the control areas with less rainfall than the false crawl samples. The crawl samples, up to 125 feet east of dune, did not reach control TDS levels until the end of July 2004. This assumption is somewhat illustrated in figure 12. The decrease of the false crawl TDS levels is consisted with how the sea turtles responded to the beach. Zone G provides an excellent example. Prior to receiving 6.5 inches of rain, the number of nests to total emergences (number of nests plus false crawls) was approximately 18 %. A normal ratio is considered to be 50%. During this same period, neighboring zones to the project area, zones D and J experienced nesting ratios over 50%. This suggests that some sea turtles may have false crawled in the project area and then tried to nest as close as possible by settling for a neighboring zone.

RESEARCH AND CONSERVATION RESULTS OF THE 2004 SEA TURTLE NESTING SEASON IN THE PARIA PENINSULA, VENEZUELA

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Project activities in 2004 were initiated by April 5th at Cipara Beach (62º42'W, 10º45'N). At Querepare Beach (62º52'W, 10º42'N) preliminary surveys were made April 18 - 20 and the biologists were finally established by April 28th. Female leatherback turtles (*Dermochelys coriacea*) were double-tagged with metallic tags in the left fore-flipper and AVID PIT tags in the right shoulder; the Cheloniidae species only received a metallic tag. Pictures were taken of the pink spot on the head of each leatherback. Curved carapace measurements (SCL and CW) were recorded, in addition to the general condition and the presence of tag scars. Daily surveys were made to estimate the total number of reproductive events and related information. Most nests were relocated to protected hatcheries to avoid poaching. The number of released hatchlings was recorded. The activities finished by September 6th in Querepare Beach and September 9th at Cipara Beach.

A total of 96 female leatherback turtles arrived at these two beaches (including those tagged in 2004, recaptures and females of unknown origin). More than 10,000 hatchlings were released. Exchanges between nearby beaches were observed as well as with other islands from Venezuela and Lesser Antilles. One turtle tagged at the project died entangled in a net at Cipara Beach and several other carcasses arrived to Cipara, including one olive ridley (*Lepidochelys olivacea*) rarely observed in the area. After leaving the beach in 2004, fishermen attempted to kill a green turtle female, but the local research assistants prevented it. However, several drowned turtles have been found and several nests were poached at the beginning of the nesting season at Querepare Beach, but the poaching almost stopped with our arrival to the beach. During this year there were more awareness activities conducted toward military personnel and schools, more environmental education materials published (one poster and three brochures), and a sea turtle exhibition. The exhibition was titled "Sea turtles…. Travelers of Paria" installed in the World Environment Day, June 5th until August 28th, being the first activity of this kind in Venezuela. This exhibition presented photographs, artwork, craftwork and educational banners and posters relating to sea turtles, their ecology, their cultural value and their conservation.

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NATIVE AND NOURISHED BEACH SAND PROPERTIES AND THEIR RELATIONSHIP TO SEA TURTLE NESTING SUCCESS IN FLORIDA

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Florida's sandy coastline provides nesting habitat to thousands of sea turtles. However, natural undeveloped coastlines are disappearing and being replaced by urbanization such as condominiums, inlets and piers. Coastal development can have a negative impact because it prevents beaches that are naturally eroding and moving landwards from reestablishing their structural elements. This is particularly apparent after strong storm events such as those that occurred in Florida during the 2004 hurricane season.

Beach nourishment projects replace native sands with sand usually dredged from an offshore location. This sand can differ from the native in a multitude of properties such as compactness, grain size, temperature and moisture content. These differences are not always due to sand source, but can also be attributed to the renourishment depositional process. They can affect gas diffusion rates and may have a detrimental impact on sea turtle embryonic development. This project aims to compare the physical characteristics inherent to native and nourished beaches.

Sand samples were collected from transects located between the dune and high tide in 5 native (Cape San Blas, Casey Key, Melbourne Beach, Merritt Island and Flagler Beaches) and 5 nourished (Anna Maria Island, Naples, Delray, Juno and Melbourne beaches) sea turtle nesting beaches. Samples were analyzed for grain size composition, water content, sand color, surface reflectance index, bulk and particle density, porosity and tortuosity, pH, total organic content, total calcium carbonate and inorganic composition. Data, such as compactness and shear resistance were measured in situ. Results show that there are statistically significant differences between native and nourished beaches for particle density and compactness with the latter beach having higher values. In general, the east and west coast beaches of Florida are very distinct and differences were seen in almost all parameters measured. The west coast has finer grain sand, is more compact, has higher porosity, lower % organic content and holds more water. When all beaches were combined for analyses, no differences were found between the sand collected at the dune and high tide line. However, when individual beaches were analyzed for differences within the dune/high tide transect sand, several differences were found.

This study shows that Florida beaches are very distinct and generalizations should be made with caution. Beach parameters varied the most between the east and west coast beaches. Native and nourished beaches differ primarily in their compactness and particle density with nourished beaches being more compact. These differences are also seen within the same beach between the dune and high tide lines. This is more prevalent in nourished beaches perhaps because of ongoing beach settlement following a nourishment project.

The parameters investigated in this study are correlated and, depending on individual beach nourishment projects, have the potential to negatively or positively impact sea turtle nesting and incubation. Because of differences in the depositional processes between a native and a nourished beach, a nourished beach can be different from the native beach even when they have the same sand. Also, a nourished beach with one type of sand can differ from a native beach with another type of sand because of the different ways they were formed and not because of the differences between the types of sand present. Beach nourishment projects that take into account the parameter/coast/beach relationships shown by this study can produce a habitat more similar to the native nesting environment for sea turtles in Florida.

THE RECONCILIATION OF HAWKSBILL (*ERETMOCHELYS IMBRICATA*) NESTING HABITAT WITH VEGETATION ISLANDS ON LONG ISLAND, ANTIGUA, WEST INDIES

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Pasture Bay, Long Island, Antigua, West Indies supports a unique population of nesting hawksbills that has been monitored by a saturation-tagging program since 1987 and challenged by both unnatural and natural forms of habitat loss. Within the past century, humans have modified the beach by reducing the amount of native vegetation and introducing non-natives species. These anthropogenic alterations coupled with the periodic occurrence of hurricanes have significantly reduced the availability of maritime forest for nesting habitat. Depletion of intact maritime forest has contributed to habitat loss through coastal erosion further complicating the turtles' ability to readily locate an adequate nesting site. Vegetation islands have been designed as an instrumental conservation measure to return critical native flora and preserve existing forest structure that is essential to nesting success. The islands have also been created as a tool to integrate and reconcile critical habitat needs of the hawksbill with human economic and developmental needs. This strategy and art of establishing and maintaining new habitats in the face of human enterprise, to essentially 'reconcile' human land use with that of another species, is an efficient and harmonious approach to conservation challenges. The primary focus of this study was to examine the use of created nesting habitat by hawksbills on Pasture Bay beach and to quantify the changes in available beach structure through time by comparing aerial photos and analyzing changes in nesting and false crawl distribution. Our comparison of the 1984 and 2004 aerial photographs of Pasture Bay revealed a dramatic visual decrease in forest cover. Additionally, the distribution of false crawls along the beach significantly decreased and the percentage of nests increased in the restored area after construction of the vegetation islands. Results will be elaborated in a manuscript currently in preparation. From these results, the message is clear: these vegetation islands are providing hawksbill nesting habitat and appear to be compensating for that role of the native forest that preceded them. An understanding of how we can maintain successful nesting habitat within human enterprise and reconcile our needs with those of wild, native species will aid in the formulation of effective conservation management tools both on Pasture Bay and other Caribbean hawksbill nesting beaches.

IN SITU VERSUS CORRAL NESTS: THREE-YEAR STUDY OF THE EFFECTS OF MOVING NESTS ON THE SEX RATIOS OF HATCHLING KEMP'S RIDLEY SEA TURTLES

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The Kemp's ridley is the one of the most endangered sea turtles in the world. Like all species of sea turtle, the Kemp's ridley possesses temperature dependent sex determination. This form of sex determination introduces the potential of producing skewed sex ratios, which could affect the survival status of the species. As such, it is of ecological and conservational interest to examine hatchling sex ratios of Kemp's ridleys. For over 25 years, the majority of Kemp's ridley nests at the primary nesting beach near Rancho Nuevo, México, have been moved to protected egg corrals. The purpose of the current study was to examine the sex ratios produced in nests that incubated in their natural location (*in situ*) on the primary nesting beach for the Kemp's ridley and compare those data to sex ratios produced in the egg corrals. Sex ratios were predicted based on the average incubation temperature during the middle third of incubation.

To monitor incubation temperatures during each nesting season, data loggers were programed at the University of Alabama at Birmingham to record temperature at least once an hour and sent to Rancho Nuevo for placement within nests. Data loggers were placed into the approximate center of the egg mass within individual nests throughout each nesting season. From 2001-03, data loggers were used to monitor temperatures in a total of 138 nests within the egg corrals at Rancho Nuevo. Further, nest temperatures were monitored in 126 nests left to incubate *in situ* during this time. The average temperature during the middle-third of incubation was used as a predictor of sex ratio. The Kemp's ridley has a pivotal temperature of approximately 30.2ºC. Temperatures above 31º C produ ce 100% females, while temperatures below approximately 28ºC produce 100% males. Incubation temperatures between the pivotal and the all-female and all-male ranges produce female-biased and male-biased sex ratios, respectively.

In general, nest incubation temperatures were warm throughout each season, suggesting the production of an overall female bias. Of the nests monitored in the egg corrals, 112 were predicted to produce 100% females, 10 to produce a female bias, while 15 were predicted to produce a male bias (laid in April). Only 1 nest was at pivotal temperature. These results are consistent with data from egg corral nests monitored during previous nesting seasons (1998-2000). Nests monitored *in situ* during the 2001-03 seasons revealed cooler incubation temperatures than those monitored within the egg corral nests.

Nonetheless, the results show an overall female bias in the *in situ* nests, where 42 of the nests were predicted to produce all females, 59 to produce a female bias, 5 to be at/near the pivotal temperature and 20 to produce a male bias. No nests were predicted to produce all males. The incubation temperatures of *in situ* nests are of interest for several reasons. It is of conservational interest to first ascertain a "natural" sex ratio for this population and second to determine effect of relocating nests in the conservation program implemented at this beach.

The results suggest that the natural sex ratio produced from this nesting beach is female biased. Further, the results indicate the act of moving nests to the egg corrals does not appear to have drastically altered the overall female bias predicted to occur naturally in the hatchling sex ratio at Rancho Nuevo.

A PRELIMINARY CHARACTERIZATION OF SEA TURTLE NESTING BEACHES ALONG THE KENYAN COAST

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The challenges sea turtles face from human activities are enormous as they impact every stage of their life cycle, from loss of nesting beach and foraging habitats to fishing related mortalities. The influx of coastal developments is one of the greatest problems facing Kenya's coastal beaches and is an important conservation issue. Threats to nesting beaches emanate from the construction of sea walls and other armoring structures, increased human presence and presence of recreational or beach equipment and beach erosion. A rapid ground survey was undertaken along the Southcoast, Mombasa, Kilifi, Watamu, Malindi, Robinson Island and Lamu areas to profile sea turtle nesting beaches with the aim of assessing the current status the beaches and developing a baseline GIS database. A spatial index of the following physical parameters were taken: GPS location, beach slope, sand grain size, presence and type of armoring structures, their length and distance from the high water mark, human presence and fishing activity, predominant threats, presence of predators and vegetation. Semi-structured interviews with local fishermen and residents revealed evidence of nesting habitat loss particularly in areas with high beachfront development and human activity in the Southcoast, Mombasa and Kilifi. The database will be an important reference tool for research and monitoring of Kenya's turtle nesting beaches.

THE STATUS OF SEA TURTLE NESTING IN BROWARD COUNTY, FLORIDA

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Loggerhead nesting has declined by more than 31% since 2000 and there has been a significant ($P = .028$) decline since 1995. While this could be due to changes in the remigration interval or the clutch frequency, the down trend could also indicate a decrease in the size of the nesting population. Green sea turtles have shown a pattern of relatively high and low nesting in alternating years, suggesting a predominant two-year remigration interval which has persisted for 16 years. Most loggerhead nests were relocated due to the heavily urbanized coast and brightly illuminated beaches. The eggs from 930 relocated loggerhead nests produced 59.4 percent released hatchlings while eggs from 207 in situ nests had a success rate of 63.7 percent. Hurricanes Frances and Jeanne adversely impacted 245 loggerhead and 64 green nests.

LOGGERHEAD TURTLE NESTING IN ITALY: AN OVERVIEW

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Historically, loggerhead sea turtle (*Caretta caretta*) nests have never been common on Italian beaches. Their distribution is confined to the southern part of peninsular and insular Italy, between the Calabrian coast and the Pelagie Islands (Sicilian channel). The best-known regular nesting sites are located in the Pelagie islands, an archipelago well known for its strong natural values. These are the Conigli beach, on Lampedusa and the Pozzolana di Ponente beach, on Linosa. This presentation endeavors to represent an updated picture of the Calabrian and Sicilian nesting areas. We have thoroughly investigated the 2 sites on the Pelagie Islands since the late spring of 2000. In 2000-2003, this study was carried out within the framework of the EU-Life Project "Urgent conservation measures for *Caretta caretta* in the Pelagie islands" (LIFE99 NAT/IT/006271). We will continue this investigation in 2004-2006, within the framework of LIFE03 NAT/IT/000163 "Reduction of the impact of human activity on *Caretta* and *Tursiops* and their conservation in Sicily". As concerns the southern Sicilian coastline, in 2004 three SCIs were monitored. All available information on this general area will be discussed, both from current and "grey" literature, as well as from verbal communications. The Ionian coast of Calabria has been monitored since spring 2000 and 26 nests were identified (2000-2004, Mingozzi et al., in press). The importance of these "new" sites may well be comparable to that of the Pelagie Islands. Future investigations, therefore, will address the number and the continuity of nidification in this area.

NEST COUNTS FOR MARINE TURTLES (LEATHERBACK, *DERMOCHELYS CORIACEA*; GREEN, *CHELONIA MYDAS*; OLIVE RIDLEY, *LEPIDOCHELYS OLIVACEA*; AND HAWKSBILL, *ERETMOCHELYS IMBRICATA*) ON THE SOUTHERN BEACHES OF BIOKO ISLAND (GULF OF GUINEA, AFRICA) ACROSS FOUR NESTING SEASONS (2000/2001 THROUGH 2003/2004)

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Bioko is the largest of the four Gulf of Guinea islands (2,027 km^2) and the nearest to mainland Africa, lying only 32 km offshore from Cameroon. Four species of marine turtles (leatherback, *Dermochelys coriacea*; green, *Chelonia mydas*; olive ridley, *Lepidochelys olivacea*; and hawksbill, *Eretmochelys imbricata*) are known to nest on the 19 km of black sand beaches along the southern shores of the Island's Gran Caldera and Southern Highlands Scientific Reserve. For the past four (2000/01 through 2003/04) annual nesting seasons (October through April), the Bioko Biodiversity Protection Program, a cooperative enterprise of Arcadia University and the Universidad Nacional de Guinea Ecuatorial, has employed local patrols to record turtle activity on these beaches. Leatherback nests were the most common and showed the greatest year-to-year fluctuation (typically between 2500 and 6000 nests), followed by green turtles nests (between 1000 and 2000), olive ridley nests (between 50 and 100) and hawksbill nests (fewer than 20). When combined with comparable results by other scientists for the 1996/97 and 1997/98 nesting seasons, long-term trends became evident and indicated relatively stable nest counts for green, olive ridley and hawksbill turtles. Leatherback nests increased to over 5,000 for three seasons, followed by a decline to approximately 3000 in the 2003/2004 season, but all these totals are considerably higher than those recorded in the 1990's (approximately 1000 per season). Although egg-poaching is relatively rare, commercial hunting of the nesting turtles is more common, with "official" permits issued each year for the capture of 250 green turtles.

RESULTS OF FOUR YEARS OF PROTECTION UNDER THE CONSERVATION PROGRAM OF THE UNIVERSITY OF GUADALAJARA IN TWO BEACHES OF JALISCO, MÉXICO: "LA GLORIA" Y "EL COCO"

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For almost 20 years, the University of Guadalajara via the (DEDSZC/CUCSUR), has obtained hopeful results from sea turtle protection activities in Jalisco, México. There are four species that arrive at this state, but the most abundant is the *Lepidochelys olivacea*. In 2003 important nesting of *Dermochelys coriacea* at La Gloria and El Coco beaches was observed. During the 2000-2003 seasons the nesting along the protected area of Camp "La Gloria" increased. Monthly results are shown. Also presented are the results of the camp "El ¨Coco", where activities were initiated in 2000, also coordinated by the University and the social group "Tortuga Azul A.C. " and adjacent Municipalities.

