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PROCEEDINGS OF THE THIRTY-SECOND ANNUAL SYMPOSIUM ON SEA TURTLE BIOLOGY AND CONSERVATION

11 to 16 March 2012

Huatulco, Oaxaca, Mexico

Compiled by:

Eduardo Cuevas, Shaleyla Kelez, and Lisa Belskis

U. S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

Southeast Fisheries Science Center

75 Virginia Beach Drive

Miami, Florida 33149

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PRESIDENT´S REPORT

32nd Annual Symposium on Sea Turtle Biology and Conservation

"Time for Innovation"

11 – 16 March 2012, Huatulco, Oaxaca, Mexico

Ana Rebeca Barragán Rocha, President, ISTS

Mexico is a special place for the conservation of sea turtles, where six of the seven species that exist in the world can be found, including one of the oldest conservation programs of the continent, the National Sea Turtle Conservation Program. Oaxaca in particular is a very important place, with nesting beaches of recognized relevance and coastal communities with strong cultural ties to sea turtles. In this sense, Huatulco did not disappoint as our venue. The week of 11 to 16 March 2012 was full of culture, science, music, tradition, innovation, and of course, sea turtles.

The theme this year was ***"Time for Innovation"***, with a focus on innovative aspects of the conservation of marine turtles: new techniques, new perspectives and new actors. Many programs for the conservation of these species in the world have promoted various measures of protection for more than two decades. Thanks to these long-term programs, it has been possible to define and establish protocols internationally standardized for the most basic aspects of the research and management related to sea turtles. It has been necessary to rely on these platforms to support other equally strong and successful programs around the world, using a common language and always with the perspective of applying the best techniques for the conservation of the stocks of these marine reptiles. Today, many regions of the world have used these platforms as the foundation of their conservation initiatives, and many of them have promoted and performed the same activities for a long time, which is the essence of long-term monitoring. However, what if turtle conservation demands new strategies and perspectives due to changes in the natural, social, economic or political environment? Are we prepared for these changes? Do we have the will to adopt new generation approaches or technologies? Do we even know our options to improve and make our turtle conservation projects evolve? These are the aspects that we set out to explore during our stay in Huatulco.

The academic program allowed us to recognize those initiatives whose approaches and methodologies proposed new ways of doing conservation. We could show to the international community those projects and programs that have had the vision and the courage to go beyond the protocols and standardized and traditional techniques, and achieved creative and functional adaptations with respect to the above-mentioned basic platforms. This is the essence of the development and evolution of the science of conservation, in constant movement, creation, adaptation and innovation to achieve best results.

During the MiniSymposium *"The Sea Turtles of Mexico"* we reviewed the work existing in the country by researchers, institutions and groups both national and international, who have recognized the relevance of Mexico in this topic. It was evident that, unlike two decades ago, the conservation of sea turtles is not performed by a single individual, group or institution, but each time we can see more collaborative efforts, NGOs working alongside with Government institutions, academia and local community groups. Now more than ever the conservation is synergies, communication and cooperation.

This same trend was observed in the rest of the sessions. We saw an enhancement of multidisciplinary initiatives, combinations of technologies and disciplines such as engineering with biology to fill gaps in knowledge; Social Sciences combined with the Biological Sciences in creative conservation projects, comprehensive approaches which two decades ago were not possible, but that now suggest a very rich and interesting future.

We also found long-lived projects re-evaluating their approaches and methodologies in the light of new discoveries and technologies, teaching us that nothing is written in stone and that both science and conservation are dynamic and, like humans, they should adapt and evolve or disappear.

Finally, we witnessed a greater involvement of local coastal communities in sea turtle conservation projects, something unthinkable 30 years ago. Increasingly more presentations and posters have locals as co-authors, and we met members of community groups on the coast of Oaxaca who attended academic sessions throughout the week, attending scientific presentations that were not written "to their level". The International Sea Turtle Society has broken the myth that the residents of local communities cannot attend a scientific meeting and less be interested in it; we have tested that the exchange of experiences can be done at all levels, with a little effort. This is something that honestly we should be very proud.

In summary, the balance of the 32 International Sea Turtle Symposium has been very positive. It will become the cradle of new ideas for projects, new collaborations and strengthening of projects in conservation, new partnerships, and new teachings. This makes the future of the conservation of sea turtles in the world very promising, and with all my heart I thank all who have made this possible.

Ana Rebeca Barragán Rocha
ISTS President, 2012

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Atlantic Leatherback Regional Meeting	Nagore Zaldua-Mendizabal, Alejandro Fallabrino
Climate Change Workshop “Train the Trainers”	Marianne Fish, Diego F. Amorocho
Selecting and Attaching Appropriate Biotelemetry Tags to Answer Your Research Question	Todd Jones, Ann Rupley, Kevin Ng, Kevin Lay
Environmental Education Workshop	Frances Kinney, Mireya Viadiu
IUCN Marine Turtle Specialist Group Anual General Meeting	Roderic Mast, Nicolas Pilcher, Brian Hutchinson
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Llew Ehrhart 4th (1984, Oviedo, USA)

Sally Hopkins 3rd (1983, Charleston, USA)

Chuck Cowan 2nd (1982, St. Simon Island, USA)

Fred Barry & Bob Shoop 1st (1981, Jacksonville, USA)

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STUDENT AWARDS

There were 135 student presentations eligible for the Archie Carr Student Awards (59 oral presentations and 76 poster presentations). All presentations were viewed and ranked by 15 judges, all recognized sea turtle researchers and project leaders. The awards were given to:

	FORMAT	PRIZE	STUDENT	INSTITUTION
Biology	Poster	Winner	Anahí Martínez Arenas	Universidad Nacional Autonoma de Mexico
		Runner up	Ana Patricio	University of Puerto Rico, USA
Conservation	Poster	Winner	Joanna Hancock	University of Exeter, UK
Biology Experimental	Oral	Winner	Daphne Goldberg	Universidad de Estado do Rio de Janeiro Brazil
		Runner up	Anthony Rafferty	Monash University, Australia
Biology Field-based	Oral	Winner	Deasy Lontoh	Moss Landing Marine Lab, USA
		Runner up	Karl Phillips	University of East Anglia, UK
Conservation	Oral	Winner	Monette Auman	University of Central Florida, USA
		Runner up	LoriKim Alexander	Florida Gulf Coast University, USA
		Runner up	Nick Ehlers	University of Northern British Columbia, Canada

ISTS AWARDS 2012

ISTS Lifetime Achievement Awards:	George Balazs
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	Llewellyn Ehrhart
ISTS Champions Awards:	Laura Sarti
	George Petro
ISTS Ed Drane Award for Volunteerism:	Gary Buckles
ISTS President's Award:	Cuauhtémoc Peñaflores

KEYNOTE PRESENTERS

- *Luis Fueyo MacDonald*
  "Conservation program for species at risk: species and spaces for sea turtles in Mexico"
- *Larry B. Crowder*
  "Innovative Approaches to Science and Policy in Sea Turtle Conservation"
- *Lekelia D. Jenkins*
  "Fishermen Selectivity: The Science of How to Best Engage the Right Fishers to Reduce Bycatch"
- *Jack Frazier*
  "Revitalization or Innovating Innovation for Marine Turtle Conservation"

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Anatomy, Physiology and Health

ANTHROPOGENIC THREATS TO THE SEA TURTLE POPULATIONS ALONG THE BRAZILIAN COAST

Cecília Baptistotte[1], Gustave Lopez[2], Denise Reith[2], Marcelo Renan de Deus Santos[3], Marcillo Altoé Boldrin[3], Max Rondon Werneck[4], Henrique Becker[5], Daphne W. Goldberg[6,7], Gustavo David Stahelin[6], Maria Angela Marcovaldi[2], and Thaís Pires[2]

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[3] Centro Universitário Vila Velha – UVV-ES, R. Comissário José Dantas de Melo 21, 29102-770, Vila Velha- ES, Brazil
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Post mortem examination is an important tool in sea turtle diseases investigation and its relation to anthropogenic stressors. In order to identify the possible causes of sea turtle strandings, Projeto TAMAR-ICMBio conducts necropsies at its research stations along the Brazilian coast. Moreover, TAMAR has developed research agreements through veterinary universities research programs to allow more accurate diagnostics. In this study, we analyze results from 989 necropsies performed at TAMAR Stations in Bahia, Espírito Santo, São Paulo and Santa Catarina States, from January 2009 to May 2011. During this period, we examined necropsy findings from 920 *Chelonia mydas* and 69 *Eretmochelys imbricata*. The samples from Bahia and Espírito Santo included respectively 191 and 372 *C. mydas* and 49 and 20 *E. imbricata*. Two hundred and seventy two *C. mydas* were necropsied at the Ubatuba Station, in São Paulo, and 85 at the Florianópolis Station, in Santa Catarina. Among these animals, 93% were juveniles, with the curved carapace length (CCL) varying between 0.25 and 0.48 m. In 33% of the necropsied *C. mydas*, drowning was characterized as the main cause of death, which may provide a strong indication of fishing interaction. Thirteen percent of the animals had gastrointestinal lesions (not related to debris ingestion) and 10% had their death related to marine debris ingestion. Sixteen percent of the individuals died as a result of other health disorders, and in 28% of the turtles, it was not possible to determine the cause of death. In hawksbill turtles, a 33% incidence of gastrointestinal complications was observed, as well as 30% of marine debris ingestion and 7% of drowning signs. 17% had other types of health disorders and in 13% it was not possible to determine the cause of death. Although information concerning sea turtles health conditions is scarce, it is possible that data on specific cases, may improve post mortem diagnosis. The results show that drowning is the first leading cause of death, which suggest possible fishery interaction. Secondly, lesions along the gastrointestinal tract indicate marine pollution, especially marine debris ingestion as a relevant threat. This information can be useful to improve the knowledge on sea turtles threats and consequentely indicate some conservation actions.

TRENDS IN FIBROPAPILLOMA RATES OF JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) CAPTURED OFF OF SOUTH HUTCHISON ISLAND, FLORIDA*

David Clark, Michael J. Bresette, Steve Weege, Jeff Gomas, Cody Mott, Jeff Guertin, and Jonathan Gorham

Inwater Research Group Inc.

Near shore habitat off the Coast of South Hutchison Island, Florida is primarily composed of Sabellariid worm-rock reef. These reefs provide important developmental habitat for juvenile green turtles. The Florida Power and Light St. Lucie Nuclear Power Plant is located on South Hutchinson Island and draws ocean water into a cooling canal from an area adjacent to the near shore reefs. Green turtles are regularly entrained with ocean water into the intake canal where they are captured, tagged, measured and released. Using capture data obtained between 1984 and 2010 from the power plant's Sea Turtle Program, seasonal and temporal trends in fibropapillomatosis (FP) rates of juvenile green turtles were analyzed. We found no significant long-term trend in FP rates; however, significant seasonal trends in FP rates were observed in this aggregation of green turtles. Links between the seasonal FP rates of green turtles on the nearshore reefs of Hutchinson Island and the rates of FP found among green turtles in the adjacent Indian River Lagoon are discussed.

CLINICAL AND POST MORTEM FINDINGS OF A GREEN TURTLE (*CHELONIA MYDAS*) CAPTURED IN THE GULF OF VENEZUELA

Brirelys Conde[1], Jordano Palmar[2], Marycruz Alvarado[3], Vanessa Ilukewitsch[4], Mariela Mavarés[5], Jesús E. Camacho[6], Hector Barrios Garrido[7], and Ninive Espinoza Rodriguez[2]

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[6] Unidad de Anatomía Patológica. Policlínica Veterinaria Universitaria del Zulia. Maracaibo. Venezuela
[7] GTTM-GV. Laboratorio de Ecología General, FEC, Universidad del Zulia, Maracaibo – Venezuela. IUCN SCC MarineTurtle Specialists Group (IUCN SCC-MTSG). Centro de Modelado Científico, Universidad del Zulia (CMC)

In the Guajira Peninsula, the green sea turtle (*Chelonia mydas*) is the most abundant sea turtle species and is extensively used by local inhabitants as a food, religious, and economic resource. Although currently green turtle populations have been depleted as a result of fishing activities, community-based conservation programs conducted by Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela have involved people in sea turtle conservation efforts and decreased consumption. The close relationship that has developed with fishing

communities has resulted in frequent reporting of sea turtle by-catch events. Here we report the incidental capture of a juvenile green turtle in an artisanal fishing net in Kazuzain (Mid-Guajira, Venezuela). The size of the turtle was typical for juveniles in this area; 29.1 cm curved carapace length and 25.8 cm curved carapace width (CCW), with a weight of 1.8 kg. The green turtle was transferred to Maracaibo City for clinical evaluation, where it exhibited abnormal postures and movements on land and water, exaggerated responses to stimuli, excitability in response to handling, and muscle tremors. When observed in water, the turtle presented poor swimming coordination and continuous turning behavior; from the time of its arrival, when at rest, the turtle supported its body by using the rear flippers to push upward to the water's surface, holding its body at a 45 degree angle. Over the course of 7 days during, the turtle displayed a lack of appetite, bowel movements were absent, and polyuria was observed; however hematological analyses yielded values within normal parameters. Following this 7 day period, the turtle was found dead and was immediately necropsied. The most prominent pathologic findings were thickening of the walls of the digestive tract and the presence of a yellowish, odorless fluid. Fecal material was present in the posterior portion of the digestive tract and appeared normal, without evidence of petrification. The bladder was filled with urine, lungs remained filled with air subsequent to removal of the plastron, and although the muscles were pale and pasty, other tissues did not present apparent injuries. Samples of organ tissues were collected for subsequent histopathologic analysis, which might provide information regarding cause of death; however initial diagnosis was made that mortality occurred as a result of the stress and associated immunosuppression associated with captivity. Despite the absence of a clear cause of death, from a clinical point of view all of the data collected (symptoms, signs, and diagnosis) are of value due to the lack of information about diseases in sea turtles in their natural environment and their relevance to ecosystem health. Furthermore, from a public health perspective, it is important to assess the possibility of zoonotic disease transmission to a human population that culturally consumes sea turtles.