The total results for the 2000 season include 1,201 nests collected with 111,857 eggs protected for an average of 97 eggs per nest and 82,836 hatchlings released. During 2001 there were 1,425 nests with 127,200 eggs for an average of 89 eggs per nest and 99,320 hatchlings released. In 2002, there were 1,202 protected nests with 113,502 eggs and an average of 95.89 eggs per nest and 86,775 hatchlings released. The total of this season 2003 is 1,726 nests protected with 175,006 eggs, these nests presented an average of 94.7 eggs per nest and 135,803 hatchlings were released. It is important to mention that during 2003 there were 45 *Dermochelys coriacea* nests of which 14 were collected.

In the sea turtle camp "El Coco" the nests were protected in the seasons 2001, 2002 and 2003. The most nests were protected during 2003 (297), followed by 2001 (200 nests) and 2002 (197 nests). The number of incubated eggs/year follows the same trend: 2003 (28,512 eggs), 2001 (19,159 eggs), and 2002 (18,943 eggs). With regard to the hatchlings released, the 2003 season had the most (20,116), followed by the years 2001 and 2002 (14,280 and 13,487 respectively). It is important to note that in the season 2003, in the beach El Coco, there were 60 tracks of *Dermochelys coriacea* of which only 16 nests were protected.

IS THE WAVELENGTH OF CITY GLOW GETTING SHORTER? PARKS WITH NO BEACHFRONT LIGHTS RECORD ADULT AVERSION AND HATCHLING DISORIENTATIONS IN 2004

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During the 2004 nesting season in Boca Raton, female sea turtles avoided a City park area (South Beach Park) that contained no lighting. This park area has a low profile dune that appears flat when viewed from the ocean looking west whereas other City Parks have a high dune profile and tall Australian pine trees. Sea turtle crawls in the South Beach Park area decreased from a ten-year average of 0.074 crawls per foot (C/F) to an all time low of 0.022 C/F in 2004. When Mobile GIS pinpointed crawl locations, sea turtle crawls were visualized as predominant in front of condominiums and City Parks with high dunes and/or Australian pine trees. The loss of sea turtle nesting activity in South Beach Park can only be explained by the presence of City Glow, as that is the only light source in the area. Because the area was renourished in 2004 it is important to demonstrate that city glow, not renourishment is responsible for the lack of nesting. Although not measured, the intensity of the city glow does not appear to have increased based on photography taken during lighting surveys. In the past year, the City has installed metal halide street lighting fixtures and many businesses and residences are replacing high pressure sodium fixtures with metal halide or halogen fixtures. The increased use of these "daylight" fixtures may be actually reducing the wavelength of the city glow so the glow is becoming more visible to nesting female sea turtles and their hatchlings. City glow disorientations now appear to have more impact on sea turtle nesting and hatchling disorientations in Boca Raton. Sea turtle nesting data was collected according to the Florida Fish and Wildlife Conservation Commission's (FWC) Guidelines. Each crawl in the Boca Raton City limits was recorded using an HP Compaq Ipaq 3850 hand-held computer fitted with a Compactflash GPS receiver. The hand-held computer utilized ArcPad 6.0.3 Mobile GIS software (ESRI. Inc., WWW.ESRI.com). Sea turtle crawl data was evaluated with ArcView 3.2 and ArcGis 9.0 software (ESRI, Inc.) on desktop computers. Beach photography was standardized by using Kodak Gold 400 print film in a 35 mm camera fitted with a 24 mm f/2.8 lens. The film was exposed for 1 second at f/2.8.

The density in 2003 is almost identical to the 10-year average for Zone F (0.074 crawls/ft) whereas in 2004 the density is nearly 4 times less (0.02 crawls/ft). In 2004 Zone E had a crawl density of 0.045 crawls/ft, which is twice the density in an area that was not renourished. When the zone is broken down into South Beach Park (E South) and Red Reef Park (E North) it can be seen that E South has a similar crawl density as Zone F (0.026 c/ft) whereas E North has nearly three times more crawls (0.074 c/ft). The dune line in Red Reef Park is higher and more uneven than that of South Beach Park. In 2003 there is little difference in the crawl densities of Zone E.

In the past, light from city glow has been responsible for hatchling disorientations on rainy nights when the clouds are low and reflect the glow onto the beach. In

2004 city glow was reported to be involved with 42 of 56 hatchling disorientation events (nests) whereas 2003 reported sky glow in 24 of 54 reports. Significantly, in 2004, there were 10 hatchling disorientation reports in City parks, including for the first time, disorientations reported in Red Reef Park on rainless nights. The loss of nesting activity in South Beach Park is likely due to its lower dune capped with seagrapes resulting in what may appear to be a bright horizon to a near-sighted female at the water's edge. Red Reef Park has a very high dune (10-14 m) capped with Australian pines and Spanish River Park has a dense stand of Australian pines throughout the park. Renourishment causes increased false crawl to nest ratios, which is why total crawls were reported. Zone G and area of condominiums just south of South Beach Park had similar numbers of crawls before renourishment as it did after but there were fewer nests following renourishment. Renourishment is not responsible for the loss of activity in South Beach Park. Boca Raton has stricter lighting guidelines than most municipalities, which is why nighttime photos of Florida show Boca as visibly dimmer. In order to preserve nesting in urban areas it may be necessary to move beyond the beach and enact a citywide ordinance to reduce sky glow. A good Model Ordinance to reduce city glow is available on the International Dark Sky Association' website (www.darksky.org).

EFFECT OF AUSTRALIAN PINE REMOVAL ON LOGGERHEAD TURTLE NESTING PATTERNS AND INCUBATION TEMPERATURES ON KEEWAYDIN ISLAND, FLORIDA

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Australian pines, *Casuarina equisetifolia*, were introduced to Florida in the early 1900's for protection against strong winds and storms. Ironically, these trees are prone to falling down due to their shallow root system, thus limiting beach access to nesting sea turtles. The pines also invade disturbed areas and out-compete native vegetation. In March 1998, Rookery Bay National Estuarine Research Reserve, managed by Florida Department of Environmental Protection, removed standing and fallen Australian pines from Keewaydin Island, Collier County, Florida in effort to restore native biodiversity and reclaim sea turtle nesting beach habitat. The present study used Geographic Information System (GIS) to examine loggerhead, *Caretta caretta*, nesting patterns and determine whether turtles were using areas of the beach that were previously inaccessible due to the fallen pines. Beginning in 1998, Global Positioning System (GPS) locations were recorded for each nest and false crawl. The project would be considered successful in restoring nesting beach habitat, if sea turtles were using natural areas and areas where the fallen pines were removed in equal proportions. During 2001, 2002 and 2004, temperature data loggers were deployed in sea turtle nests to determine whether the shade from the pines altered hatchling sex ratios. Control loggers were also deployed along the dune throughout the nesting season to examine incubation temperatures in areas where Australian pines were present, Australian pines removed and native vegetation. Histology was conducted on dead hatchlings found in excavated nests to verify predicted sex ratios.

BASE DATA ON NESTING SEA TURTLE POPULATIONS ON THE OSA PENINSULA

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Since 2002 SITMAR has been studying and protecting the population of nesting sea turtles on the eight kilometers of Carate, Rio Oro and Pejeperro beaches in the Osa Peninsula, Costa Rica. We have collected a base of scientific data on the marine turtles that we have encountered on our beach patrols and in our hatchery. The most common nester is *Lepidochelys olivacea* with more than a thousand nests per season, followed by *Chelonia mydas agassizii* with approximately 20 nests per season and the seldom seen *Dermochelys coriacea* seen in 2003/2004 with fourteen nests from two individuals. We have collected data on nesting frequency around the Osa Peninsula; the beaches here are some of the most productive sea turtle nesting habitats on the Pacific coast of Costa Rica. We have begun to establish ranges and averages of lengths and widths for nesting turtles and hatchlings. We have ascertained the best time to encounter nesting turtles and studied the correlation of lunar and tidal cycles on nesting frequencies. Our tagging program for long-term population studies had the first recaptures in 2004 from turtles tagged in 2002. We have recorded time of incubation, temperatures and hatching success rates; and we have released more than 32,000 hatchlings. After three years, we have been able to eliminate all of the feral dogs on the beach therefore lowering non-native depredation rates. This data collection and analysis is to enrich the base of information about these turtles and the nesting habitats along the Osa Peninsula.

AN ASSESSMENT OF LEATHERBACK NESTING IN GABON BY AERIAL SURVEY

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The Gabonese coastline extends along 850 km of mostly wide, gently sloping beaches. Four species of sea turtles are known to nest here, but the leatherback (*Dermochelys coriacea*) is by far the most abundant. Since 1998, our organisation (Aventures Sans Frontieres) has been monitoring some of the most significant nesting sites, including Pongara, Iguela and Mayumba (in the north, center and south, respectively). The Mayumba leatherback nesting population is considered among the largest in the world. However, there are extensive stretches of coastline where access is difficult and where nesting records have only been anecdotal. Thus, aerial surveys were selected as the most appropriate methodology to obtain a snapshot of nesting density and distribution along the Gabonese coastline. We surveyed from Pointe Pongara (near the capital Libreville) to the Congo border during three flights in January and February 2003. These were timed to coincide with peak nesting season and with the spring tides and were carried out at dawn, filming the beach from a light aircraft. We counted only fresh crawls from the previous night, grouping nesting and non-nesting emergences. Our work is the first of its kind published in Gabon since a single overflight carried out in 1988 and will surely play a major role in setting conservation priorities for this endangered species.

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NESTING STATUS AND NEST PREDATION ON OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) AND GREEN TURTLE (*CHELONIA MYDAS*) ALONG JAMNAGAR AND JUNAGADH COASTS OF GUJARAT STATE- INDIA

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Nesting status and predation pressure were studied along two regions of the coastline in the state of Gujarat, India in 2004. In total 14 beaches; seven each in Jamnagar coast (JAMC) to the northwest and Junagadh coasts (JUNC) to the southwest were surveyed once a month for five months. JAMC was surveyed from March – July while JUNC from February- June. A total of 70 surveys were conducted on foot during morning or evening hours. Information on active nests and predation by animals and humans were recorded.

Of the 743 recorded nests, 52.76 % were at JUNC (392 nests) while JAMC had 47.24% (351 nests). Species specific nesting status showed that green turtles dominated on both coasts and nested more in JUNC (69.13%) than in JANC (58.12%) with overall 63.93%. The estimated overall density was 2.34 nests/km, with the highest density in JUNC (2.70 nests/km) and species specific density was in favour of green turtle (JAMC -1.18, JUNC - 1.87 and overall 1.5 nests /km).

In JAMC, species specific variation in nesting density for olive ridley and green turtles was 0.32 to 1.25 and 0.40 to 1.66 nests/km respectively. In JUNC, olive ridley density ranged from 0.13 to 2.16 while green turtle was 0.77 to 3.20 nests/km. Out of 743 nests recorded, 46.43% (345) were predated (48.15% JAMC; 44.90% JUNC). Animal predation (27.46%) was found to be more abundant in the study area than human predation (18.98%). Overall olive ridley nests were under higher predation pressures (53.53%) than green turtle nests (42.53%). The olive ridley nests had higher predation from animals (43.33%) than the green nests (21.89%), probably due to their more shallow depth. Humans appeared to predate equally on both species (olive 19.09% and green 20.64%). Since the frequency of the survey was very low the estimated nesting population was minimal. Both species do sporadic nesting out of their nesting season. One option to tackle the high animal predation is by using a scientific hatchery, while public awareness can minimize the human predation.

SEA TURTLES AND LIGHTS ON FLORIDA'S NESTING BEACHES

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Each year, loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*) and green turtles (*Chelonia mydas*) return to nest on Florida's sandy beaches amid a myriad of tourists, snowbirds, beach paraphernalia and lights. During regular nest survey work on these beaches, volunteers document dis- and misorientation events after adult or hatchling sea turtles orient toward beachfront lights and not the water. Volunteers record the date, the number of individual animals involved, any potential light sources and the ultimate fate of each animal, if known. Since 1987, approximately 8,700 disorientation events have been reported from beaches on Florida's Atlantic coast, the Gulf of México and the Panhandle. The majority of events were attributed to taller parking lot or roadway lights. Lights from the interior of buildings also contributed to a number of disorientation events; and sky glow from urban areas was also a factor, although less so. Staff in the Florida Fish and Wildlife Conservation Commission (FWC) work with permitted volunteers on Florida's beaches and local governments to reduce documented lighting impacts where possible. To reduce the number of turtles lost immediately, volunteers must work directly with the nests, installing restraining cages over the nest and "sitting" by nests throughout the night, or placing opaque barriers on the landward side of the nest. To achieve a more effective, long term solution, these same individuals and others will also work with local governments on the adoption and implementation of ordinances to control beach front lighting.

EFFECTS OF BEACH NOURISHMENT ON LOGGERHEAD NEST SITE SELECTION AND REPRODUCTIVE SUCCESS

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Sarasota County represents the largest concentration of nesting turtles on the west coast of Florida with nesting densities of 40-70 per km. Mote Marine Laboratory has monitored nesting sea turtles along Sarasota County beaches since 1982. The present study made a retrospective analysis of this historical monitoring data to evaluate the effects of beach nourishment in comparisons of non-nourished and repeatedly nourished beaches. The dataset consisted of 14 years of monitoring data (1990-2003) for Longboat Key (treatment- five separate nourishments) and Siesta Key (control-no nourishments). The dataset compiled records for 8429 loggerhead emergences (4573 nests, 3856 false crawls) for 17.6 km of beach over the course of five nourishment projects on Longboat Key (1993, 1997, 1998, 2001, 2003). We compiled dependent variables for nesting success (#nests/ (#nests + false crawls)), nesting frequency per km and hatching success (#hatched/#eggs) for the two beaches. To avoid spatial pseudo-replication, we also compared control and impact sites on Longboat Key. The analysis will later be extended to include other replicate sites in a before-after control impact (BACI) design. This preliminary project reports the first stage of a larger scale research project.

Findings-(1) Four of the five nourished stretches of Longboat Key had significant drops in nesting success in the post-nourishment year. The 1993, 1998, 2001 and 2003 nourishment projects were followed by -30%, -6%, -30% and -27% drops in nesting frequency, respectively. The 1997 nourishment project marked a +22% increase in nesting frequency to the preceding year. The projects in 1993, 1998 and 2003 received sand from a tidal inlet, whereas the 1997 and 2001 projects took fill from offshore. The effect of beach nourishment on nesting success was less dramatic in the 2nd year following nourishment. Four of five nourishment projects for the 2nd year post-nourishment had an improved nesting success, with respect to the 1st year post nourishment. (2) Over all years, nourished beaches in the 1st year post-nourishment were significantly lower in mean nesting success. By the 2nd year of post-nourishment monitoring though, most beaches still hosted slightly lower (though not significantly so) nesting in comparison to non-nourished or 1st year post-nourished beaches. There was substantially more variability in nesting success (compare the ranges) for 1st and 2nd year post-nourished beaches than for pre-nourished or non-nourished beaches. (3) Beach nourishment had no significant effect on the hatching success. The mean hatching success was highest on 2nd year post-nourishment beaches and 1st year post-nourished beaches, respectively. This may be an influence of higher elevation on a nourished beach, but other factors may contribute as well. However, there was substantial variation for individual nests as well as among the beaches. The highest and lowest mean nesting successes is less than 4%. (4) Incubation temperatures at nest depth from representative beach sections, measured by I-button data loggers, suggest that nourished beaches with darker sediments (Longboat Key) had higher incubation temperatures and greater daily thermal variance than on a non-nourished beach (Siesta Key). We intend to repeat the thermal monitoring to better evaluate the potential effects on hatchling sex ratio from differing incubation regimes at nourished and non-nourished beaches.

RESULTS AND EVALUATION OF A LEATHERBACK HATCHERY EMPLACED IN THE RÍO ESCALANTE-CHACOCENTE WILDLIFE REFUGE, PACIFIC COAST OF NICARAGUA (2002/2004)

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Between the end of September and the beginning of April, Fauna & Flora International with the support of Chacocente de Acayo S.A. and NOAA, conducted conservation and monitoring actions on the near extinct Pacific leatherback, *Dermochelys coriacea*. The work area encompassed the northern coast of the Rio Escalante – Chacocente Wildlife Refuge. This area is one of the most important nesting sites for this species in Nicaragua. Due to the high frequency of poaching, nests from three different sea turtle species were relocated to 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 2002/03 and 2003/04 seasons a total of 160 sea turtle nests were protected (leatherback: 98, black turtle: 19 and olive ridley: 43). The average emergence rates (live hatchling out the nest/yolked eggs) were 22.2 % for leatherback, 75% for black turtle and 64.7 % for olive ridley. A monthly decline in the emergence rate of nests was observed. Additionally, nests under shade showed higher emergence success that the nests relocated under the sun. This presentation presents the results obtained in the hatchery during both seasons and analyzes some factors that could have influenced the emergence success rates observed.