FISHING HOOK LESIONS INCIDENTALLY RECORDED IN LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) BYCATCHED IN BOTTOM TRAWLING

Antonio Di Bello[1], Simona Soloperto[2], Olimpia R. Lai[2], Carmela Valastro[1], Daniela Freggi[3], Pasquale Salvemini[4], and Giuseppe Crescenzo[2]

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[3] WWF Sea Turtle Rescue Centre, Lampedusa (Ag), Italy
[4] WWF Sea Turtle Rescue Centre, Molfetta (Ba), Italy

During the period October 2010 - October 2011 the WWF Rescue Centre of Molfetta (Italy) referred 134 loggerhead sea turtles (*Caretta caretta*) to the Faculty of Veterinary Medicine of Bari (Italy) for clinical evaluation following to bycatch in bottom trawling in Manfredonia Gulf (Southern Adriatic Sea, Italy). After biometric assessment, all the turtles underwent clinical evaluation and radiographic examination to check for lesions ascribable to the capture (carapace and plastron trauma, skull or limb fractures, pneumonia subsequent to forced submergence and drowning). Dorsoventral, lateral and craniocaudal (horizontal beams) projections of head, total body and limbs were performed. In 8 turtles (6%) the presence of fish hooks in upper gastrointestinal tract was assessed: 3 animals presented an evident fishing line, while the presence of the hooks resulted accidentally at the x-ray

examination without apparent clinical abnormalities in the other subjects. Four hooks were localized in the intracoelomatic tract of the esophagus, in correspondence of tracheal bifurcation, and the other ones in cervical esophagus. In one case the hook was manually removed after sedation, while the others required surgical procedures. The hooks located in upper esophageal tract were removed after cervical esophagotomy, while the removal of the ones positioned deeper in non papillated esophagus was achieved after a transversal supraplastron surgical approach to access the coelomic portion of the esophagus. During surgery, one of the turtles, presented in critical conditions, revealed a long fishing line attached to the hook, so a right prefemoral approach to coelomic cavity was performed in order to remove it from intestinal lumen with multiple enterotomies on the exteriorized small intestine. In 3 turtles the hook had pierced the esophageal wall and were located extra-lumen, giving rise to large inflammatory responses with granulomatous abscessations, which caused the displacement of trachea and the partial obstruction of esophageal lumen. Nonetheless, surgery proved solving, and adequate post-surgical management (with 2 to 5 weeks of hospitalization) allowed the total recovery and the release of the turtles. Data from this study show that the major risks of longline fishing bycatch are not only the presence of tracts of lines in the gastrointestinal tube, as reported by numerous Authors, but also the hook itself, as it can give rise to foreign body granulomatous reactions that can occlude the gastrointestinal tract, and impair the feeding capacity of the turtles. Acknowledgements: The authors wish to thank International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service, and the Sea Turtle Symposium for their generous support.

HEARING SENSITIVITY OF HATCHLING LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*)*

Wendy E. Dow Piniak[1], Craig A. Harms[2], Elizabeth M. Stringer[3], and Scott A. Eckert[4]

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Rising levels of anthropogenic noise throughout the world's oceans are creating concern about the potential impact of sound on many marine species. Sea turtles do not appear to vocalize or use sound for communication, but may use sound for navigation, locating prey, avoiding predators, and general environmental awareness. Critically endangered leatherback sea turtles (*Dermochelys coriacea*) have the largest latitudinal distribution of all sea turtles, foraging in high-latitude sub-polar waters and nesting on low-latitude tropical beaches. Much of their habitat overlaps with sound producing activities, so they are exposed to anthropogenic sounds such as: oil and gas exploration and extraction; shipping; construction; and sonar. To determine if leatherbacks are capable of detecting these sounds, we measured the hearing sensitivity of hatchlings in both water (n=11) and air (n=12) by recording auditory evoked potentials (AEPs). AEPs are produced by the synchronous discharge of neurons in the auditory pathway after acoustic stimulation. Before testing, we isolated hatchlings from noise and vibrations and lightly restrained them to prevent movement that would mask AEP signals. To reduce stress and further decrease

muscle movement we chemically restrained hatchlings using midazolam (water: n=11; air: n=7) or anesthesia (air: n=5). For underwater measurements, we submerged hatchlings 13-15 cm below the surface (measured at the location of the ear) and presented stimuli with an underwater speaker (Clark Synthesis AC339), calibrated with a hydrophone (HTI-96-MIN). We submerged hatchlings and collected AEP recordings during one-minute intervals, raising hatchlings to the surface between intervals. For aerial measurements we placed hatchlings on foam pads and presented stimuli with a suspended aerial speaker (Definitive Technology DI6.5R), calibrated with a microphone (LinearX Systems, Inc. M31). A Tucker-Davis Technologies Evoked Potential Workstation with SigGen and BioSig software generated stimuli and recorded AEP responses. Using a three-electrode array, we recorded responses to 50 ms tonal stimuli between 50-3200 Hz, and attenuated tones in 6 dB steps until no AEP signal could be detected. We determined an AEP to be present if the signal recorded showed a peak at twice that of the presented stimulus frequency and at least 6 dB above the background noise 100 Hz on either side of the doubling frequency in the frequency domain, defining threshold as the lowest level at which a peak was present. Results showed that hatchling leatherbacks are able to detect sounds in water and air, responding to stimuli between 50-1200 Hz in water and 50-1600 Hz in air. These represent the first measurements of leatherback sea turtle hearing sensitivity and, like other species of sea turtle, they appear to have a relatively narrow, low frequency range of hearing sensitivity. Their hearing sensitivity overlaps with the frequencies of many anthropogenic sounds, suggesting that leatherback hatchlings are able to detect the sounds of these activities, and highlighting the need to investigate their potential behavioral and physiological impacts. We would like to thank the Bureau of Ocean Energy Management for supporting this research and the International Sea Turtle Symposium, International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service for Symposium travel support.