CREATION OF A DATA BASE IN THE PROJECT MONITORING AND CONSERVATION OF GREEN TURTLE (*CHELONIA MYDAS*) POPULATION IN AVES ISLAND WILDLIFE REFUGE, VENEZUELA

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The project Monitoring and Conservation of the Green Turtle (*Chelonia mydas*) Population in Aves Island Wildlife Refuge (the most important nesting area in Venezuela) is under the responsibility of the Direction of Natural Protected Areas, which is part of the Ministry of Environment and Natural Resources. This project is the oldest sea turtle monitoring project in the country. Over the years this project has generated a large quantity of information which frequently is difficult to manage and analyze. Thus the urgent need to develop a database.

In 2004 with the collaboration of an assistant student of informatics, it was possible to start the database design. We chose to work with the Visual Basic program (version 6.0). Tag series, date, time, body measures, location during the tagging and relevant details about each animal were included in the database. All data from 1972 to the present was included. After three months of work the database had approximately 5500 data points and was ready to operate. The first screen shows the identification of the project and the main menu. On the following screens the user can introduce new data, including recaptures, consult data registered and modify or eliminate data.

During its initial use it was possible to quickly find information on registered tags and to complete previous analysis. The database is a very easy tool to use. Its construction was part of the objectives previously established for this project. It is necessary to make an effort at the national level so that each project can manage their information with modern tools like this.

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HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) AND GREEN TURTLE (*CHELONIA MYDAS*) NESTING ACTIVITY DURING THREE CONSECUTIVE NESTING SEASONS (2002-2004) AT EL CUYO BEACH, YUCATAN, MÉXICO

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The nesting populations of hawksbill turtles (*Eretmochelys imbricata*) along the Yucatan Peninsula are very important worldwide. Within the Biosphere Reserve of Rio Lagartos, at El Cuyo beach, the nesting tendency of both hawksbill and green turtle (*Chelonia mydas*) was evaluated during three consecutive nesting seasons (2002-2004). Night patrols from mid-April to September allowed the tagging of females and the collection of data on the number of nests, nest location and size of nesting turtles. The hawksbill turtles' average Standard Carapace Curve Length (SCCL) in 2003 and 2004 increased in relation to 2002. There was no difference in the SCCL of green turtles between even years, being smaller in 2003. Hawksbill and green turtles on this beach nested 2 and 2.4 times per season respectively. Both species also showed high nest site fidelity and the average distance between nests was 2.96 and 1.8 km respectively. Nest density maps were created and differences between species and seasons were found. The number of hawksbill turtle nests decreased along seasons, being approximately 40% lower in 2004 than in 2002. For green turtles the number of nests in 2004 was 50% lower than in 2002. Several hypotheses are advanced to explain this decrease in nesting events: The Isidore hurricane (2002) may have destroyed feeding grounds for both species; low hatchling rates 15-20 years ago may have caused low recruitment; in 2004, seismological experiments were conducted near mating areas and this could have caused disorientation and prevention of mating.

A GREEN SEA TURTLE WITH LIVING TAG NESTS IN X'CACEL, QUINTANA ROO, MÉXICO

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In 1990 the living tag technique was used in X'cacel beach, Quintana Roo, México. During the nesting season (May-October), the main nesting sites were patrolled resulting in a 90% tagging efficiency. In 2004 the first nesting event of a green turtle with a living tag was reported. The animal measured 98.7cm curved carapace length (CCL). The living tag was located on the third right costal scute corresponding with 1991 season and was released a year after hatching. The animal was tagged with the plate J3630 and measured 28cm CCL at the time of release. The nesting process and both tags were documented with photos. The finding, the living tag program and the nesting females' importance for the Sea Turtle Sanctuary X'cacel-X'cacelito are discussed.

PATHOLOGY, HEALTH AND REHABILITATION

MERCURY FLUCTUATION IN DIAMONDBACK TERRAPIN, *MALACLEMYS TERRAPIN*, COLLECTED IN CHARLESTON, SOUTH CAROLINA

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Mercury pollution is among the most significant anthropogenic threats to marine and freshwater ecosystems across the United States and around the world. The estuarine habitat, long life span and site fidelity of the diamondback terrapin, *Malaclemys terrapin*, may make this species susceptible to mercury bioaccumulation and a candidate for biomonitoring of mercury. In this study, we investigated the seasonal fluctuations of total mercury in the blood and scutes of terrapins collected in the Ashley River, Charleston Harbor, SC. Linear regressions between total mercury levels in blood and scutes were not significant in April (R^2 =0.11, p=0.24), but were significant during the months of June and August (R^2= 0.70 and 0.74 resp.).

REHABILITATION OF STRANDED SEA TURTLES IN PORTUGAL

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It is virtually impossible to run an oceanographic facility close to a coastline without receiving regular and urgent distress calls regarding stranded marine animals. Since it opened in 1991, Zoomarine, located in southern Portugal (Europe), began to physically respond to live strandings of marine species. The majority of the events were related to sea turtles mainly *Caretta caretta* and *Chelonia mydas*. Whenever possible, these specimens are rescued, rehabilitated and reintroduced back to the Atlantic Ocean, after undergoing rehabilitation periods which vary between a few weeks to several months. Zoomarine and ICN (Institute for the Preservation of Nature – Portuguese authorities) celebrated an Agreement of Understanding which establishes our park as the only official rehabilitation centre for sea turtles in the Portuguese continental territory. Under such Agreement, Zoomarine opened in 2002, Porto d'Abrigo, our Rehabilitation Centre for Marine Species. Zoomarine now has the facilities and trained staff exclusively dedicated to the rehabilitation of marine species (sea turtles and marine mammals).

MERCURY AND HEALTH IN LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)

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Mercury is a highly pervasive environmental pollutant that can cause neurotoxicity and behavioral impacts, reproductive and developmental abnormalities and immunotoxicity. Previously presented work demonstrated mercury accumulates in loggerheads in the southeastern U.S. but the toxicity of the reported levels is unclear. Those preliminary data showed negative correlations between blood mercury and lymphocyte proliferation ($p = 0.01$, $n = 11$), total white blood cell counts ($p = 0.02$, $n = 6$) and plasma sodium concentration ($p = 0.0003$, $n = 6$), prompting further research in this area. The current work will expand these datasets to a larger sample size ($n \sim 80$) using additional blood samples collected from loggerheads captured in the nearshore waters of South Carolina, Georgia and Florida. These data will be used to more thoroughly assess the relationships between mercury and immune function (lymphocyte proliferation, lysozyme production and white blood cell counts) and blood chemistry parameters. Laboratory exposure of peripheral blood leukocytes to methylmercury resulted in suppression of proliferative responses. Additionally, mercury concentrations in scute scrapings collected from debilitated loggerhead strandings will be compared to samples collected from stranded loggerheads suffering from acute boat strike injuries and apparently healthy live captures to determine if higher mercury burdens are associated with the chronically ill debilitated condition. Preliminary results from a one-way analysis of variance revealed no significant difference between scute mercury levels in apparently healthy turtles and debilitated turtles, but higher mercury levels in strandings with boat strike injuries ($p = 0.0002$).

SUCCESSFUL REHABILITATION OF A GREEN TURTLE WITH CATASTROPHIC CARAPACE DAMAGE

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A juvenile green sea turtle with severe carapace damage, broken rib heads and a torn lung was given a second chance for life through the relentless efforts of the Bermuda Aquarium rehabilitation team. The maintenance of an unsullied marine holding area with exposure to natural sunlight combined with dedicated long term tending to the debriding and cleansing of wounds are essential components to the successful rehabilitation of boat strike injuries in sea turtles. The use of a carbon fiber composite stabilizer attached and subsequently reattached with cyanoacrylate glue proved to be an effective mechanism in this recovery process.

THE SEATURTLE OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) STOCK DENSITY KEEPING IN CAPTIVITY AT THE CENTRO MEXICANO DE LA TORTUGA

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Aquaculture of sea turtles could be a good way of allowing the species to survive other than in the wild. No previous papers exist on the best manner to keep them in captivity, which is why it is necessary to understand the first steps in sea turtle aquaculture. How many can possibly be held in a specific water volume, what do they eat, how often must they eat, what kind of food do they need, etc. We kept neonatal olive ridleys until they reached an initial weight of 17.4 g. They were kept at four different stock densities (6, 8, 10 and 12 hatchlings per tank) with three tanks per treatment and were weighed weekly during the study. Chemical parameters were monitored (pH, oxygen and temperature daily; nitrates of the water every two weeks). The following water data were obtained: pH 8.26 ± 0.336 (n=937), Temperature 26.90 ± 1.33°C, dissolved oxygen averaged 3.10 ± 2.87 mg/l (range 0.5-9.95), nitrates 0.26 ± 0.075 and saltpeters 0.12 ± 0.018 mg/l. Results show that there was a greater growth based on the bio-mass corporal singular of 71.58 g in the tank with 6 hatchlings and the lowest individual growth was observed in the tanks with 10 with 59.39 g. The lowest growth of hatchlings was presented in the treatment with 12 turtles.

EMERGING CONTAMINANTS IN LOGGERHEAD AND KEMP'S RIDLEY SEA TURTLES FROM THE SOUTHEASTERN COAST OF THE U.S.

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Studies measuring organic contaminants in sea turtles have focused primarily on compounds that were banned in the U.S. decades ago, such as polychlorinated biphenyls (PCBs) and pesticides. Current-use compounds have recently been found at significant concentrations in wildlife and humans. Two classes of compounds of emerging interest are the perfluorinated compounds (PFCs), used as stain repellents and in fire-fighting foams and food packaging and the flame retardants, polybrominated diphenyl ethers (PBDEs). This study examined 12 PFCs in plasma of 73 loggerhead and 6 Kemp's ridley sea turtles. Juvenile turtles were captured in Core Sound, North Carolina (NC) and in offshore waters of South Carolina (SC), Georgia (GA) and Florida (FL). Perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA) were the predominant PFCs detected with respective mean (standard deviation) concentrations of

11.0 (17.2) ng/mL and 3.20 (1.49) ng/mL for loggerhead turtles and 39.4 (17.1) ng/mL and 3.57 (0.55) ng/mL for Kemp's ridley turtles. PFOS concentrations were comparable to PFOS concentrations measured in human serum, but they were 3 to 10 times higher than the concentration of ÓPCBs typically measured in the blood of these turtles. Gender did not influence the ÓPFC concentrations in loggerhead turtles.

Loggerhead turtles captured from inshore waters of NC had significantly higher ÓPFCs concentrations than those captured in offshore waters of SC, GA and FL. Using only the turtles captured in the offshore project, backward stepwise regression models showed that the Kemp's ridley turtles had significantly higher ÓPFC concentrations than the loggerhead turtles; straight carapace length (proxy for age) was positively related to ÓPFC concentrations; and turtles captured at higher latitudes had greater ÓPFC concentrations.

These findings suggest that bio-accumulation of PFCs in turtles may be influenced by trophic level, age and capture location. Preliminary studies show that PBDEs are also present in loggerhead turtle plasma. Future studies will examine temporal changes in PBDE concentrations using archived samples.

BASELINE HEALTH ASSESSMENT OF IN-WATER JUVENILE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN NORTH CAROLINA

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In an ongoing project, the health status of juvenile loggerhead sea turtles passively captured in pound nets in Core Sound, North Carolina is being analyzed using hematologic, biochemical, parasitologic and toxicologic parameters. Each turtle undergoes a general physical examination with digital photographs, tagging, morphometrics including body depth and skin biopsy for genetic analysis. Blood samples for a complete blood count and biochemistry are also taken. A body weight, laparoscopy for gender determination and cloacal and external lesion cultures for microbiology including antimicrobial sensitivity are obtained from a subset of turtles. When available, fecal samples are obtained for parasitology. Scute scrapings for heavy metal analysis and subcutaneous fat for organochlorine assays are being collected for other on-going projects. To date, 50 loggerheads have been sampled with two turtles sampled twice and one sampled three times. Hematology and biochemical data are similar to that seen in juvenile loggerheads sampled within Pamlico Sound during the fall of 1997 and summer of 2000. Associations between hematologic and biochemical parameters are stronger with body depth than with weight, SCL or Fulton's body condition index indicating the potential usefulness of this measurement. Cloacal cultures have included 142 isolates of 26 different species, of which 45% exhibit endogenous antimicrobial resistance to 3 or more antimicrobials tested.

HEMATOLOGY AND PLASMA CHEMISTRY REFERENCE VALUES FROM FREE-RANGING LOGGERHEAD SEA TURTLES ALONG SOUTHEASTERN US COAST

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Whole blood and plasma samples were collected from 172 loggerhead sea turtles (*Caretta caretta*) during an in-water study by the South Carolina Department of Natural Resources (SCDNR) off the coasts of South Carolina, Georgia and northern Florida in years 2000-2003. Upon capture the animals were weighed, tagged and photographed. Ten corresponding measurements for morphometric analysis were obtained as well as blood samples for genetic and testosterone analysis. In an effort to develop blood and plasma chemistry reference ranges in wild loggerheads, whole blood and plasma were submitted to Antech Diagnostic Lab and analyzed for 26 blood parameters; mean, median as well as standard deviation values are presented. Selected relevant parameters in "healthy" animals are compared with those of clinically ill animals captured in the same SCDNR project.

ADMINISTRATION OF INTRACOELOMIC FLUIDS AS AN ANCILLARY TREATMENT OF FLOATER SYNDROME IN LOGGERHEAD SEA TURTLES

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Loggerhead sea turtles control their diving behavior by a combination of flipper propulsion, lung air volume and intracoelomic fluid buffering. The floater syndrome is characterized by a loss of neutral buoyancy and depth control. Animals with this syndrome typically become fatigued and then stranded by tidal and wave actions that they cannot escape by diving. Proposed etiologies include gut air volume disorders, ruptured lung alveoli and resultant intracoelomic air disorders, decreased body mass to lung volume ratio and cold-stunning. Three loggerhead sea turtles were treated for their persistent floating condition by the intracoelomic administration of large volumes of sterile fluids after intracoelomic endoscopic exam. An equal mixture of lactated ringer's and isotonic saline solution with amikacin (5mg/kg) displaced all gas present in the coelom. Pressure was applied to the plastron during closure of the endoscopy entry (and fluid administration) site to evacuate all gas. Maximal removal of gas was confirmed by observing a small amount of fluid ejected from the incision site just before final surgical closure was achieved. All three turtles were released back into the environment. In all three cases, correction of the primary etiology was required before administration of intracoelomic fluids could correct the floating disorder. It is felt that without the addition of the fluids, full recoveries and releases would have been significantly delayed. Ancillary treatment with intracoelomic fluids could play a significant role in a standardized treatment plan for "floater syndrome" in all sea turtles with this frustrating syndrome.

THE HOT ZONE EXPANDS: RECENT INCREASES IN THE DOCUMENTED DISTRIBUTION OF FIBROPAPILLOMATOSIS IN FLORIDA

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The Florida Sea Turtle Stranding and Salvage Network (FLSTSSN) has been collecting data on dead, sick, or injured (i.e., stranded) sea turtles in Florida since 1980. The number of FLSTSSN observers and number of coastal counties monitored increased during the early to mid 1980s, but both have remained relatively consistent since the late 1980s. From 1980-2003, observers documented almost 23,000 stranded sea turtles, of which 5,677 were green turtles (*Chelonia mydas*). The activities of the FLSTSSN during this time period were coordinated by the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI). FLSTSSN observers documented stranded sea turtles using a standardized data collection methodology and FWRI staff provided periodic guidance and training to ensure that data were consistently collected according to this methodology and therefore were accurate. All FLSTSSN data reporting forms were reviewed and edited by FWRI staff. Photographs were often submitted and used to verify the presence or absence of fibropapilloma-like tumors. A green turtle was determined to have fibropapillomatosis (FP) when at least one verrucose tumor was present. From 1980 to 1999, FP was documented only in stranded green turtles that were found in southeastern and southwestern Florida (south of 29° latitude). However, during 2000-2003, 14 stranded green turtles with FP were found in northeastern (Nassau, Flagler and Volusia counties) and northwestern (Gulf, Franklin and Wakulla counties) Florida (all north of 29° latitude), where FP had not been previously documented. These recent discoveries suggest that FP may now be affecting green turtle populations throughout Florida.

THE SOUTH CAROLINA AQUARIUM REHABILITATION PROGRAM

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Before it opened its doors in 2000, the South Carolina Aquarium (SCA) was contacted to care for stranded sea turtles. Strandings are on the rise on the Southeast coast and there exists a strong regional need for a stranding center. As conservation and education is central to the mission of the SCA, a sea turtle stranding program is a natural fit. Of the 20 strandings to date, 50% of the illnesses have come from unknown causes, 28% have had major trauma and 22% were cold-stunned. Standardized treatments include taking blood for complete blood counts, chemistries, blood cultures and sensitivities, performing radiographs, analyzing fecal samples and removing ectoparasites. Depending on etiology, the animal may be given freshwater baths, fluid therapy, iron supplements, antibiotics and parasite treatments. Recovered turtles are released off the coast of South Carolina.