FROM FIELD TO LABORATORY STUDIES: CASE OF SELENIUM IN CHELONIANS*

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Persistent organic pollutants (POPs) and trace elements (*e.g.* Cd, Pb, Hg) have been detected in marine turtles at all stages of their life cycle. They are reported to disrupt development and function of wildlife. However, little information is currently available about the accumulation and the effects of pollutants on turtles. The threat associated with pollutant exposure was investigated in the green (*Chelonia mydas*) and the hawksbill (*Eretmochelys imbricata*) marine turtles from Guadeloupe (Lesser Antilles). The toxicodynamics and kinetics of an essential element, the selenium, was more precisely tackled through an *in vivo* and *per os* study using an experimental turtle species, the yellow-bellied slider turtles *Trachemys scripta scripta*. Field study: In 2008, eggs from 11 greens (n=22) and 4 hawksbills (n=8) were collected in Guadeloupe and analyzed for POPs (PCBS, DDTs, HCHs, Aldrine, Dieldrine, Chlordecone) and minerals (Ca, Fe, Cu, Se, Cd, Pb, Hg). Calculation of the screening risk assessment (SRAs) and related hazard quotients (HQs) was done. Most investigated POPs and minerals were detected in eggs from both species although in low concentrations. Among minerals, selenium was of concern since the worst-case HQ reached 17.8 in hawksbill eggs. Since deleterious effects can be suspected at a HQ ≥ 1, results suggested a likely risk of selenium toxicity for developing embryos. In vivo

study: In September 2010, 160 yellow-bellied slider turtles of four-weeks old were acquired and housed by pair in plastic tank. A six-month holding period was used to accustom turtles to the feeding regime and to laboratory conditions. Three groups of 42 individuals were designed. The feeding trial consisted in an eight-week supplementation period followed by a four-week depuration period. At defined intervals, six individuals per group were sacrificed and tissues were collected (carapace, scutes, skin, blood, liver, kidney, muscle) for selenium analysis. During the supplementation period, two groups of turtles were fed with diet containing 23 or 47 µg/g of selenium and compared to a control-group feeding on non-supplemented food. During the depuration period, all the remaining individuals were fed with non-supplemented control diet. Se-concentration in all collected tissues increased in a dose-dependent way over the course of the supplementation period. Higher Se levels were observed in kidney, followed by muscle and blood. At the end of that period, tissue selenium reached up levels exceeding toxic thresholds established for birds or fishes. However, no effect was observed on survival, diet behavior or growth. In addition, significant relationships were highlighted between internal tissues (kidney, liver, muscle) and external ones (carapace, skin, blood). Conclusion: While pollutant levels were generally low in green and hawksbill turtle eggs, results suggested a potential threat of selenium to developing embryos. Results from the in vivo study however indicated that high selenium levels failed to impair young individual body condition. Lack of toxic thresholds in turtles warrant the need of further investigations on turtles to better understand responses to pollutants. Besides, carapace and skin were proposed as relevant non-invasive tools in biomonitoring toxicological studies conducted on field. Keywords: maternal transfer – ecotoxicology – selenium.

AEROMONAS GREEN TURTLE INFECTION IN URUGUAY

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The microorganism more patogen in reptiles are Gram negative bacterias, and from this group *Aeromonas* sp. are involved in septicemia, pneumonia and estomatitis diseases. Aeromonas is a normal habitant of the oral cavity, gastrointestinal tube and skin. But in inmunosupressed conditions they can be very pathogens. This is a description of three clinical cases associated at *Aeromonas* sp. in *C. mydas*. In winter of 2010 two green turtles stranded in Coronilla (Rocha) and one in Punta del Este (Maldonado). The LSC and weight averaged 33.8 cm y 4.56 kg respectively. All turtles had bad corporal condition, anorexia, lethargy, depression and buoyancy problems. Only one had constipation and the others defecated without anthropogenic debris. The treatments consist in hidratation with serum, nutritional complex and antibotictherapy with enrofloxacin and sulfatrimetrprim. Two of the turtles died a month after arriving at the Rescue Center. A month later the remaining turtle presented necrosis of the distal part of both forelimbs. The X- Ray showed normal radiodensity of the phalanges. The hemoculture was sensitive at amikacin, ceftazidime, ceftriaxone, cefuroxime, piperacilin tazobactam, amplicilin sulbactam and imipenem. One week later the turtle died. In the necropsy all turtles had severe muscular atrophy, serosanguinous collection in the coelom and congestive trachea, epiglottis and lungs. *Aeromonas* sp. was isolated from the joint between the second and third phalange of the second finger from the last turtle and was sensitive to the same antibiotics of the blood culture except piperacilin tazobactam and amplicilin sulbactam that was resistant. The first two dead turtles presented caseous nodules in the lungs whose isolated agent was also

Aeromonas sp. and were sensitive at ciprofloxacin, gentamicin, trimetroprim sulfametoxazol. The septic ulcerative skin disease can caused lethargy, anorexia and debility. The pathogens associated at this illness are *Aeromonas* sp., *Pseudomonas aeruginosa*, *Pseudomonas fluorescens*, *Staphylococcus aureus*, *Proteus* sp., *Acinetobacter* sp., and *Citrobacter* sp. The turtles in this study had different skin lesions, being worse those from the last dead turtle. Unfortunately it is uncommon to know what is the particular pathogen involved because skin lesions are frequently contaminated with a lot of microorganism and the cultures can be unspecific. The election of the correct antibiotic is not easy. Despite the agent isolated from blood and lungs of the last dead turtle were the same (*Aeromona* sp.), the antibiotigram was very different. In the first study the pathogen was sensitive to piperacilin tazobactam and amplicilin sulbactam but in the second they were resistant. A possible explanation is that the *Aeromonas* sp. isolated were not from the same species so they could have different sensitivity. Acknowledgments: Daniel Del Bene, Mauro, Bruno and all the voluntiers that participate in the care of the turtles.

GHRELIN, LEPTIN AND THE NESTING ACTIVITY OF THE HAWKSBILL SEA TURTLE (*ERETMOCHELYS IMBRICATA LINNAEUS*, 1766)*

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Sea turtles make long-distance reproductive migrations, and some species are thought not to feed after arriving at their nesting grounds. Therefore, while on their foraging waters, these species must store energy and nutrients required for reproductive output. Females may become underactive between oviposition episodes to save their energy reserves for nesting purposes. Among explanations for this hypophagia, low food availability in waters near the nesting beaches has been pointed out, but data on hormones capable of regulating food intake by these turtles have yet to be published. Leptin (appetite-suppressing protein) and ghrelin (hunger-stimulating peptide) affect body weight by influencing energy intake in all vertebrates. Expression and secretion of ghrelin are increased by fasting and reduced by feeding. Conversely, leptin is an adipocyte-derived hormone related to body adiposity, which secretion is reduced by fasting. To correlate these hormones with nutritional parameters that indicate food consumption or fat metabolism, consecutive blood samples were withdrawn repeatedly from each of 21 specimens of *E. imbricata* during the 2010/2011 reproductive season. These turtles were nesting along the coast of Parnamirim municipal district, Rio Grande do Norte State, Brazil. On first contact, the females exhibited an average post-oviposition weight of 83.95 kg (± 12.07; n=14). At the end of the nesting season, this average dropped to 77.18 kg (± 9.85; n=14). They had an average weight loss of 7.73% (± 5.2). Triacylglycerols, urea and total protein concentrations changed with increasing number of nesting episodes, indicating lipolytic and proteolytic responses to fasting. During fasting, adipose tissue triglycerides are broken down by a hormone sensitive lipase to glycerol and free fatty acids. Fatty acids are used as an energy source, especially in muscle tissue, reducing the demand for organic glucose. Small amounts of glycerol from fat are then converted into glucose through gluconeogenesis. Moreover, during fasting, catabolism of

muscle proteins to aminoacids produces the major source of carbon for maintenance of blood glucose levels. A consistent rise in blood urea nitrogen (BUN) throughout the nesting period also indicated muscle protein utilization. Leptin in serum decreased significantly as the number of nesting events per individual increased. Initially the average serum levels were 2005.95 ng/ml (± 708.34; n=12), decrasing to 348.7 ng/ml (± 198.6; n=8). On the other hand, ghrelin serum levels were markedly lower at the beginning of the nesting period (31.56 pg/ml ± 28.32; n=9) than at the end of the nesting season (540.82 pg/ml ± 312.58; n=7). Our findings indicate that the hormones leptin and ghrelin, both capable of affecting appetite and food intake, could be involved with the hypophagia observed in nesting sea turtles.

MASS STRANDING EVENT OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) TURTLES ON GUATEMALA'S PACIFIC COAST

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Eight weeks before the official start of the 2011 nesting season, a male olive ridley turtle (*Lepidochelys olivacea*) was found stranded at Hawaii, one of Guatemala's most important nesting beaches. The turtle was found in extremely poor condition and was taken by a local villager to Parque Hawaii, the local sea turtle hatchery operated by ARCAS (Association for Rescue and Conservation of Wildlife). Over the course of the next 20 days, 18 additional olive ridley turtles, (8 alive and 10 dead) were found stranded across a 12km area in the Hawaii region. The majority exhibited external signs which included excessive algae growth on the carapace and plastron, heavy epibiota, severe emaciation, and distinctive dark markings on the plastron area. An additional 15 turtles in similar conditions were located offshore within a 20 mile radius of the stranding site, during four in-water surveys conducted by Akazul and Protortugas staff. Sea turtles with such conditions are often described as suffering from Debilitated Turtle Syndrome (DTS). In total, 16 live turtles were brought to Parque Hawaii for treatment, which included the administration of intramuscular injections of antibiotics and vitamins, oral electrolytes and a food solution of liquidised fish and shrimp. Blood samples were taken and analysed at the University of San Carlos in Guatemala City. Although the condition of some individuals seemed to improve whilst undergoing treatment, all eventually died. Most turtles survived an average of 2-3 days, with only a few of individuals surviving more than a week treatment. Necropsies were conducted on all 16 turtles, revealing emphysema as the most common finding, followed by a serous atrophy of fat, enlarged liver, pericardial fluid, and diarrhoea. Organ tissue samples from seven of the necropsied turtles were submitted by ARCAS to the laboratories at the National Wildlife Health Center, in the Honolulu Field Station in Hawaii (USA) for microscopic examination. Results from histological tests showed no unifying cause of death; there was no clear evidence to suggest the presence of any infectious agent (virus, bacteria, parasite or fungus) or man-made toxin which could be attributed to these mortalities. Considering all of the above, it appears that all turtles were debilitated for an extended period of time (possibly months) and suffered secondary conditions due to emaciation and dehydration. In total, 34

turtles were observed during the stranding period, (18 alive, and 16 dead) comprised of 12 males (35%), 14 females 41%) and 8 turtles of unknown gender (24%). The mean curved carapace length (CCL) was 61.66 cm. This is the first mass stranding event that has been documented in Guatemala and has been important for reporting on sea turtle health in the region and improving Guatemala's knowledge and techniques of sea turtle rescue and rehabilitation.

VARIATIONS IN DORSAL AND COSTAL SCUTES IN LOGGERHEAD HATCHLINGS

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The loggerhead nesting population in Cape Verde is one of the most important in the Atlantic Ocean and many internationally-supported actions to conserve this population have been conducted through the NGO CV Natura, particularly during the past 6 years. Beginning in 2006, an important experimental and conservation program was initiated to re-establish a loggerhead nesting colony in the Canary Islands by moving a portion of eggs from the Cape Verde nesting population to Canarian beaches. These long-distance egg translocation experiments were conducted from 2006 to 2010. Also, during this same time frame, a hatchery program has been implemented to conserve this colony, moving 600 nests per breeding season from areas with low hatching success to hatcheries. During 2011, a total of 223 nests was collected within 0 to 8 hours after being laid and moved a maximum distance of 5 km from southeast Boa Vista beaches to the hatchery. Typically, loggerhead sea turtles are characterized by having five vertebral and five pairs of costal carapace scutes, with marginal scute number varying between 12 and 13 per side. However, during recent years variations in scute numbers were observed and it was proposed that these changes might be the result of the extensive nest relocations conducted as part of the conservation program. The current study describes the types of variations observed in carapacial scute number for loggerhead hatchlings. In addition, the potential influence of nest relocation on scute counts was assessed by comparison of hatchlings from: a) non-relocated nests from Boa Vista beaches (522 hatchlings); b) nests relocated a short distance to a nearby hatchery (1,773 hatchlings); 3) nests relocated long distances from Cape Verde to Canarian beaches (1,138 hatchlings); and 3) nests relocated from Cape Verde to the Canary Islands and incubated in laboratory conditions (384 hatchlings).