The presentation will cover a case study of a stranded turtle, construction of a hospital area with pools and life support systems and setting up a medical laboratory. Challenges faced in building a rehabilitation program include operating costs, fundraising, staff time and space requirements. Partners in the SCA Rehabilitation Program are: South Carolina Department of Natural Resources; University of Charleston, Department of Marine Biology; National Institute of Standards and Technology, Hollings Marine Laboratory; Medical University of South Carolina (MUSC), Marine Biomedicine and Environmental Science Center; other turtle rehabilitation facilities; Roper University;

University of Georgia, College of Veterinarian Medicine; University of North Carolina, College of Veterinarian Medicine and South Carolina Barrier Island Turtle Patrol groups.

HISTOPATHOLOGICAL FINDINGS IN OLIVE RIDLEY SEA TURTLES IN OSTIONAL AND NANCITE BEACHES IN THE PACIFIC COAST OF COSTA RICA

Carlos Mario Orrego Vasquez

Refugio Nacional de Vida Silvestre Ostional, Área de Conservación Tempisque, Ministerio del Ambiente y Energía, Costa Rica

The purpose of this study was to study the natural and anthropogenic causes of death of sea turtles along the Pacific coast of Costa Rica. We performed necropsies on sea turtles found stranded on Ostional and Nancite beaches. Macroscopic and histopathological findings indicated the potential mortality causes, which can help to elaborate protocols as diagnostic guides to find the cause of death. The fieldwork was carried out on Nancite and Ostional beaches, located along the north Pacific coast of Costa Rica, from August, 2003 to January, 2004. At Nancite there was a resident volunteer who was previously trained to follow a necropsy protocol. In Ostional there was a trained assistant plus a main investigator who constantly patrolled the beach. The carcasses postmortem state/condition was categorized according to Wolke and George (1981) and Work (2000). Only those dead sea turtles in good post-mortem condition with little autolysis were sampled for histopathology evaluation. A total of 40 dead turtles were found (Nancite 8; Ostional 32). However, only 6 were in sufficiently good postmortem condition to warrant a necropsy and histopathological analyses (Ostional 2; Nancite 4). The remaining 34 dead turtles were too decomposed to be analyzed. The macroscopic findings in 2 dead turtles indicated the potential mortality by natural predators (crocodiles) and by anthropogenic activities (hooks incrusted on their mouths).

INJURIES OBSERVED IN NESTING FEMALES OF LOGGERHEAD TURTLES (*CARETTA CARETTA*, L.1758) ON BOA VISTA ISLAND (REPUBLIC OF CAPE VERDE, WESTERN AFRICA)

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Different kinds of physical anomalies are frequently observed in any sea turtle breeding population. Nesting beaches are an excellent place to study the injuries and defects that occur in adult females. The archipelago of Cape Verde is situated about 500 km of Senegal, West Africa. Boavista is the eastern most island and may constitute the most important nesting area for the loggerhead turtle in the archipelago. The studies conducted from 1998 to 2004 indicate that Cape Verde might account for one of the most important loggerheads populations in the eastern Atlantic. The nesting females in Boavista were surveyed during the 2004 season, in order to (1) know the health status of the population (2) determine the effects of physical anomalies on nesting behaviour and (3) determine the possible origin of the injuries observed. A random survey of this nesting population was carried out to search for the cause of different lesions or injuries on the carapace and flippers and to check for the presence of fibropapilloma. A sample of 688 different turtles were included in the analysis. About 34.5% of the turtles surveyed showed some kind of external lesion, like fractures in carapace, tears, partial or total amputations, deformities, injuries and others. This value could increase approximately 20% if tears caused by tag loss in the trailing edge of both fore flippers were also included. We may conclude that lesions were, in general, light and occurred more frequently in the flippers. With respect to the nesting success, we observed that the occurrence of determinated lesions could reduce the nesting success. Related to the natural or anthropogenic origin of the lesions, it is important to remark that none of these turtles showed clear evidence of either damages caused by interactions with fisheries or boat traffic. Interactions with the environment and predators may also inflict marine turtles with a different set of lesions. We have observed that 23% of our injured turtles showed signs of shark attack. It is interesting to confirm that the nesting colony of *Caretta caretta* in Boavista have not shown fibropapilloma-like lesions.

THE ASSESSMENT AND TREATMENT OF OPHTHALMIC ABNORMALITIES IN STRANDED SEA TURTLES

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The Virginia Aquarium Stranding Program has been involved with long term sea turtle rehabilitation since 1999. This report focuses on six sea turtles (1 Kemp's ridley and 5 loggerheads) that presented with ophthalmic abnormalities ranging from mild to severe. We will discuss the management of these cases that demonstrate the variability of ophthalmic abnormalities and the successful treatments we employed. Three of the cases, which involved a corneal ulceration and two corneal perforations, were deemed releasable following non-invasive treatments. A fourth case, that presented with bilateral granulomatous conjunctivitis of parasitic origin, is currently undergoing treatment and will likely be releasable. The case of corneal ulceration resolved rapidly with topical medications. Treatment of the corneal perforations included topical medications accompanied by medicated baths, systemic anti-fungal agents and antibiotics. The case of granulomatous conjunctivitis is presently being treated with topical and systemic antibiotics. Two severe cases, a traumatically induced ventral deviation of an eye and skull fracture and a case of bilateral cataracts, required surgical intervention. The trauma case required surgical remodeling to streamline the skull profile. Post surgery, the turtle exhibited normal foraging behavior and normal vision in the deviated eye, precluding the need for ophthalmic surgery. In a case of functional blindness due to bilateral cataracts, cataract extraction by phacoemulsification was performed. This surgery restored vision and resulted in a releasable turtle. These case studies demonstrate the importance of thorough ophthalmic examinations for live stranded sea turtles.

METAL CONCENTRATIONS IN LOGGERHEAD SEA TURTLE EGGS FROM THE FLORIDA GULF AND ATLANTIC COASTS

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The loggerhead sea turtle (*Caretta caretta*) is the most prevalent sea turtle species to nest on Florida's beaches. Egg yolks collected in 2003 and 2004 from nests at St. George Island in Franklin County, on the Gulf Coast of northwest Florida and in 2003 Flagler County on the Atlantic Coast of northeast Florida were analyzed for Al, Cr, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Mn, Cd, Cs, Ba, Pb and Hg, using ICP-MS batch metal analysis. Although there was great variation between samples, the mean metal concentrations were greater in the last two sections, indicating the first eggs lain. The Franklin County site had previously been sampled in

1992 by Alam and Brim (2000) and their data suggest a 55% and a 42% increase in Hg and Pb respectively. For the Inter-site comparison all of the 17 metals, except Ni and As, were significantly greater in Franklin County than Flagler County, based on samples located throughout four nests at each site. The intra-clutch variation suggests contaminate concentration might be influenced by laying order. The inter-site comparison suggests the difference in diet and/or feeding locations can create different metal exposure regimes for sea turtle populations in the Atlantic and Gulf of México.

LEAD CONCENTRATION IN BLOOD OF *CARETTA CARETTA* SAMPLED AT THE WWF SEATURTLE RESCUE CENTER OF LAMPEDUSA, SICILY (ITALY)

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Heavy metals are considered some of the most important toxic elements for marine organisms. In the present work we measured the concentration of lead in the blood of individual *Caretta caretta* hospitalized at the WWF Seaturtle Rescue Center in Lampedusa, Sicily (Italy). One cc of heparinized blood was collected from each animal and frozen at –20°C until analysis. The samples were then diluted in TRITON-X 0.05% and analysed by a Varian grafite furnace atomic absorption spectrophotometer for Pb determination. The animals were divided into three groups by carapace length, the only suitable parameter to calculate the age of sea turtles (group 1: 30-50 cm; group 2: 50-60 cm and group 3: over 60 cm). The following values (µg/g) were obtained (mean ± S.E.): group 1: 29.44 ± 2.44; group2: 32.69 ± 3.79 and group 3: 34.73 ± 3.05. These lead levels (30 ± 14.5 ppb) are two-fold higher than those detected in the blood of Texas and Louisiana Kemp's ridley sea turtles. This difference can be explained by the fact that the species studied and the areas where the two studies took place are very different. However these lead levels are lower than concentrations found in *C. caretta* tissues from the Mediterranean Sea and under the background level defined for reptiles at 100 ppb. Considering existing toxic thresholds for lead, there seems to be no concern about sea turtles health. Analysis of whole blood can be a safe method to monitor lead levels in live sea turtles, even though it may be a conservative estimate of this load when compared with potentially higher levels in other tissues.

POPULATION BIOLOGY

OLIVE RIDLEY NEST TEMPERATURES AND POPULATION DYNAMICS

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A simple, sustainable yet precise methodology has been adopted for monitoring turtle nest temperatures at the Hawaii hatchery on the Pacific Coast of Guatemala. Data have now been collected over two nesting seasons. Here natural nests are extremely rare because of the prevalence of egg poaching for commercial purposes. Our data identify shading and rainfall as critical factors that lower temperatures to the levels required for successful hatching. The data, surprisingly, are showing that natural beach nests are not generally viable due to excessive temperatures. This may be a natural situation, with nests only being viable during chance periods when there is sufficient precipitation, or anthropogenic influences may be playing a role (eg. climate change or modification of over-storey vegetation at the natural nest sites). Our studies are long-term and we hope to reveal more about the underlying causes. It may be that a local economy based on egg sales and turtle conservation can be mutually supportive through a programme of effective hatchery operation. A related observation that we are investigating is that the few prolific ‘arribada’ sites of the region (in México, Nicaragua, Costa Rica and Panama) appear to coincide exactly with the cordillera-gaps of the Central American isthmus, which allow penetration of Caribbean trade winds to the Pacific coast. It is possible that increased rainfall and cloud-cover, or decreased sea temperatures (resulting from upwelling caused by local offshore winds) are reducing nest temperatures in these areas and enhancing population viability.

NEST TEMPERATURES AND DEVELOPMENT DIFFERENCES BETWEEN CENTRAL AND PERIPHERAL EGGS OF *ERETMOCHELYS IMBRICATA*, IN EL CUYO, YUCATAN, MÉXICO

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For the last few years the nesting populations of *Eretmochelys imbricata* in the Yucatan Peninsula have been among the better preserved in the Caribbean. El Cuyo beach, in Yucatan, México, is located in the Ria Lagartos Biosphere Reserve and is one of the most important hawksbill nesting beaches in this area. The objective of the present study was to determine the average nest center temperatures in El Cuyo beach and to discover possible development differences between central and peripheral eggs. During the 2004 nesting season, 10 randomly selected nests were studied *in situ*. All but the peripheral eggs were painted with methylen blue and a tube was placed in the center of the clutch to allow temperature measurements with a penetration thermo hygrometer. After hatching, the studied nests were excavated and eggs counted and subsequently inserted into the following mutually exclusive categories: hatched, rotten, with or without apparent embryonic development (EWAED and EWNED, resp.) and hatching dead or alive (HD and HA). Most eggs were peripheral, with approximately a 3:1 ratio. The major differences observed between central and peripheral eggs were observed in EWAED and Rotten categories. The eggs in these categories were mostly central ones. On the second third of incubation, 6 nests always had inner temperature values above pivotal, while the average temperatures on the remaining 4 were just slightly higher. This suggests that a female biased population was originated in this beach. This has very important implications to the conservation of this species in the Caribbean.

TEMPORAL DISTRIBUTION OF HAWKSBILL NESTING IN THE EASTERN CARIBBEAN

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Low-density nesting, ephemeral tracks, cryptic nests and an extended nesting season make population assessment of hawksbill nesting populations problematic (Kerr et. al, 1999). Optimizing survey efforts, measured by survey frequency and/or duration to achieve monitoring goals is therefore essential. Our objective was to assess the potential of a shorter survey period to capture a significant proportion of females for use in nesting population trend analysis. We analyzed the daily encounter history of nesting hawksbills in tagging programs in Antigua and Guadeloupe in the eastern Caribbean to estimate the proportion of the annual nesters that would be detected by partial-season surveys of varying lengths. We chose partial-season surveys lasting 18, 21, 30 and 45 days. The histories are summed by survey start date for the length of the selected partial-season. The detection probability is thus the proportion of the year's nesters captured by the shorter survey. The probabilities are calculated for each survey year and then averaged over all seasons. This allowed us to estimate peak detection probabilities. Modeling the temporal distribution allows us to maximize survey effectiveness by providing an optimal sampling time frame to conduct partial-season surveys. For the Antiguan population, surveys greater than 30 days in August will capture more than 60% of the entire season's nesters. Peak detection probabilities in Guadeloupe are in late June and early July and capture up to 80% of the females during a 45-day survey. The precision of the surveys (indicated by lower CVs) improves as the partial-season sampling period increases. However, the gain in precision is relatively modest, with CVs decreasing from 0.15 (15%) for 18-day surveys to 0.09 (9%) for 45-day surveys. The precision of the estimates from partial-season surveys will determine how useful a sub-sampling method is for population trend analysis because statistical power is very sensitive to the precision of parameter estimates (Gerrodette, 1987). We hypothesize that the differences in peak nesting in Antigua and Guadeloupe might be artifacts of closed season fisheries regulations.

PRELIMINARY APPROACH TO THE HATCHLINGS SEX-RATIO OF A POPULATION OF *CARETTA CARETTA* OF BOA VISTA ISLAND, CAPE VERDE ARCHIPELAGO (WESTERN AFRICA) – AN UPDATE FOR 2004 SEASON

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A nesting population of loggerhead sea turtles *Caretta caretta* has recently been described for Boa Vista Island, Cape Verde Archipelago (Western Africa). Since 1998, three beaches have been monitored during the turtle breeding season by "Projecto Cabo Verde Natura 2000". The beaches monitored - Calheta, Ervatão and

Ponta Cosme - are located in the southeast coast of Boa Vista Island. Between 29th August and 30th September 2004 70 recently dead hatchlings were collected. Only hatchlings found dead due to natural causes were collected. Hatchlings were preserved in 10% formalin and necropsied in the laboratory. Duplicate gonads were withdrawn for histological sex assignment. This work provides an update of the first preliminary assessment of this population's sex-ratio done in 2003, using a larger sample size.

LEATHERBACKS IN SURINAME: AN UPDATE OF 6 YEARS OF PIT TAGGING IN A MAJOR LEATHERBACK ROOKERY

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Suriname and French Guiana support one of the largest leatherback nesting colonies worldwide. Whereas French Guiana leatherbacks have been intensively studied and tagged by various groups since 1970, until recently not much was known about those nesting in Suriname. Therefore, during the 1999-2004 nesting seasons, we collected data on nesting ecology and identified individual turtles that nested on the Surinam beaches Babunsanti (Galibi Nature Reserve), Samsambo, Kolukumbo and Matapica. In the Guianas, TROVAN ID100 PIT tags are injected in the muscle of the right shoulder during nightly beach patrols (5-6 hours around high tide). Scanning, with TROVAN LID500 PIT readers and tagging are done at all nesting stages. The main leatherback nesting beaches and spatio-temporal tagging effort varied among years.

We observed a total of 7,881 leatherback females, 6,500 of which we PIT tagged. The remaining 1,381 females had been previously PIT tagged in French Guiana or had unknown PIT codes. From 1999 to 2004, the proportion of newly tagged females decreased from 89.9% to 45.6%, whereas that of remigrants increased from 0% to 40.5%. The proportion of females of a non-Surinamese origin fluctuated between at 10.1% and 17.6%. Of the observed turtles of 1999-2002, 41%, 17%, 16% and 6% were seen again by 2004 respectively. Mean observed internesting period (OIP) was 9.5 days. Annual mean observed clutch frequency (OCF) ranged between 1.6 - 3.1 clutches; annual mean estimated clutch frequency (ECF) ranged between 4.1 - 4.9 clutches.

The PIT tagging data collected on the Surinam nesting beaches undoubtedly confirm the status of Suriname as a major leatherback rookery. Since there was incomplete beach coverage and nesting outside the survey area not all females were observed, therefore we estimated a minimum of 1,500-5,500 leatherbacks nesting annually in Suriname alone. With similar numbers of females nesting at French Guiana (Rivalan 2003) and given the other major Atlantic leatherback rookeries that are found at Trinidad, the Caribbean coast of Central America and Gabon, it can be assumed that the number of Atlantic leatherback females used for estimating the leatherback world population (Spotila 1996; IUCN Red List 2000) is much too low.