SEA TURTLE RESEARCH, RESCUE AND REHABILITATION CENTRE (DEKAMER), DALYAN, MUGLA-TURKEY: RESULTS OF REHABILITATION, BLOOD AND HORMONE PARAMETERS

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The first sea turtle rescue centre (DEKAMER) in Turkey was established in 2008 and its activities are explained in this work. A total of 40 injured turtles were admitted until the end of 2011. The main causes of injuries were related to fishing activities such as hook ingestion, fishing line cuts, propeller cuts, speed boat crashes and buoyancy problems. A large effort is made to increase public awareness because its importance to the overall goal of sea turtle protection is crucial to the survival of the species. An outreach program for locals, students, tourists and tourist companies was created by DEKAMER. The center provided information to approximately 30,000 visitors annually. The physiologic blood parameters of 23 *Caretta caretta* and two *Chelonia mydas* individuals were investigated. Sex affects plasma concentration of cholesterol (Chol), triglyseride (Trig), urea, creatinine, lactate dehydrogenase (LDH), potassium (K), phosphorous (P) and magnesium (Mg). Plasma Chol and Trig levels were considerably high in healthy group of turtles which has a large proportion of nesting females. Females have considerably high LDH levels. K levels were also high in females which may be resulted after high nesting effort on land. Urea levels were lowest in female turtles. All altered plasma biochemical values except urea can be explained by increasing physical effort due to nesting of *C. caretta* females. All parameters were found very low in injured turtles. We have also investigated Steroids hormones Testosterone (T), Estradiol (E2), Progesterone (Pro) and Corticosterone (B) of healthy loggerhead turtles. Hormone levels of turtles were affected by health condition. We found that T and E2 levels were important according to health condition. Plasma E2 and Pro levels were found higher, T and B levels were found lower in injured turtles. E2 levels were found dramatically high in injured turtles in both sexes and maturity conditions. There were no significant differences in T levels among sexes when injured turtles included for statistical analysis. Healthy male and subadult turtles are not providing enough sample size for statistical analysis but mean plasma T levels were higher in male turtles. Based on the results of this study, no significant differences were found between male and female individuals among the injured turtles. Thus, we can claim that injured turtles are not showing appropriate models for sex ratio studies and should be excluded from sex ratio estimation studies. Having a large proportion of nesting female turtles in healthy turtles group, thigh B levels can be related to mobilization of lipid, carbonhydrate and protein reserves during ovarian development and yolk deposition. Environmental stressors can also affect plasma B levels of nesting females due to spending time on the land. Results of this study can be used for injured sea turtles' medical treatment and include reference values for future studies.

BACTERIA AND FUNGI CULTURED FROM SAND, CLOACAL FLUIDS, AND UNHATCHED EGGS OF *LEPIDOCHELYS OLIVACEA* AND STANDARD TESTING OF ANTIMICROBIAL PROPERTIES OF CLOACAL FLUIDS

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The antimicrobial properties of the cloacal fluid of olive ridley sea turtles (*Lepidochelys olivacea*), were studied at Marine National Park Las Baulas in Guanacaste, Costa Rica. This study spanned the 2010-2011 and 2011-2012 seasons. During the first season, bacteria and fungi were isolated and identified from 23 sample sets, which included a nest chamber sand sample prior to oviposition, cloacal fluid after 25 eggs, and up to 10 unhatched eggs from excavations. Samples were frozen and bacteria were identified using API 20E systems in the field or identified by Laboritorio San Jose. Fungi were identified visually using the standard clinical method of tape preparation with lactophenol cotton blue as described by Larone (2002). This method provides no confidence interval, thus slight uncertainties lead to no identification. The bacteria cultured and isolated from unhatched eggs at the 95% CI included two isolates of *Citrobacter freundii*, two of *Citrobacter youngae*, four of *Enterobacter cloacae*, two of *Enterobacter sakazakii*, and four of *Pseudomonas aeruginosa*. We also isolated the fungal genera Cladosporium four times, Aspergillum once, Mucor twice, and Penicillium three times from unhatched eggs. Sand samples contained no gram negative enteric bacteria identifiable at the 95% CI. We did, however, isolate Cladosporium from two samples, and a variety of yeast strains which could not be confidently identified. The most important find from the first season was the absence of bacteria in cultured cloacal fluid. Eight samples did, however, contain strains of Aspergillum, one contained Cladosporium, three had strains of Penicillium, one had Fusarium, and one had Geotrichum. The lack of bacteria cultured from cloacal fluids during the 2010-2011 season was the rationale for designing experiments to test for the presence of antimicrobial properties in the cloacal fluids in the 2011-2012 season. Since *Enterobacter cloacae* and *Pseudomonas aeruginosa* were the most common bacterial isolates found cultured from unhatched eggs, strains of these organisms were used as controls in the Kirby Bauer disk diffusion test. These species have also been associated with nest sand and cloacal fluid in other studies. *Staphylococcus aureus* standard cultures were also used as a gram positive control since Staphylococcus species have previously been found in olive ridley cloacal fluid and unhatched eggs. Our preliminary results suggest the presence of antimicrobial properties in cloacal fluid based on the presence of inhibition zones around disks dipped in cloacal fluid. The presence of antimicrobial properties in cloacal fluid against bacteria previously isolated from the beach indicates that deposited fluids have the potential to protect eggs from microbial infection, especially during the early stages of development, and could be an important component for hatchling development.

PHENOTYPIC ANOMALIES IN HATCHLINGS OF GREEN TURTLE (*CHELONIA MYDAS*) IN MICHOACAN, MEXICO

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The occurrence of anomalies, malformations, or asymmetries in wild animals may serve as an indicator of developmental instability, a variable negatively correlated with fitness. Phenotypic anomalies are common in wild populations and multiple genetic biotic and abiotic factors might contribute to their formation. Turtles are excellent models for the study of developmental instability because anomalies are easily detected in the form of malformations, albinism, additions or reductions in the number of scutes. The objectives of our study were: a) to identify turtles with anomalies like supernumerary scutes, albinism, carapace malformation, mandibles malformation; b) to compare variation in carapatial scutation between adults and hatchlings. We studied 943 hatchlings from 21 nests and 101 adult females from Maruata, Michoacán, Mexico. We observed the presence of two albino turtles, both with supernumerary scutes; one with mandible malformation; and one conjoined twin individuals of unequal size. Twinning has been reported to be much rarer in sea turtles than in freshwater turtles. The most common abnormality in this study was supernumerary scutes. 42% of the hatchlings and 42.5% of the adult females had supernumerary scutes, mainly at the vertebral ones. The implications of scute variation for sea turtle biology are unclear; nevertheless, in *Chelonia mydas* has been reported that the adults display a smaller percentage of supernumerary shell scutes with respect to the hatchlings, but in this work, we did not find the reported variation. It has been also reported that hatchlings with supernumerary shell scutes are not significantly different from those with normal shell scutes, in form or in asymmetry, suggesting that the presence of supernumerary shell scutes does not affect the shell shape. Developmental instability in turtle carapace formation might be caused by genetic factors, although the influence of environmental factors affecting the developmental stability of turtle carapace cannot be ruled out. Further studies of genetics, of the effects of environmental factors, pollutants, heritability of anomalies, as well as, geometric morphometrics and symmetry analysis of the shell, would be useful to better understand the complex origin of anomalies in sea turtle populations.