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SEA TURTLE TAGGING AND HEALTH ASSESSMENT STUDY IN THE MARYLAND PORTION OF THE CHESAPEAKE BAY

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The Chesapeake Bay has been identified as an important region to study sea turtle distribution, site fidelity, genetic origin, baseline health, sex and growth rates. In 2001, the Maryland Department of Natural Resources initiated a sea turtle tagging and health assessment study in the Maryland portion of the Chesapeake Bay. Through the cooperation of commercial watermen, data were obtained from sea turtles that were incidentally captured in pound nets, a type of passive, stationary fishing gear utilized in the Chesapeake Bay to catch finfish. Since 2001, 58 sea turtles (37 loggerheads, 20 Kemp's ridleys and 1 green) have been examined as part of this study. Recaptures occurred from May to October, with the majority in June (n=29) and July (n=19). The loggerheads ranged in size from 52 to 105 cm (average=74.0 cm, curved carapace length, notch to tip), the Kemp's ridleys from 32 to 57 cm (average=43.4 cm) and the green measured 83.1 cm. Of these 58 animals, 7 were recaptures – 2 were previously tagged by other studies and 5 were tagged as part of this project. The recaptures occurred both within and between sampling seasons, suggesting site fidelity and demonstrating long distance migrations. Blood samples are being analyzed to aid in establishing reference ranges for loggerhead and Kemp's ridley sea turtles. Analysis of tissue samples will be performed to determine the genetic origin of sea turtles in the Chesapeake Bay. Future work includes comparing blood work results with those from other studies along the U.S. East Coast and utilizing satellite telemetry to identify habitat preference within the Chesapeake Bay and migratory routes upon leaving the Bay.

SEX RATIOS OF JUVENILE LOGGERHEAD SEA TURTLE, *CARETTA CARETTA*, IN THE MEDITERRANEAN

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We examined the sex ratios of 100 juvenile loggerhead turtles with CCLn-t ranging from 24.0-69.0 cm (mean: 41.8; SD: 10.2) from the central and eastern Mediterranean by histological analysis of gonads. The tissue samples were fixed in 10% formalin for minimum of 48 h, dehydrated through a graded series of alcohols, embedded in paraffin and sectioned at 8 µm. Sections were stained with hematoxylin and eosin and examined with a light microscope. Histological analysis of gonads and sex determination followed Merchant-Larios (1999). Gonads composed of flat, monostratified surface epithelium and seminiferous tubules with more or less differentiated germ/ spermatogenic cells were determined to be testes while ovaries exhibited membranous structure, folded, often partly transparent, enclosing spherical follicles. The sex ratios are given as a male/female ratio (M:F). Based on CCLn-t, we divided loggerheads into three size classes (ontogenetic groups): pelagic (oceanic) juveniles (< 30.0 cm), post-pelagic juveniles (30.0 - 49.9 cm) and benthic (neritic) juveniles (50.0 – 69.9 cm). We tested a difference between sex ratios in different size classes by the means of a chi-square test; the Yates correction was applied when necessary. The overall sex ratio equaled 1.00. In pelagic juveniles, the sex ratio showed strong male bias (2.00), but it could be explained by the small sample size (N = 9). In both, post-pelagic and neritic juveniles we have found no significant aberration from a

1:1 ratio (0.92, N = 69 and 1.00, N = 22, respectively, $p < 0.01$). No difference was also found between the sex ratio in the central and the eastern Mediterranean; in both regions it equals to 1.00 (N = 42 and 58, respectively). Our results are discordant with the theoretical predictions of a strong female hatchling production in the Mediterranean. However, our findings support the results of a previous study on sex ratios of juveniles from the central Mediterranean based upon testosterone levels.

No studies at present show different mortality patterns between male and female post-hatchlings and juveniles. To explain such results we suggest several alternative hypothesis: H1: Sex ratios in Mediterranean marine habitats are influenced by male-biased immigrations of NW Atlantic juveniles. H2: Juveniles in the study area derived from rookeries with less skewed hatchling production. H3: The overall hatchling production in the Mediterranean is not as female-biased as predicted.

Sex ratios are among the most important demographic parameters that significantly affect the viability and conservation of endangered species. Without knowing the population of origin, sex ratios in marine habitats are not necessarily representative of the sex ratios of the whole population, at least where the juvenile size class is concerned. Although the explanation of our results is not clear at present, it questions the proposed strong female bias of hatchling production in the Mediterranean. Obviously, more data on the sex ratios on the nesting beaches are needed, particularly by employing direct methods of sex determination.

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METABOLIC HEATING IN LEATHERBACK TURTLE NESTS (*DERMOCHELYS CORIACEA*) ON THE NORTH COAST OF TRINIDAD

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Marine turtles have been shown to employ temperature-sensitive sex determination (TSD). This aspect of their life history has received much attention in recent years. The study of many marine turtle populations has suggested that there may be a high bias towards the production of females and that this may be due to climate change, presenting a possible conservation concern. The role of metabolic heating is an important factor in TSD as it has been shown to raise nest temperatures by 0.8°C in leatherbacks, which could mean the difference between the production of 100% male or 100% female hatchlings. The sex is thought to be determined during the middle third of incubation. Our experiment was designed to determine the temperatures of leatherback turtle nests on the north coast of Trinidad and investigate how metabolic heating might affect the sex ratio. We recorded the temperatures in four leatherback nests. Each nest had two controls to allow metabolic heating to be measured; one in the sand and one in a false nest constructed with water filled Ping-Pong balls. The temperature in the nests ranged from 27.8°C–29.3°C and the mean overall metabolic heating was 0.7°C. The mean metabolic heating in the middle third of the incubation period was 0.12°C. It is thought that this amount of metabolic heating could affect the sex ratio of the hatchlings if the mean temperature was very close to pivotal. However, the overall temperatures during the middle third of incubation in the turtle nests never reached the pivotal temperature for leatherback turtles (29.5ºC). Therefore it is likely that all hatchlings produced from these nests would have been male despite metabolic heating. It is believed that metabolic heating should be taken into account when trying to estimate sex ratios from sand temperatures. More data were collected in summer 2004 which will be added to this analysis. We think it likely that seasonal temperature changes are an important factor in sea turtle determination in leatherbacks nesting in Trinidad.

SEA TURTLES OF MOROCCO: A 15 YEAR SURVEY

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There are three main species of sea turtles present along the approximately 3000 km coastline of Morocco and Western Sahara: loggerheads (*Caretta caretta*), leatherbacks (*Dermochelys coriacea*), and green turtles (*Chelonia mydas*) (De los Ríos et al, in prep). The presence of *Lepidochelys olivacea*, *Lepidochelys kempii* and *Eretmochelys imbricata* is anecdotal. For the loggerhead turtle, there is a developmental area and one possible nesting area (De los Ríos et al, in prep.) in the Atlantic and one feeding area in the Mediterranean, in the transition with the Atlantic, where they feed almost exclusively on the portunid crab *Polybius henslowii* (De los Ríos y Ocaña, in press.). The leatherback has been seen in the same bay at the beginning of the African Mediterranean, another feeding ground. Turtles migrate through the Strait of Gibraltar to feed on the jellyfish appearing there in blooms. Strandings of both live and dead turtles are also recorded in the rest of the Mediterranean and in the Atlantic littoral region (De los Ríos et al, in prep.). In the South Atlantic region, there is a development area for green turtles confirmed by strandings and observed sizes. There is also evidence of nesting spots (De los Ríos et al, in prep.). Sea sightings, beaches surveys, medical rehabilitation, necropsies, anatomo-osteological studies, satellite tracking, etc… have been performed. The origin, distribution, abundance, dynamics, ecology and threats of each of these species are discussed thanks to a 15 year survey, representing the deepest study of this kind in this north-west African littoral.

THE GTD: CREATING THE FIRST GIS TURTLE DATABASE FOR JUVENILE GREEN TURTLES IN BROWARD COUNTY, FLORIDA, USA

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There has been a long 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’ juveniles.

A CONCEPTUAL MODEL OF KEMP'S RIDLEY (*LEPIDOCHELYS KEMPII*) OCCURRENCE IN THE NORTHWESTERN GULF OF MÉXICO

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Post-pelagic juvenile and subadult Kemp's ridley sea turtles (*Lepidochelys kempii*) utilize nearshore waters of the northwestern Gulf of México as nursery or developmental feeding grounds. Entanglement netting surveys conducted at Sabine Pass, Texas and Calcasieu Pass, Louisiana during April-October 1993-2002, primarily were used to characterize long-term abundance and distribution of Kemp's ridley sea turtles at historical index habitats in this region. Additionally, an ecosystem-based approach, utilizing a conceptual model that incorporates data on nesting dynamics, environmental conditions, prey availability and predation pressure, is used in assessing factors that may influence ridley in-water abundance and distribution. Of these conceptual model components, only analyses regarding the influence of nesting activity on nearshore ridley abundance are reported in this presentation. Overall, annual mean Kemp's ridley catch-per-unit-effort (CPUE) across study areas peaked in 1994, 1997, 1999 and 2002, suggesting a 2-3 year cycle in abundance. Average clutch size and hatch success at the Rancho Nuevo nesting beach also exhibited this 2-3 year cyclic pattern, with ridley nearshore abundance most significantly related to hatch success (plotted with a 2-year lag to account for the lost years). However, trends in nearshore ridley CPUE remained relatively constant or declined slightly even as number of hatchlings released from Rancho Nuevo increased exponentially. This disparity between number of ridley hatchlings released and abundance of recruits in the northwestern Gulf is puzzling and warrants further investigation.

PUBLIC EDUCATION AND POLICY

THE CPU NATURAL HISTORY SCIENCE EDUCATION MODEL: AN INTEGRATIVE MODEL BASED ON SEA TURTLE CONSERVATION

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The St. Catherines Island Sea Turtle Conservation program integrates conservation, education and applied research into a dynamic natural history education model useful for systemic reform of science education. The CPU Natural History Science Education Model employs the computer as its metaphor and the charismatic conservation of threatened and endangered sea turtles as its content. The model is adaptable to numerous natural history problems. Using hands-on, real-world, field experiences, science, mathematics and pedagogical content is presented as a two-semester science sequence through Georgia Southern University to ~14 teachers/year. Teachers serve a seven-day residency on St. Catherine's Island after two days of face-to-face and at-a-distance training supported by a Handbook for Sea Turtle Interns and several content web sites. Teachers are trained in the field by lecture, demonstration and experiential activity, operate in the field as a conservation team and network with colleagues from their school or area within their cohort. Formal reinforcement is provided by a follow-up course in which the teachers integrate content into their teaching situation by writing an endangered species teaching unit tailored specifically to their students. Because each teacher teaches a new cohort of students each year, the teaching of teachers has a dramatic compounding effect. In 15 years our program has taught 135 teachers who have impacted 155,843 school children while resulting in documentation of 1,657 sea turtle nests and putting 93,816 hatchlings into the sea. Informal science education has been enhanced by delivery of 10 web sites, 5 museum exhibits, 16 papers and 38 presentations.

EDUCATING ABOUT SEA TURTLES

Marco P. Bragança and Élio A. Vicente

Zoomarine - Mundo Aquatico S.A., Est. Nac. 125, Km 65, Guia, 8201-864 Albufeira, Portugal

Zoomarine is an oceanographic facility located in Southern Portugal (southern Europe), in a sea-side province where occasional sightings of sea turtles (mainly leatherback, loggerhead and green) can occur year round (either in the ocean or as stranding episodes). As such, Zoomarine's involvement in the rehabilitation of sea turtles started shortly after the opening of the park in 1991. Considering the above, our technical team always had first-hand contact with the negative impact of human activities on these species. Being strongly aware of the importance of an effective educational strategy, our technicians have been trying, ever since, to effectively teach our visitors about the major threats that these taxa undergo during their life, as well as trying to involve the public in conservation efforts. Zoomarine's Educational Department has been a fundamental partner in this effort, as it dedicates an important part of its resources to actively showing our visitors the importance that small changes in their daily activities (their attitudes) can have a relevant impact in the life of (among others) these marine reptiles. Either by direct contact with the general public, visiting schools and/or universities, or through close cooperation with local and national media, we have been "opening" every year, the sea turtles' fragile world to hundreds of thousands, showing the importance and urgent need of protecting these amazing and ancient creatures.

ENVIRONMENTAL EDUCATION: STRATEGY WITH MEDIATE AND LONG-TERM RESULTS IN THE CONSERVATION OF SEA TURTLES, UNIVERSIDAD DE GUADALAJARA/CUCSUR, MÉXICO

Rosa E. Carretero-Montes, Jose A. Trejo Robles, Francisco de Asis Silva Bátiz and Felipe J. López Chávez

Universidad De Guadalajara-Centro Universitario De La Costa Sur, Jalisco, México

The sea turtle conservation program in Jalisco, México promoted by The Universidad de Guadalajara, has strengthened over seven years of environmental education activities, which are carried out in the nearby communities at the camp “La Gloria (Municipality of Tomatlán) and in the last four years in the camp “El Coco” (municipality of Cihuatlán). The activities of environmental education are applied principally to children of primary, secondary and young people from high school. By means of this program, workshops have been developed in local schools and turtle camps. The activities also le t adults get involved when they come as volunteers. We have observed these activities help the communities get more involved and take part more directly in the conservation of these chelonians, adding and adopting a sense of property towards the sea turtles and the natural resources in general.

From 1996 to 2005, 4,267 children visited the camp joining in the activities programmed. We have offered 52 workshops at different schools (19 primary schools, 9 secondary and 9 high schools). Visitors to La Gloria include 595 students from different high schools, 383 students from different universities, 326 volunteers from international NGOs, 288 volunteers from national NGOs, and 358 from independent groups.

SCHOOL PROJECT ABOUT SEA TURTLES, OFFICIAL RURAL SCHOOL SAN FRANCISCO DEL MAR, SPECIAL PROTECTED AREA OF PUNTA DE MANABIQUE, IZABAL, GUATEMALA

Ana Beatriz Rivas Chacón

Fundación para la conservación del Medio Ambiente y los Recursos Naturales, Mario Dary Rivera –FUNDARY

The following work took place during the months of March to November 2004, in the rural official school and hatchery of San Francisco del Mar, located in de Protected Area of Punta de Manabique, Izabal, Guatemala. This is a natural area for the conservation of flora and fauna and it is the only place in the Caribbean coast of Guatemala where hawksbill and other species of sea turtles, like greens and leatherbacks, nest. The objective of the project was to call the attention of students to the conservation of sea turtles, because the people of the communities collect and sell the eggs of sea turtles.

A group of 35 students received information about sea turtles and the importance of their conservation. They learned how to work in a hatchery. They also released the sea turtles and were in charge of taking care of the nests. They carried out this work with an adult of the community who was in charge of the hatchery. The kids also named the hatchery as “Vivero Guatemala” and during the visits to the school, they were very interested in the theme. The vision of the Foundation is to work with children so they can learn more about their resources and care about them.

MOONLIGHT, MOSQUITOS AND MOTHERS: WHAT ELEVEN YEARS OF FLORIDA'S TURTLE WALKS HAVE TAUGHT US (1994-2004)

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As the lead agency for protection of marine turtles in Florida, staff in the Florida Fish and Wildlife Conservation Commission (FWC) must review and approve activities involving marine turtles, their nests, or hatchlings. This includes oversight of individuals offering public educational opportunities that involve sea turtles. For more than a decade, trained FWC-permitted individuals have conducted nighttime turtle watches, which allow members of the public to observe a female loggerhead turtle depositing eggs into a nest. These walks, conducted under the guidance provided in FWC’s Sea Turtle Conservation Guidelines, are conducted in an effort to educate the public. Turtles observed by turtle watch groups are minimally affected, making turtle watches an effective and invaluable educational tool. From 1994 to 2004, FWC-permitted organizations conducted 3,629 public turtle walks; participants in 2,475 of the walks witnessed a female loggerhead depositing eggs. A total of 105,021 people participated in turtle walks over this 11-year period. Authorized turtle watches also assisted in reducing the effects to nesting turtles due to other nighttime beachgoers; approximately 1.4% of the total number of people participating in turtle watches consisted of individuals encountered on the beach while the watch was being conducted. While the number of organizations conducting turtle walks has remained fairly consistent over this period, the number of participants has increased in recent years. Anecdotal reports suggest the number of untrained individuals attempting to observe nesting turtles has also increased. Resource managers should continue to assess potential negative effects to nesting and hatching turtles, with the highest priority on minimizing the potential harassment caused by all turtle walks. Management concerns are that the popularity of turtle watches continues to exceed the number of opportunities available to the public, possibly increasing the number of untrained individuals attempting to encounter turtles in unauthorized manners; the labor intensity associated with conducting turtle walks is great, which may discourage already permitted organizations from conducting more turtle watches than are currently allowed; extending watches into August is not as attractive because of the potential to negatively affect emergent hatchlings. Management recommendations are: it is critical that managers continually review and amend their guidelines to minimize effects on nesting turtles to the greatest extent possible; in areas where all available turtle watches consistently “sell out” and remaining demand is known to be great, managers could revise the guidelines to allow a greater number of watches per week; additional organizations could be encouraged to increase the number of turtle watches available in areas of unsatisfied demand; turtle watch organizations should be encouraged to expand their schedules to include the later part of May.

POSTCARDS FROM THE EDGE: A TOURIST’S VIEW OF THE KEY WEST TURTLE FISHERY

C. Kenneth Dodd, Jr.

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In the United States, the use of souvenir postcards was authorized in 1893 by the U.S. Post Office. The first postcard that I have found featuring a sea turtle taken by fishermen is an undated Undivided Back postcard (1901-1907), but this card is not directly attributable to the sea turtle fishery at Key West. The earliest postcards illustrating turtles on their way to slaughter at Key West’s turtle kraals were Divided Back cards (1907-1915). Linen postcards were common from 1930-1945, followed by photochrome cards (1939-Present). Photochrome cards featuring the turtle kraals were popular especially in the 1950’s. Occasionally, actual photographs served as postcards. More recently, sketches illustrating the historical/tourist nature of the kraals have appeared. In this poster, I present an array of 33 souvenir postcards and 2 decals dating from the early 1900’s to the present that document the industry as it was to the tourist attraction it became. These postcards provide a vivid statement of how sea turtles were used as commodities, often for amusement, on their way to the soup kitchens. They also provide a glimpse into the species, size and sex of turtles captured and the sociology of the times.

PROMOTION OF SEA TURTLE CONSERVATION IN BAY COUNTY THROUGH PRODUCTION AND DISTRIBUTION OF EDUCATIONAL MATERIALS AND TELEVISION ANNOUNCEMENTS

Nancy M. Evou, Bradley S. Smith and Kennard P. Watson

St. Andrews Bay Resource Management association Turtle Watch, Panama City Beach, Florida, USA

The St. Andrew Bay Resource Management Association (RMA), a Florida non-profit organization, has protected sea turtle nests on Panama City Beach since 1991. In 2003 the Florida Sea Turtle Grants Program funded RMA to further its educational efforts to protect sea turtles on local beaches. Panama City Beach is an ideal place to educate people about sea turtles, because this area hosts over three million visitors annually and the tourist season in this part of Florida coincides with the turtle season. Print materials describing the turtles that nest on our beaches were produced and distributed to beachfront homes, condos, businesses and schools. Fliers describing Bay County's new lighting ordinance to protect sea turtles were distributed to property owners in the affected area. Additionally, a Public Service Announcement on sea turtles and lights, entitled "Sea Turtles Dig the Dark," was aired on local TV stations.

A REVIEW OF THE SEA TURTLE RECOVERY ACTION PLAN FOR VENEZUELA

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The "Sea Turtle Recovery Action Plan for Venezuela" (STRAP) was prepared between 1992 and 2000 thanks to the leading process conducted by WIDECAST and the Sea Turtle Working Group of Venezuela (GTTM). The action plan was published as a Technical Report by the Caribbean Environment Programme (UNEP). In 2004, the STRAP was 5 years old and needed to be evaluated and updated to establish goals for the next five years. Here we compare the proposed and accomplished goals for 2000 to 2004. This is the first step in the review process to be conducted during 2005 within GTTM.

A first view indicated that the lack of sufficient financial support prevented us from achieving several important research and conservation goals. The capacity that was built through the sea turtle biology and conservation courses and specialized workshops has begun to yield concrete results as the developing of several undergraduate theses. At least some important index beaches are being monitored periodically. The production of new awareness materials has been increased. The challenges of the review are related with to get more funding for the implementation, the enforcement and the relationships of the GTTM members. An important situation is generated through the implementation process of the "Inter-American Convention for the Protection and Conservation of the Sea Turtles".

TRAINING COURSES ABOUT SEA TURTLE PROTECTION AND CONSERVATION BY THE CENTRO MEXICANO DE LA TORTUGA, MÉXICO

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Sea turtle conservation programs' require training for personnel that will conduct fieldwork. The required training includes how to handle and locate nests on the beach, differentiation of rakes, according to the species nesting. It is of vital importance that the students and technical personnel in the turtle camps have an extensive background on many topics: problems and current situation of the marine turtles in México, identification of species, basic biology and natural history, strategies of conservation and handling, training in the programs of marked adults and hatchlings, knowledge of the best incubation techniques and subsequent release of neonates, as well as how to analyze the data. It is also important that they know sea turtle regulations, environmental legislation, programs of environmental education and sensitization, importance of the social participation, among others. In this way, the students learn the best way to write projects and to present the information at the regional level. It is for that reason that theoretical-practical courses such as these courses are taught. In this poster we present the subjects of the training and our results teaching in different states of the Mexican Republic.

TURTLE WATCH - GULFCOAST GIRL SCOUTS PATCH

Lucinda Hathaway and Emmy Lou Gilbert

Longboat Key Turtle Watch, Inc., Longboat Key, FL USA

Longboat Key Turtle Watch, Inc. was the recipient of a grant from Caribbean Conservation Corp. The grant money was used to establish a Girl Scout Patch, "Turtle Watch", in cooperation with the Girl Scouts of Gulfcoast Florida. Emmy Lou and Lucinda assembled ten file boxes of information on sea turtles for Girl Scout Troop Leaders to borrow. An activity sheet was compiled for the girls to choose activities related to earning their patch. The patch was designed using the LBK Turtle Watch logo. The files of sea turtle information are available to any Girl Scout Troop leader in the USA and patches may be purchased by calling : Girl Scouts of Gulfcoast Florida : Kathleen O'Leary 941-921-5358 X 242.

WHY DO WE HAVE TO WORK TOGETHER WITH FISHERMEN TO AVOID THE EXTINCTION OF SEA TURTLES?

Martín Laporta, Philip Miller, Pablo Sánchez and Andrés Domingo

CID/Karumbé, Montevideo, Uruguay

Fisheries are a major threat for sea turtle populations all over the world. Pacific populations of leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) turtles have declined drastically during the last decade. One of the major reasons for this fact is the incidental capture of sea turtles by fisheries. Research efforts are being conducted to modify fishing gear and operations; bycatch assessments are being made to determine spatial and temporal fishing bans. The results of these processes might take years to reduce the sea turtle bycatch and mortality. Considering the critical situation of sea turtle populations, we can not wait to see those results. Fishermen, who work on the deck of fishing boats, have the opportunity to decide the fate of incidentally captured sea turtles. They have inherited an empirical knowledge from generations of work, which is very valuable to research and the conservation of sea turtles. Most of them are willing to help sea turtles and to work with conservationists to avoid their extinction. This is why we strongly believe that fishermen have a vital role to play in sea turtle conservation programs. We have to increase sea turtle conservation awareness in fishermen by developing educational programs and integrating them into conservation and research activities. Every sea turtle which is rescued from any fishing gear by an aware fisherman today will help them avoid extinction.

SEA TURTLES PUBLIC AWARENESS IN PERU: AN IMPORTANT STEP WITHIN CONSERVATION

Camelia Manrique and Shaleyla Kelez

Grupo de Tortugas Marinas – Perú / APECO

Since the beginning of our work with sea turtles in Peru we have realized the importance of implementing and developing public awareness campaigns to reduce the capture and consumption of sea turtles by the local coastal communities. As part of our conservation project, we decided to direct our awareness campaign to the fishermen, because they have a direct interaction with sea turtles during their fishing activities. Port authorities were contacted for their support in the coordination of awareness talks with the fishermen of the inlets and ports along the coast. The talks included sea turtle evolution, adaptations, ecology, life cycle, threats and mitigation measures. Furthermore, materials were designed, such as posters, stickers and pamphlets; to be distributed to the public and posted in the markets and docks so people who want to buy sea turtle meat may think twice. We found it very difficult to get the people interested. We realize some fishermen are not interested in conserving sea turtles. In fact, as some of them kill them or have done it before they are afraid they are going to be blamed. But we have also found that some of the fishermen do have an interest in what could happen if these animals go extinct. So we are making them think about the consequences. The most important output is that, step by step, fishermen can change the ways they act with sea turtles.

WALT DISNEY WORLD'S SEA TURTLE CONSERVATION PROGRAM AT DISNEY'S VERO BEACH RESORT

Lance Miller[1], Anne Savage[1], Jane Davis[2], Joe Christman[1], John Lehnhardt[1] and Kathy Lehnhardt[1]

[1] Disney's Animal Kingdom, USA
[2] Living Seas at EPCOT, USA

The Walt Disney Company (WDW) has an extensive history in sea turtle conservation. We present a model for integrating various business units into an effective partnership for sea turtle conservation. Through our efforts of rehabilitation, collaboration with ACCSTR and UCF to develop telemetry devices to track juvenile green sea turtles, public education initiatives and funding efforts through the Disney Wildlife Conservation Fund, WDW continues to expand efforts to protect sea turtles. Our focus at Disney's Vero Beach Resort (DVBR) has been to increase public awareness of sea turtle conservation. Our staff monitors nesting activity along a 3km stretch of beach in Indian River County. Education initiatives have had a significant impact on changing visitors' attitude and increasing interest in sea turtles. We have instituted a program to watch nesting sea turtles from an observation deck using night vision goggles, resulting in a significant decrease in false crawls within the study area. Given our commitment to keeping the beaches clean for wildlife, DVBR is "plastic lid and straw free." We also participate in NESTS, Neighbors Ensuring Sea Turtle Survival, which was developed to work with coastal homeowners associations and individuals living on Florida's barrier islands. The idea is to engage individuals living in coastal areas in simple activities that will have a direct benefit to the survival of sea turtles and protecting their nesting habitat. This integrated approach to conservation, that aligns various lines of business within WDW, can serve as a model for other corporations in developing their conservation efforts.

LA VIDA DE LA TORTUGA: BRINGING LIFE HISTORY DATA INTO THE SPANISH AND ENGLISH SPEAKING CLASSROOM

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As many as 35,000 endangered sea turtles are killed each year in northwestern México's waters by poachers and as fisheries bycatch (Nichols 2000). In an effort to reduce anthropogenic mortality and educate young students, researchers and educators collaborated to produce an elementary-level resource for children in México. The resulting resource, La Vida de la Tortuga, follows juvenile Eastern Pacific green turtles until maturity in Baja California Sur, México.

La Vida de la Tortuga was published online in January 2004 and is a multi-part instructional package. The resource is available online in English www.vims.edu/bridge/wildcoastenglish1.pdf and Spanish www.vims.edu/bridge/wildcoastespanol.pdf. It includes science and math standards of learning correlations for México and the U.S., information about sea turtle biology and Pacific sea turtle species, vocabulary words, a teacher's guide and key, an activity, extension ideas, a student worksheet and web resources. The activity uses data from studies in Bahia de los Angeles (Seminoff 2000, Seminoff et al. 2003) to create a life history model that allows students to follow juvenile turtles throughout their Baja California coastal life history stage. After completing all of the juvenile stages, the turtle/student that survives the longest is the winner. The activity allows students to calculate mortality and survivorship estimates for the turtles while learning life history and conservation concepts. Since March 2004, La Vida de la Tortuga was used by more than 1,574 students, 154 educators and 14 park staff members from around the world. Discussion with participants at the 2005 Sea Turtle Symposium suggested even greater dissemination numbers. La Vida allowed international collaboration among more than 18 agencies, organizations, parks, aquariums and research groups. La Vida is used as part of Blue Ocean Institute's Ocean Connections Program and helps connect Hispanic students in the U.S. to Latin American students. La Vida also allows researchers to share their data with students while conveying important science concepts and conservation issues. This resource and activity model has the potential to be used with different sea turtle species and foreign languages.

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COMMUNITY CONSERVATION OF BASKING GREEN SEA TURTLES: RECOMMENDATIONS FOR PUNALU'U, HAWAII

Amber L. Pitt

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Punalu'u Beach, Hawaii is famous for its black sand and basking green sea turtles. Being the Big Island's only easily accessible black sand beach, Punalu'u is a popular tourist destination. Most tourists eagerly photograph the basking turtles, but some inevitably attempt to ride or beat on the turtles' carapaces. Several programs have been initiated to prevent turtle abuse at Punalu'u including volunteer monitoring of basking turtles, educational sign postings at the site and the creation of websites that discourage inappropriate behavior. Signs and websites are effective for some tourists but are frequently overlooked. The constant supervision of tourist activity is a frustrating task for volunteers who would prefer educating to scolding visitors. Furthermore, many tourists are ignorant of the turtles' threatened status and the detrimental effects of their actions. They admit that prior knowledge would have discouraged inappropriate behavior. This situation begs for more proactive methods to alleviate turtle harassment. Suggestions include: 1. Enlist the aid of local hotels, resorts, airlines and tour companies via presentations and informational packets, 2. Provide inter-island airlines with conservation brochures to place in seat backs of flights going to the Big Island, 3. Encourage hotels and resorts to distribute educational brochures in their rooms and include conservation information on their websites, 4. Create durable, attractive turtle info-cards to attach to tour bus seat backs, 5. Encourage tour guides to remind participants prior to their beach visit to behave appropriately around the turtles. These actions will enhance the protection of basking sea turtles.

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ENVIRONMENTAL EDUCATION THROUGH RESEARCH ACTIVITIES: CUBAN EXPERIENCES IN GUANAHACABIBES PENINSULA

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The project for the Study and Conservation of the Marine Turtles in Cuba, directed by the CIM, dedicated their first phase of investigation to the turtles nesting in Guanahacabibes. This project has been linked to more than 500 students and workers, coming from very diverse institutions such as the Faculties of Biology, Physics, Chemistry, Geography, Arts and Letters, Economy, Nuclear Physics, Superior Institute of Industrial Design, National Botanical Garden, Agrarian University of the Havana, among others. The participants work closely with nature in a practically virgin area, in contrast to their daily experience which is fundamentally in the city. This is the first step in sensitizing them to the environment. In the beginning they receive information from the project specialists' through conferences and from an illustrative pamphlet of the local flora and fauna.

An interesting interactive process takes place in which the biologists and non- specialized participants learn about nature and the local residents, to receive a higher level of information and the conscience to conserve their natural resources. In this sense an interactive conception is being developed between investigation and environmental education to increase and to diversify the social and natural transformation.

SAVING LEATHERBACK SEA TURTLES IN NEW HAMPSHIRE, USA

Jill R. Rolph, Melody G. Rolph, Kayley J. Peters, Martha B. Stanley and Craig M. Metivier

Great Brook School, Antrim, New Hampshire*, USA*

In New Hampshire (NH) "Live Free or Die" is not just the state motto, it is a lifestyle. At Great Brook School 5th-8th grade students in four rural communities believe leatherback turtles can be free from pollution and free from the needless other deaths brought upon them by the human population. Leatherbacks are endangered in New Hampshire and nearing extinction worldwide. This year, students became members of the first ever Great Brook School Leatherback Sea Turtle Biology and Conservation Club. Their main goal is to educate the New Hampshire public about these fascinating sea turtles and conservation efforts that can make a difference in their ultimate survival. Since leatherback turtles don't nest in New Hampshire, students and educators at Great Brook School have probably never seen them. The club created a 24"X36" art image of the leatherback turtle eating its favorite food, jellyfish. Their creation was made from thousands of little pieces of old magazines and mylar balloons. It has been displayed at Great Brook School and in local libraries in New Hampshire. Mylar (helium) filled balloons are particularly harmful to leatherback turtles. They are very long lasting balloons that stay inflated for up to 5 months. If released in the atmosphere in any part of NH, they could end up in the ocean. One balloon could kill a leatherback. The displayed artwork and poster created by Great Brook School students in grades 5th-8th was designed to foster awareness and stewardship of the leatherback sea turtle in New Hampshire. The poster depicts all the clubs activities, which also include the creation of the New Hampshire Sea Turtle Foundation web site, Leatherback Sea Turtle Coloring and Activity Book, Leatherback Turtle Educational Brochure, and Teacher's Resource Page. The club will be going on a field trip to Hampton Beach in New Hampshire to help clean up beaches of plastic and other pollution that might end up in the ocean where it could injure or kill leatherback sea turtles.