EXAMINING THE EFFECT OF AGING ON REPRODUCTIVE OUTPUT OF HAWKSBILLS NESTING ON JUMBY BAY, ANTIGUA, WEST INDIES

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Many aspects of marine turtle fertility, such as reproductive longevity and how senescence affects fecundity, are not well understood. Although numerous studies have compared the reproductive output between neophytes and remigrants in nesting populations, few studies have accumulated enough data to examine the reproductive output of individual turtles

through time. The Jumby Bay Hawksbill Project (JBHP), with over two decades of comprehensive nesting data for nearly 400 individuals, can begin to address these questions of long-term reproductive output. The JBHP has monitored Long Island, Antigua's nesting hawksbill population with saturation tagging protocols (identifying nearly 100% of individuals) for 25 years. Many remigrants have been documented nesting for over 15 years. Our objective with this investigation is to evaluate within- and among-season changes in fecundity as hawksbills senesce. We focus on a subset of the JBHP nesting population, comprised of 43 individuals with over 6 documented nesting seasons spanning 12 to 25 years. We examine several features of individual reproductive output, including remigration intervals, inter-nesting intervals, number of clutches per season, clutch size, and hatch success. We evaluate these reproductive parameters in two ways: with respect to individual age and nesting experience. Finally, we discuss the ecological and management implications of our findings and make recommendations for future analyses to better understand the relationship between hawksbill senescence and fecundity. My participation at the 32nd International Sea Turtle Symposium has been made possible by support from the International Sea Turtle Society, the Western Pacific Regional Fishery Management Council, the U.S. Fish and Wildlife Service, and the U.S. National Marine Fisheries Service.

A PARASITOLOGICAL SURVEY ON SEA TURTLES STRANDED IN THE NORTHERN ADRIATIC

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Necropsies were conducted on 25 loggerhead sea turtles and one leatherback stranded along the Northern Italian Adriatic coast between June 2009 and December 2010. Macroscopic observation of skin and internal organs, parasitological and histological exams were carried out. The collected parasites were fixed and stored in 70% alcohol until identification. Due to bad conditions of conservation, not all animals were examined for all criteria. The parasitological survey, carried out on 14 loggerhead turtles, relieved the presence of *Ozobranchus margoi* (Hirudinea) on the skin of one animal; four species of intestinal Digenea (*Orchidasma amphiorchis* [35.71%], *Rhytidodes gelatinosus* [35.71%], *Pleurogonius trigonocephalus* [14.28%] and *Enodiotrema* sp. [7.14%]) were found and the parasite *Plesiochorus* sp. was observed in the urinary bladder of two animals (14.28%); adults of the Nematoda *Sulcascaris sulcata* were observed in the stomach of one animal. Specimens of the digenean trematode *Pyelosomum renicapite* were isolated from the intestine of *Dermochelys coriacea*. Spirorchid migrating eggs were an occasional finding in histological sections of the lung, spleen and pancreas of a loggerhead turtle, associated with multifocal granulomatous inflammation of tissues; no gross lesions or adult worms were observed. Mycotic pneumonitis was diagnosed in 5 loggerheads, by the use of PAS stain. Multifocal granulomas, with multinucleate giant cells, and hyphae were present, probably belonging to *Fusarium* spp. or *Aspergillus* spp. Results of this study contribute to knowledge of parasitofauna in sea turtles populations of the Mediterranean area. Further studies will be necessary to assess the presence of Spirorchidiasis in the Mediterranean basin, since these parasites are responsible for high mortality rates in other parts of the world.

INFLUENCE OF FEMALE SIZE ON EMBRYONIC DEVELOPMENT AFTER EGG-LAYING: COULD SMALLER FEMALES HAVE LONGER EGG RETENTION PERIODS?

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Ecological and biological factors determine the early embryonic development driven variation among nests. A significant variability on the duration of the internesting interval, varying in loggerheads from 10 to 18 days, could be caused by plasticity on time at ovulation after the previous egg-laying, the duration of the egg formation process or variability on the egg retention period before laying. All these factors can affect the embryonic stage at oviposition, the appearance of the embryonic disc and the duration of the embryonic development. These parameters can have a deep influence on embryo survival and incubation duration as well as our estimations of fertility, stages and causes of embryonic death or hatchling sex-ratio. The study of the early embryonic development in the nest can help to understand the sources of variability among nests on this cryptic life stage. As an honest non-invasive indicator of embryonic development we have used the size of the white embryonic disc that it is externally visible and grown on the eggshell during the first 10 days of development. We measured the size of white spot in 34 nests naturally incubated on the beach and 34 nests relocated to a beach hatchery during the 2009 and 2010 nesting seasons in Cape Verde. We studied the white spot at the first 48 hours of incubation and, for 36 of the 68 nests from both locations; we also studied the white spot at the first 6 days (144 hours) of incubation. The rest of the nests were not studied at this second time to assess the possible effect of the experimental manipulation at day 6 on embryo viability. We also recollected data about female size, nest depth and clutch size of each nest. We found a significant negative correlation among size of white spot and female size. We did not find relation between female size and nest depth so we discard that less nest temperature in deep nests cause this retard. We also found significant positive correlation between female and clutch size, although there was no relation between clutch size and white spot. It is common in Cape Verde to find females nesting a few days after her first nesting attempt. We have seen females laying their clutch on the beach despite not being able to dig up a nest. We relate this behavior as the female incapacity to retain mature eggs inside the oviduct for more time. Perhaps large females have a shorter egg retention period before laying and nest when eggs are at an earlier embryonic stage than smaller females do, probably because of a high nesting experience than smaller ones, which may do more failed nesting attempts. A consequence of the shorter eggs retention of big females could be the less develop of embryos at the moment of laying. Acknowledgements: This works was supported by grants fro the Canary Islands Government (D.G. Africa and D.G. Research), the Andalusian Government (Andalusian Environmental Office), FEADER program and Marine Turtle Conservation Found (USFWS). The authors thank the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service for having provided travel grants for assistance in attending the symposium.