NEIGHBORS ENSURING SEA TURTLE SURVIVAL (NESTS): A COMMUNITY PROGRAM TO INCREASE AWARENESS AND ACTION FOR THE CONSERVATION OF SEA TURTLES NEAR THE ARCHIE CARR NATIONAL WILDLIFE REFUGE

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The Archie Carr National Wildlife Refuge along Florida's Atlantic Coast hosts not only the largest number of nesting sea turtles in the U.S., but also a large number of coastal residents, visitors and businesses. As elsewhere in Florida, beachfront communities can have a tremendous impact on the success or failure of sea turtle nesting. To increase awareness, interest and protection of sea turtles, a new program NESTS – Neighbors Ensuring Sea Turtle Survival, was developed to work with coastal homeowners associations and individual homeowners living on Florida's barrier islands. Program partners include Walt Disney World, The Ocean Conservancy, Caribbean Conservation Corporation, U.S. Fish and Wildlife Service, Friends of the Carr Refuge, Brevard Zoo, Sea Turtle Preservation Society and the Florida Park Service. The concept of NESTS is to engage individuals living in coastal areas in simple activities that will have a direct benefit to helping the survival of sea turtles and protecting their nesting habitat. Through three levels of certification (Partner, Guardian and Champion) participants have the opportunity to become directly involved, as well as engaging others in their community, through completing activities that protect sea turtles and their habitat. The first year of our program has been successful and generated considerable interest and community support. Our hope is that NESTS will continue to grow to include additional communities that will positively impact the conservation of sea turtles and their habitat. www.nests-certified.org

ONBOARD TAGGING AND DATA COLLECTION PROGRAMME (PROMACODA): TESTIMONIES OF TRAWL FISHERMEN WORKING AS SEA TURTLES ONBOARD OBSERVERS IN URUGUAY

Andrés Vidal, Gustavo de León, Ernesto Rodríguez, César Larrañaga, Santiago Codina, Jorge Vignolo, Daniel Rodríguez, César Pérez, Philip Miller, Andrés Domingo, Pablo Sánchez and Martín Laporta

PROMACODA/Karumbé, Montevideo, Uruguay

The coastal bottom trawl fishery fleet that operates in the Common Argentinean-Uruguayan Fishing Zone (ZCPAU) is known to incidentally capture sea turtles. The Onboard Tagging and Data Collection Programme (PROMACODA) was created in November 2002 to quantify the incidental capture of sea turtles and analyze its spatio-temporal distribution. PROMACODA currently has 15 participants who are fishermen, skippers, engineers, biologists and researchers. The activities undertaken onboard the fishing vessels include sea turtle rehabilitation, identification, measurement, tagging, photo identification, tissue and epibionts sampling, geopositioning and fishing effort data collection. These activities are voluntary done by the fishermen once they have concluded their fishing maneuver which takes up to 20 hours of continuous work. Up to this date, the fishermen have worked on 71 turtles, of which 56 have been tagged. This work is the testimony of a group of fishermen who are part of the PROMACODA and includes their opinion on the importance of sea turtle research and conservation projects, as well as their willingness to collaborate on them. Those fishermen answered the two following questions: “Why do you think that the existence of a sea turtle conservation project in Uruguay is important?” and “Why are you willing to collaborate and participate in a sea turtle conservation project?” The data collected by the PROMACODA are the results of the effort and commitment of some fishermen who believe that “the existence of a sea turtle conservation and research program in Uruguay is very important and will allow advancement in the conservation of marine ecosystems and achieve a sustainable and responsible fishing”.

SOCIAL AND CULTURAL ISSUES

ECOTOURISM IN CABO VERDE: A FUTURE'S CHALLENGE

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The second most important reproductive colony of *Caretta caretta* in the Atlantic Ocean and the third more important in the world is located in the Cabo Verde Republic. Most of the nesting is concentrated on the vast sandy beaches on the islands of Maio, Sal and Boavista. Sightseeing of nesting females is offered to tour operators and leisure enterprises.
The goal is to show turtles laying eggs in the nest without interfering with the natural process. The turtle nests under natural, undisturbed conditions and the client is satisfied. This activity produces funds for research and wardening, increases the interest of the local populations for conservation, and stresses the high value of a living turtle, otherwise poached for human consumption. The main threat at this rookery is the significant level of human predation which is why the strongest effort is concentrated on education and control. The main reason for turtle poaching is the financial benefit; therefore, it is of major importance to make sea turtle conservation a profitable, sustainable and steady activity, producing incomes for local community as an alternative to poaching. A "Sea Turtle Day" is held every year were hundreds of children from all around the archipelago set free hundreds of hatchlings in a symbolic act aimed at environmental awakening and education.

VOLUNTEER-DRIVEN TURTLE EGG COLLECTION AS A COMPLEMENT TO VOLUNTARY DONATIONS: THE SOCIO-ECONOMIC IMPLICATIONS FOR THE FUTURE OF SEA TURTLE CONSERVATION IN GUATEMALA

Colum Muccio[1], Francesca Barker[2] and Scott Handy[2]

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Although sea turtles are on paper completely protected in Guatemala, the reality is very different. Behind a facade of laws and governmental decrees there is an informal system of unwritten agreements known as the Donation System which, though very weak, affords the sea turtle the only degree of protection it gets in Guatemala. Under this system initiated in the early 1980s, an egg collector is given the "legal" right to sell and market a nest of eggs as long as he/she donates one dozen eggs of that nest to a hatchery. The Donation System strives but falls far short of setting up a system for the sustainable use of sea turtle eggs. ARCAS, in its sea turtle conservation activities in the Hawaii area of the Pacific coast of Guatemala has over the last 8 years tried to complement donations from egg collectors to its hatcheries with eggs collected by a variety of other methods, including whole nests found or bought by international volunteers and egg collecting competitions held in area schools. In the 16kms of coastline that it covers, ARCAS has managed to increase the amount of eggs rescued from traffickers from roughly 3% to 20% of those being laid. This study looks at the strengths and limitations of the Donation System, the socio-economic impact of sea turtle egg trading on the local and national economy and ways to increase sea turtle egg collection in other parts of Guatemala and the world.

A MODEL FOR COMMUNITY-BASED TURTLE CONSERVATION: LESSONS FROM TANZANIA, EAST AFRICA

Catharine Muir and Omari Abdallah

Tanzania Turtle & Dugong Conservation Programme, Tanzania

Five species of marine turtles (green, hawksbill, loggerhead, olive ridley and leatherback) occur in Tanzanian waters, of which two – green and hawksbill – nest. All species are threatened and populations are believed to be declining as a result of escalating pressures associated with a poor and growing coastal population who are heavily dependent on coastal and marine resources for their livelihoods. The major threats to turtles include over-exploitation for meat, eggs and shells, incidental capture in artisanal gillnets and commercial prawn trawlers and disturbance of nesting and foraging habitats. Before 2000, turtle research and conservation efforts in Tanzania were focused almost exclusively on the Zanibar islands of Unguja and Pemba, while knowledge of nesting populations and feeding and developmental habitats on the mainland coast were virtually non-existent. In recognition of their plight, scanty data and the needs of local coastal communities, a community-based Tanzania Turtle & Dugong Conservation Programme (TTDCP) was initiated in January 2001 on Mafia Island, part of the mainland. Through a network of local community monitors, nest incentives, monitoring, education and training, poaching of turtles and their eggs has declined significantly from 49% to less than 1%. Over 550 nests have been recorded, tagging and catch monitoring are underway and schools and communities are actively participating in environmental education activities.

In May 2004, the programme scaled-up to include the entire mainland coast of Tanzania, using Mafia as a successful working model. Community-level conservation activities are now underway in 6 out of 11 districts, covering approximately 1/3rd of the coastline. 28 Community Turtle Monitors have been locally elected. Mafia-trained personnel are working with coastal communities and tourist operators to collect data and develop sustainable alternatives to turtle hunting. Partnerships are being forged with coastal communities, government institutions, NGOs and commercial and private sectors. Planned activities include duplication of efforts at other key sites on the coast, capacity building and training and provision of data critical to conservation and management of turtles and the development of a Turtle Recovery and Action Plan for Tanzania.

AN INTEGRATED APPROACH TO SENTINEL SPECIES CONSERVATION: REDUCING MORTALITY OF THE NORTH PACIFIC LOGGERHEAD IN COMMUNITIES OF THE BAJA CALIFORNIA PENINSULA, MÉXICO

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Small-scale fishers can have disproportionate impacts on highly migratory species such as sea turtles. However, since their catch and bycatch are rarely monitored and enforcement is usually lacking, reducing these impacts challenges managers around the world, especially in developing nations. We employ an integrated three-part approach to loggerhead turtle conservation in BCS, México: 1) we are building diverse community conservation networks, which include fishers, students, teachers, community activists, researchers and resource managers; 2) these partnerships enable us to conduct pressing ecological research in order to develop locally appropriate solutions; and 3) this knowledge is communicated strategically in order to discourage poaching and to foster responsible fishing. The novelty and strength of our approach lies in this integration plus rigorous, ongoing assessment, yielding a conservation constituency among coastal citizens characterized by local pride, empowerment and stewardship. We report preliminary results of Proyecto Caguama indicating decreased turtle bycatch, poaching and changes in local attitude. We present our integrated approach as a model to be implemented where endangered species recovery depends on small-scale fishers' involvement.

THE GRUPO TORTUGUERO: OPEN NETWORKS AS MODELS FOR CONSERVATION

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For seven years, communities on the Baja California peninsula have worked together with international conservation organizations towards the common goal of sea turtle conservation under an umbrella known as the

Grupo Tortuguero (GT). In 2004 the GT found a new administrative home in San Diego based Pro Peninsula, a non-profit organization dedicated to empowering communities to protect their environment. Each year the GT network and the community it reaches continue to grow, encompassing the Californias and more recently, mainland México. This presentation sheds light on the GT network's model over the past seven years as well as Pro Peninsula's community based conservation efforts and the use of the following strategies towards sea turtle conservation: focusing and facilitating international support; utilization of support networks to assist local community efforts; leveraging local, national and international media; building win-win relationships with government entities; improving and facilitating academic interaction with communities; creating venues for information exchange and knowledge building. Through use of these strategies as well as other "non-traditional" conservation approaches, the GT network has become an increasingly effective vehicle for research, community outreach and capacity building, even as it grows and gains momentum. Lessons learned along the way provide valuable insight to other conservation efforts around the globe.

TURTLE CONSERVATION IN VANUATU

George Petro

Wan Smolbag Theatre, Vanuatu

This poster presents information about turtle conservation activities in Vanuatu. The presentation gives you an idea about the location of Vanuatu and the establishment of a turtle conservation network in Vanuatu – how it started, by what organization, how it developED and its scope of work. The turtle conservation network program in Vanuatu is community-based and mainly involves local village people referred to as 'Turtle Monitors'.

The presentation shows the work of the monitors in conserving turtles, which include: monitoring turtle activities in general (feeding, nesting, hatching of nests, catches), turtle tagging, involvement of village chiefs/councils/reef owners to create traditional turtle taboos, conservation of marine protected areas, and enforcement of national fisheries turtle regulations. The presentation would also show awareness activities undertaken by the turtle monitors' network through the use of plays/drama, radio, video, posters, turtle boards, workshops and school visits. Then there would be pictures depicting weaknesses, strengths and outcomes of the turtle monitors network program in Vanuatu, such as eco-tourism activities involving turtles. In short this presentation exhibits the background, growth, activities, weaknesses, strengths and the outcome of the turtle conservation work in Vanuatu since its inception ten years ago.

THE IMPORTANCE OF SOCIAL AND CULTURAL ASPECTS IN SEA TURTLE CONSERVATION PROJECT IN JAQUE, PANAMA

Martha P. Rincón-Díaz, Federico I. Solórzano, Beate Heycke and Beatriz Schmitt

Foundation Casa Taller. Av. Los Fundadores, Casa # 63, San Francisco, Panama City, Panama.

Jaqué is located along the South-Pacific coast of Panama close to the Colombian border. It has approximately 2000 inhabitants. Since 1999, the population has increased due to refugees from armed conflicts in Juradó, Colombia. This has created more pressure on the sea turtles because of the increased egg consumption and sale. Besides cultural differences between the ethnic groups, there is noticeable competition for natural resources. In 2001 some protection activities were developed for the olive ridley turtle (*Lepidochelys olivacea*) with the 8,462 hatchlings having been successfully released. These activities are supported by the "Fundación Casa Taller" in Panama. For the 2004 nesting season a team was organized to undertake a scientific evaluation of this area, to educate the people and to keep them motivated to protect sea turtles. The team consisted of biologists, social communicators and members of the community, both the Afro-Latin American people and indigenous groups called Emberá and Wounaan. The described sea turtle project does not stand alone. It was accompanied by a network, "Red Jaqué", a compound of social, educational, cultural and environmental programs that are economically and socially related to each other.

We worked on five main areas. (1) Education: The communitarian group of sea turtle conservationists was able to coordinate and execute workshops and presentations in order to handle further educative activities to gain higher participation within the community. These activities were organized in schools, hospital or police-office to turn them into multipliers of the local and regional conservation process. (2) Investigation: Together the local police unit, the hospital staff, the sea turtle conservationists and a group of fishermen patrolled the beach to record nesting events, the number of eggs and morphometric data from the nesting females. The eggs were collected and placed in two artificial hatcheries for incubation. The emerging hatchlings were released to the sea. (3) Motivation: The organization of the 1st Sea Turtle Festival in Jaqué and a painting and story writing turned out to be the motor for Jaqué´s youth to join the conservation process. Playing with various activities e.g. painting, dancing and listening to traditional African or indigenous music became the most successful elements to approach the world they live in. (4) Integration: Respecting the cultural diversity, as well as social aspects of the area, the professional team was integrated within the community to initiate a process of feedback between the scientific and empirical knowledge. (5) Communication: With the purpose of creating a common language between the people that are interested in protection and those that directly or indirectly use the sea turtles for their subsistence, a dialogue was started in order to include everyone's opinion, suggestions or alternatives while focusing on the conservation process.

TURTLE CONSERVATION AND LIVELIHOODS: EXPERIENCES WITH CONFLICT RESOLUTION ON THE ORISSA COAST

Aarthi Sridhar, Basudev Tripathy and Kartik Shanker

Ashoka Trust for Research in Ecology and the Environment, Bangalore, Karnataka, India

The growing conservation – livelihoods impasse evident in marine ecosystems, is well illustrated on the Indian coastal State of Orissa. The olive ridley nesting season for the year 2003-2004 was witness to much volatility, involving conflicts between fisherfolk, departments of the Government and conservationists over the choice of sea turtle protection measures for the State. The paper outlines the events responsible for the conflicts and the range of perspectives stakeholders in Orissa currently hold on turtle conservation measures. Emerging from this scenario was the urgent need to set in place mechanisms for conflict resolution and build partnerships among stakeholders for building and strengthening conservation initiatives. Coinciding with the new season of 2004 –2005, turtle biologists, researchers and those concerned with the stalemate are making an attempt at conciliation. The paper provides a description of the ongoing efforts towards this. In particular, the processes associated with the formation of a state level consortium - the Orissa Ridley Conservation Consortium are described. The Consortium aims at evolving a common understanding among stakeholders on sea turtle conservation and working towards its implementation.

A PATERNAL AKIN COMMUNITY WITH SAILING ANCESTORS SAVED BY SEA TURTLES

Motoki Wakatsuki

Sea Turtle Association of Japan, Hirakata, Osaka, Japan

The Okinawa prefecture consists of some groups of islands, which are located southwest of the main islands of Japan. This area had been an independent country called "Ryukyu" before the kingdom was annexed by Japan in 1879. The Ryukyu Kingdom was a small country, which occupies only 1 % of the current Japanese territory. Its national security had depended on the tribute mission of China. All exchanges between other countries had been conducted by ships, including the tribute mission. Formerly Okinawa had traded actively with each Asian country as well as China, so the living culture has reflected such historical background. In Okinawa during the great trade period, there were some families (paternal akin community) whose sailing ancestors had suffered a shipwreck, but had been saved by sea turtles. These events are reported in the archive "Kyuyou", which is a history book of the Ryukyu Kingdom.

In this poster, I address "Kobashigawa family" which is one of these families. How has the Kobashigawa family been transmitting the traditions that sea turtles saved their ancestors from shipwreck? I report primarily on discussions with the descendants. I don't inspect whether the traditions are true. However, considering the levels of nautical technique and meteorological observations we can easily guess that the risk of shipwrecking was high and that many crews drifted after sea disasters. It is also possible for adults to hold on to a sea turtle shell, judging from the size of adult sea turtles.

IMPROVED SEA TURTLE CONSERVATION, LOCAL SOCIAL AND ECONOMIC BENEFITS AND PROJECT SELF-SUSTAINABILITY THROUGH THE INCORPORATION OF A PAYING PARTICIPANT PROGRAM (PPP) AT PROJECTS IN COASTAL COMMUNITIES OF COSTA RICA

Ingrid L. Yañez, Alexander R. Gaos and Randall M. Arauz

PRETOMA, San José, Costa Rica

PRETOMA (Programa Restauración de Tortugas Marinas) started monitoring and protecting sea turtles in the communities of Punta Banco (Puntarenas, Costa Rica) and San Miguel (Guanacaste, Costa Rica) in 1996 and in 1998 respectively. Both beaches are principally olive ridley nesting sites with sporadic visits by Pacific green and hawksbill sea turtles. San Miguel also receives occasional nesting Pacific leatherback sea turtles. A Paying Participant Program (PPP) was started during the 2003 season in Punta Banco with the goals of improving beach vigilance, bringing greater social and economic benefits to community members and financial self sustainability for the project. The program turned out to be a big success in all four of these aspects. Thus the project was continued and efforts to recruit a greater number of participants was undertaken for the 2004 season. Additionally, the PPP was also started at the San Miguel project site. The PPP has provided a significant boost to the number of personnel that participate in PRETOMA's sea turtle conservation activities. Besides significantly reducing poaching levels, larger staff has resulted in an increase in the number of individual turtles identified while nesting, nests protected in project hatcheries, and hatchlings produced. Additional project personnel have also helped to improve local awareness of the project's presence. Results of more permanent vigilance during the 2004 season aimed at curbing poaching can be seen in the sharp decrease in poaching rates at Punta Banco, which dropped from 27% in 2001 to 5% in 2004 and at San Miguel, which dropped from 37% in 2001 to 9% in 2004. During the 2004 season at Punta Banco 90 nests were protected in the project hatchery, producing 8,011 hatchlings (hatchling success = 89.65%), while at San Miguel, 266 nests where protected, producing 22,383 hatchlings (hatching success =85.81%). The PPPs have been well received by local community members as they have generated substantial social and economic benefits through the creation of jobs, tourism, conservation and language education, as well as cultural interaction. Income is generated in the local economy through the provision of different food and lodging options to project participants. Education is provided by visiting local schools and establishments to teach English, discuss conservation issues and distribute literature. During the 2004 season both the Punta Banco and San Miguel projects were completely financed using monies generated by the PPP. Additionally, surplus funds generated through the PPP helped finance PRETOMA's Pacific leatherback conservation project at Playa Caletas (Guanacaste, Costa Rica) and a pilot project at Drake Bay (Puntarenas, Costa Rica).

TECHNOLOGY

SEA TURTLE STRANDINGS INFO JUST A CLICK AWAY

Lisa C. Belskis and Wendy G. Teas

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The Sea Turtle Stranding and Salvage Network (STSSN) has created a webpage to provide access to marine turtle stranding data collected by the network. Recent stranding data, is summarized by week, species and location (state and/or statistical zone) and is posted on a near real-time basis. After data forms are received, entered and verified, yearly summary data is made available through an Online Report interface. Online reports, currently available for 1998-2001, can be utilized to generate data summaries for any combination of year, month, region, statistical zone, state, county and species. Additional years, both recent and historical (back to 1980 when the STSSN was established), are currently being verified and will be added as available. Use of these data is subject to agreement to terms detailed in a data access policy posted on the website. Online data access is a valuable tool that can be utilized by network participants, fisheries managers and the general public to further marine turtle conservation efforts. In addition, general information regarding the history of the STSSN and current contact information for each state coordinator is available. The current version of the stranding data report form and information on how to complete it is provided. Links to useful reference materials, such as an anatomy manual, necropsy manuals, necropsy report forms and training videos are maintained. Links to state specific sea turtle stranding websites are also provided.

AN ONLINE SYSTEM FOR REPORTING AND MANAGING SEA TURTLE STRANDING DATA

Wendy Cluse[1], Matthew Godfrey[2] and Michael Coyne[3]

[1] North Carolina Wildlife Resources Commission, NC, USA
[2] North Carolina Wildlife Resources Commission, SEATURTLE.ORG, NC, USA
[3] SEATURTLE.ORG, Duke University, NC, USA

In North Carolina, participants of the Sea Turtle Stranding and Salvage Network (STSSN) collect stranding data that are used by state and federal managers. The data collection process can sometimes be lengthy while the reported information is, on occasion, incorrect or incomplete. Data that are accurately reported and delivered in a timely manner are crucial to making effective management decisions.

To improve the data reporting process and provide managers with accurate information, we have devised an online data collection system in collaboration with SEATURTLE.ORG that will provide a fast, efficient way for STSSN participants to report information. We will present how the system works and highlight some of the main functions. These will include informative guides to aid in correctly identifying species and taking measurements, with checks to ensure each record is completely reported and options for uploading digital photos. The data collected in the system can easily be converted into summaries or tables to be used by state managers. Each uploaded record will automatically be added to the database, thereby eliminating the need to re-enter the data and therefore saving time and decreasing transcription errors. Stranding information will also be readily available to the public, making this a useful educational tool as well. The system illustrated in this presentation will serve as a model for any organization interested in collecting and organizing their data more efficiently through collaboration with SEATURTLE.ORG.

SATELLITE TRACKING AND ANALYSIS TOOL: 150,000 DATA POINTS AND GROWING!

Michael Coyne[1] and Brendan Godley[2]

[1] SEATURTLE.ORG and Duke University, Durham, North Carolina, USA
[2] Marine Turtle Research Group, University of Exeter, Exeter, UK

The Satellite Tracking and Analysis Tool (STAT), available on SEATURTLE.ORG, is a complete package designed specifically for handling sea turtle satellite telemetry data. The STAT system downloads data from the ARGOS system, archives it into a relational database, backs up the database daily and provides integrated tools for filtering, analyzing, exporting, summarizing and mapping data. In addition, the STAT system provides a user-friendly interface for sharing sea turtle tracking projects with the public through the SEATURTLE.ORG web site. The public web site allows visitors to follow individual projects through daily e-mail updates and provide support to these projects through an adoption program. This presentation will review the progress made during the first year of use and highlight the more than 300 animals and 130,000 data points collected in cooperation with 33 partners and 43 satellite tracking projects around the world.

USING PASSIVE INTEGRATED TRANSPONDER (PIT) RFID EQUIPMENT

Sheryan P. Epperly[1], Lisa C. Belskis[1] and Lesley Stokes[2]

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Currently sea turtle researchers utilize equipment purchased from three different manufacturers: Trovan, Destron Technologies and AVID. The RFID tags of a particular frequency may not be read by all manufacturers' equipment. The result may be failure to detect a turtle that already has been marked. We presented the detailed specifications for the tags and equipment being used by sea turtle researchers and presented the results (read distance and capability to detect tags of different frequencies) from tests of each tag and reader. We showed where each is being used by leatherback sea turtle researchers and how equipment currently in use by leatherback researchers is often incompatible.

ATTACHMENT OF POPUP ARCHIVAL TRANSMITTING (PAT) TAGS TO LOGGERHEAD TURTLES

Sheryan Epperly[1], Jeanette Wyneken[2], Joe Flanagan[3], Craig Harms[4] and Shanna Kethan[5]

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Popup Archival Transmitting (PAT) tags are used in survival studies. The tags collect data over a period of time and then pop up on a designated date and transmit the data to the ARGOS satellites. In May 2003, PAT tags were attached to 3 loggerhead turtles of the 2000 year class held in captivity at the NOAA Fisheries Galveston Laboratory. At the time the tags were attached, the animals were approximately 50 cm SCL. The PAT tags were attached to a fitting on the posterior carapace via a 10 cm tether of coated monofilament. The carpacial hardware was attached by drilling two holes through the post-central scutes and securing a stainless eyestrap on the dorsal surface, through-bolting with stainless bolts and lock nuts. Nylon washers were used between stainless hardware and the carapace. During the following year we monitored the turtles weekly for subsequent changes, photographing both the dorsal and ventral surfaces of the attachment. The tags were removed in May 2004. The posterior carapace of each animal was scanned radiographically using CT and the radiographs were evaluated for the long-term impact of the attachment on the underlying bone.

FORENSIC IDENTIFICATION OF MARINE TURTLE OILS

Margaret A. Holbrook and Gloria T. Seaborn

NOAA/National Ocean Service/Marine Forensics Program, Charleston, SC, USA

Fats and oils from marine sources including threatened and endangered marine turtles may be identified using a variety of lipid analytical techniques. Marine turtle oils have been used individually and commercially as dietary supplements and in cosmetics and toiletries for medicinal or beautifying properties. Products containing oils from endangered marine turtles are prohibited by state, federal and international laws. While eggs, meat, shell and skin from marine turtles can be identified using DNA or isoelectric focusing procedures, oils generally have no DNA or protein and therefore cannot be characterized in the same manner. Forensic identification of unknown fats and oils involves a combination of analytical techniques to extract and purify the lipid fraction, separate the lipid classes present and determine lipid and fatty acid profiles for comparison with known standards. The procedures may vary for different sample matrices and are often complicated by the presence of other constituents that may also be soluble in organic solvents. Additionally, it is often difficult to obtain authentic standards for comparison due to the protected status of the animals of concern. In spite of these drawbacks, identifications based on lipid analysis are often the only option for oils suspected to have a marine turtle component and provide strong supporting evidence in wildlife law enforcement cases.

HOW TO DIFFERENTIATE REAL TORTOISESHELL FROM IMITATIONS

Laurence Leggio[1] and Jacques Fretey[2]

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When carrying out a control of objects in a souvenir shop or when objects are seized at customs, it is not always easy for the biologist, the customs agent or other official agents to differentiate real tortoise shell from imitations. Oftentimes tortoise shell is replicated by using plastic products such as celluloid, cellulose acetate, casein and bakelite. Several analysis methods can be used to differentiate these substances: microscope, short and long UV luminescence, refractive index, the "hot point" (destruction test). Under the microscope, tortoise shell reveals a characteristic coloration with light yellow-brown areas and typical dark brown spots with a fleecy appearance. Plastic imitations, on the other hand exhibit very uniform brown spots or zones that vary from yellow to dark brown. The measurement of the density and the refractive index are not significant enough to differentiate the nature of the material. By applying the heated point of a needle to the object, a characteristic odour emanates from the product: an acrylic odour when the material is bakelite, the smell of burnt milk if the product is casein, the odour of camphor is the product is made of celluloid and that of vinegar if the product is made of cellulose acetate. Genuine tortoise shell however gives off an odour of burnt hair. Imitations of tortoise shell display spectrums that are clearly diverse and with less continuous curves. The microscope is the simplest technique to rapidly differentiate between genuine tortoise shell and its imitations.

A NEW TECHNIQUE FOR MONITORING GRAZING BEHAVIOR OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) USING ACCELERATION DATA LOGGERS

Junichi Okuyama[1], Tomohito Shimizu[2], Osamu Abe[3], Kenzo Yoseda[2] and Nobuaki Arai[1]

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Understanding the grazing behavior of sea turtles is important if you want to study their behavioral ecology. Currently, there are few effective techniques available for monitoring the grazing behavior accurately over the long period. In this study, the grazing behavior of hawksbill turtles (*Eretmochelys imbricata*) was monitored with acceleration data loggers which recorded depth, temperature and accelerations in two axes. Experiments were conducted in a breeding tank at Yaeyama station, National Center for Stock Enhancement, Japan. Four hawksbill turtles were attached with two acceleration data loggers on both head and carapace with double sided adhesive tape. The turtles were released in the tank and left to recover from the handling. Their foraging behavior was recorded within a few hours. During the experiment, we recorded the behavior of turtles with an underwater digital video camera. There were four patterns of behavior that were distinguishable through the acceleration profiles and the underwater observation: resting, swimming, grazing and breathing. We extracted some patterns of head movement related to the grazing behavior using the differential analysis between head and carapace acceleration data. The new technique can clarify when and where turtles graze quantitatively as well as time allocation of their behavior patterns.

VIDEO AND FILM PRESENTATIONS

JOURNEY OF THE LOGGERHEAD: AN INTERACTIVE DVD ON MARINE TURTLES

Katy Garland, Bill Pendergraft, Ida Lynch and Jere Snyder

Environmental Media Corporation, USA

Environmental Media has produced media to support the work of environmental, education and conservation organizations for more than fifteen years, yet until we began working on Journey of the Loggerhead, we had not come in contact with so many people with such passion for one goal: the worldwide conservation of marine turtles. The sum of our work is this interactive DVD containing GIS data, satellite tracking information, still photographs, extensive interviews and a 26-minute video about the loggerhead and other marine turtle species and the people who are devoting their lives to their protection and conservation. Special video segments include: The Song "Coldwater" Written and performed by Damien Rice © 2003 Damien Rice The song accompanies a special segment on marine turtle rehabilitation. Arribada video segment - Historical footage by Andres Herrera of Kemp's Ridley sea turtles (estimated 40,000) nesting in 1947 at Rancho Nuevo in Tamaulipas, México. Journey of the Loggerhead is a multimedia exploration of the life of the loggerhead sea turtle (*Caretta caretta*). This interactive DVD is designed to help build an understanding of the connections between humans and marine turtles. Environmental Media hopes that this interactive program will help educate and inform conservation organizations, research professionals, teachers and general audiences of this critical situation. Journey of the Loggerhead has multiple uses for a variety of audiences. The DVD includes information about marine turtle life cycles, threats, innovative research, international conservation efforts, rehabilitation facilities and practices, volunteer programs, long distance migrations and the global connections between loggerheads and humans.

PLEAD FOR AWARENESS AND POLICY ADJUSTMENT

James C. D. Makor

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Liberia falls within the ecosystem of the upper Guinea Biodiversity Hotspot. It has 571 kilometers of coastline with sandy beaches interspersed with estuaries, thorny bushes and an average main temperature of 80°F. The Save My Future (SAMFU) foundation, a local environmental organization, started scientific research on sea turtle in 1999 with the aid of many key scientists. During these years of work, SAMFU identified the nesting species in Liberia, the potential threat facing these species, and four priority zones identified to establish sanctuaries for the protection and rapid replacement of depleted stock. They also hosted a national conference to develop a draft sea turtle management plan for enactment. Presently with these innovative outputs, a viable and willing team needs the basic financial support to work. Preferably, INGOs could spend a few thousand dollars for local initiatives. Some policies if not modified, will result in a waste of time and resources. "If migratory species will be protected in one global community while others enjoy killing these same species by the hundreds". We must then ask ourselves about simplified strategies for implementation at the grass root levels, or else scientific papers may continue to be presented at symposium and hundreds of nesting turtle's continued to be killed.

LOST YEARS OF THE LOGGERHEADS - NGT SEA STORIES

Alice Markowitz[1] and Cláudia Delgado[2]

[1] *Big Rock Productions*
[2] *Laboratório de Biologia Marinha e Oceanografia, Universidade da Madeira, Portugal & Centro de Estudos da Macaronésia*

The video describes loggerhead's sea turtle pelagic stage and some of the work done by Madeira University sea turtle team. This 27 minute long video was produced by National Geographic Television.

DISENTANGLING LEATHERBACK TURTLES: THE HOW-TO VIDEO

Kathleen Martin[1] and Michael C. James[2]

[1] *Nova Scotia Leatherback Turtle Working Group, Canada*
[2] *Dalhousie University, Canada*

Entanglement in fishing gear constitutes a principal threat to leatherbacks in northern foraging areas. Recognizing that the use of proper disentanglement techniques can increase the probability of post-capture survival, we developed a leatherback turtle disentanglement video with the assistance of volunteer fishers. The video demonstrates actual entanglement scenarios and releases and was distributed to more than 500 fishers across Atlantic Canada. Combined with a strong and consistent public outreach and education program, the video offers much promise in mitigating the effects of fisheries interactions on this species.

WINGS OVER THE WILD LIGHTHAWK IN MESOAMERICA

Kelly Matheson[1], Dennis Aig[2], Ken Barrett[2] and Karl Swingle[2]

[1] *Montana State University, USA*
[2] *Montana State University and The Hunter Neil Company, USA*

Combining their love of flight with their passion to protect the planet, a growing number of pilots fly volunteer missions over vibrant and threatened lands. In this film, you will meet two of these pilots - David Smith and Kevin Roache - who spend their time off from their day jobs to fly in Central America for LightHawk, a conservation aviation organization. Each spring, David Smith flies aerial surveys with marine biologist, Sebastian Troëng, in his Cessna 185 to count the tracks of nesting sea turtles along the Caribbean coast. The data collected on these flights convinced the government of Costa Rica to deny Harken Energy's - George W. Bush's old company - request to drill for oil close to the nesting beaches of the world's largest species of sea turtle. Near the Pacific, Kevin Roache, a commercial jetliner pilot, flew a group of indigenous women over the area where the Costa Rican government plans to erect Central America's largest dam. This 260-meter hydroelectric project, would cause an ecological and cultural disaster, flooding an expansive area of lowland tropical rainforest and the homes of the Boruca people under hundreds of feet of water. By putting you in the captain's seat beside these pilots, this film carries you on a fascinating journey, introducing you to people who fly to protect an ecologically rich corner of the planet. This film celebrates their belief that each of us can make a difference.

RELOCATION OF LEATHERBACK TURTLE EGGS ON A NESTING BEACH IN ST. KITTS

Patricia McCroy[1] and Barry Svendsen[2]

[1] Nova Southeastern University, Fort Lauderdale, FL, USA
[2] Volunteer for 4 years at nesting beach

On March 6, the first leatherback turtle came ashore on a beach frequented by turtles in St. Kitts. The eggs were laid on an area of the beach that could be washed away by waves as there is much sand erosion in the area. An experienced monitor, Mr. Svendsen, relocated the eggs up beach, counting them, and observing and counting the numbers that hatched later in May. This would be a presentation with a video of the turtle, eggs being laid, removed and the process of relocating. Ms. Mccroy made the video. Mr. Svendsen has been doing this for at least 4 years and has data on all years. The video would be accompanied by an introduction by Ms. McCroy and by a question and answer period by both presenters. St. Kitts is an unknown and undeveloped area in everyway in terms of information/knowledge about nesting turtles. The Ministry of Tourism and the Fisheries dept have both taken no action on a United Nations/Caribbean Environmental program suggestions for preserving turtle life done in 1992. There will be a handout on the difficulties of conservation attempts in Caribbean countries as relates to sea turtles by Patricia McCroy.

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