MATERNAL HEALTH IS LINKED WITH REPRODUCTIVE SUCCESS IN LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*)*

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The leatherback sea turtle (*Dermochelys coriacea*) exhibits the lowest and most variable hatching success of the seven sea turtle species. We explored maternal health parameters (plasma biochemistry, hematology, plasma protein electrophoresis) as correlates of low hatching success in this species. We quantified several measures of health from blood for Florida's nesting leatherback population, established a large sample of health indices, and correlated these values with hatching success of their eggs. We found that several measures of maternal health correlated with hatching success. These include alkaline phosphatase, calcium, phosphorus, calcium:phosphorus ratio, cholesterol, gamma globulin protein, and total erythrocyte count. While maternal health clearly impacts vital rates in other species, this is the first study of any sea turtle to show that some physiological measures of health, in part, explain annual offspring production. Because turtles are physiologically resilient animals, it is likely that sublethal effects on health may manifest in reproductive compromises that we detected. Long-term and comparative studies are needed to determine if certain individuals historically and consistently produce nests with lower hatching success than others and if leatherback turtles with evidence of chronic suboptimal health consistently have lower reproductive success. We thank the International Sea Turtle Society, the Western Pacific Regional Fishery Management Council, the U.S. Fish and Wildlife Service, the U.S. National Marine Fisheries Service and the International Sea Turtle Symposium for providing funds for travel.

REHABILITATION OF TWO SEA TURTLES (*DERMOCHELYS CORIACEA* AND *CARETTA CARETTA*) IN THE CENTRO DE RECUPERAÇÄO DE ANIMAIS MARINHOS (CRAM/FURG), BRAZIL

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Dermochelys coriacea and *Caretta caretta* are sea turtle species which use foraging areas near the south coast of Rio Grande do Sul, Brazil. In this area, the majority of stranded sea turtles recovered from beaches exhibit injuries which seem to be caused by collisions with boats. During 2011, the Centro de Recuperação de Animais Marinhos (CRAM) received a live-stranded leatherback (curved carapace length (CCL) 114.5 cm; 125.4 kg) and loggerhead (CCL 76 cm; 48.1 kg) displaying injuries of this type. The leatherback had a head injury in the frontparietal region extending to the supraocular region measuring approximately 20 cm, with an exposure of soft tissues, presence of bone fragments, and a

number of epibionts. The carapace of the loggerhead was broken in two places, exposing soft tissue. Initially treatment involved stabilization through cleaning of the lesions, hydration, antibiotic therapy and resting; blood samples were also collected (hematocrit: 32%, 16%; white blood cells: <1%, <1%; total plasma proteins: 4.4 g/dl, 5.4 g/dl; for leatherback and loggerhead respectively). Further treatment involved filling and remodeling the injury sites using bone cement (polymethyl methacrylate), a material that has been used to successfully anchor artificial joints in humans. Although the material has been used for medical procedures for more than half a century, this is the first time in Brazil that it has been applied in the course of veterinary treatment. During the procedures, the lesions were sterilized and then filled with bone cement. After completion, the turtles were placed into a pool filled with fresh water to assess condition and response. The leatherback turtle seemed well and active and, due to the difficulty of maintaining an animal of this size and with particular forage needs in captivity, it was released the day after surgery. The loggerhead was also released the day after surgery, as it was active and continued to eat and defecate as before the procedure was conducted. Prior to release, the two turtles were marked with flipper tags (front flippers for the loggerhead and rear for the leatherback), to allow identification of these individuals should they be encountered again. As with many turtles stranded in the area, the types of injuries exhibited by these rehabilitated turtles appear to be caused by interaction with boats. The high level of apparently boat-related sea turtle injuries in this region is consistent with the heavy vessel traffic associated with Rio Grande do Sul, as it is Brazil's second most important harbor. Although several studies have been conducted to assess the interactions between sea turtles and boats in this area, additional work is needed to create management plans for these threatened and endangered species.

FROM THE USE OF ENRICHMENT TOOLS TO DEVELOPING A ROUTINE ENRICHMENT PROGRAM FOR CAPTIVE SEA TURTLES

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Recent studies have established the psychological and physiological benefits for captive turtles when utilizing various enrichment tools. Moreover, when responding to certain stimulative accessories, turtles will exhibit various behaviors and attributes which will expose visitors to a more entertaining and educational experience. The importance of environmental stimulation increases when treating turtles that remain in captivity for their entire lives (e.g., severely maimed turtles or captive breeding programs). The Israeli Sea Turtle Rescue Center has been raising a breeding stock of green sea turtles (*Chelonia mydas*) for the past ten years. All 28 turtles were collected as hatchlings and are to remain in captivity for the remainder of their lives. The purpose of formulating an enrichment program is to stimulate the healthy, otherwise highly migratory, maturing turtles on a daily basis while considering practical limitations (i.e., limited space, time, personnel, and budget). The Israeli Sea Turtle Rescue Center relies mainly on volunteers with a wide range of training and experience. Furthermore, the number of caretakers available to make use of enrichment tools may vary significantly. Therefore, we considered it crucial to design enrichment tools that not only involve the turtles' responses to the enrichment opportunity, but that are cost effective,

durable, and require no previous experience with sea turtles. Two different devices were designed, with the purpose of physically stimulating the turtles during feeding: a) a semi-transparent rubber ball containing bits of fish, and b) a floating plastic basket with holes along the bottom containing lettuce. The rubber balls force the turtles to swim back and forth on the surface of the water in pursuit of the ball, while eating from the lettuce baskets requires constant lateral mobility, since the turtles feed underwater. In order to evaluate the effectiveness of the daily use of these devices, ten healthy turtles of similar age were monitored while feeding with and without the devices. Duration of feeding was measured and compared (from the introduction of food in the tank/devices until no food remained in the tank or the devices) for 15 consecutive days feeding normally and 15 days while being fed with the devices. Results showed (mean, SD) that when being fed by using the devices, the turtles demonstrated longer feeding times (140.72 minutes) compared to when food was placed as usual into the tank (21.7 minutes). An additional study is underway, in which we are evaluating growth-rate and hematological changes triggered by increased activity in 16 healthy turtles. Initial results indicate variations in the rate of mass gain and several biochemical factors between turtles that are fed exclusively by the enrichment devices, and normally fed turtles. The use of simple enrichment devices, which take approximately ten minutes to prepare and do not require the presence of a caretaker, enable daily stimulation regardless of budget and personnel limitations. This method offers a pragmatic and feasible solution to the stimulation of sea turtles in captivity. Moreover, by encouraging increased activity of captive sea turtles, without inducing apparent stress, the use of such an enrichment technique can prove as a useful tool not only for rehabilitation, but for studying growth controls, foraging behavior, and energy expenditure.

DESCRIPTION OF INJURIES IN GREEN TURTLE (*CHELONIA MYDAS*) NESTING FEMALES IN TORTUGUERO, COSTA RICA

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Tortuguero is one of the most important nesting beaches for green turtles (*Chelonia mydas*) in the wider Caribbean, recording from 15000 to 60000 nesting females each season. The Sea Turtle Conservancy (STC; formally known as Caribbean Conservation Corporation) monitors 8 miles of the beach during night patrols, in order to tag turtles, measure their CCLmin and SCLmax, and mark nests. However, further facts about the biology and ecology of the Tortuguero nesting population, such as the presence of injuries, still remain unknown. In this manner, we described the type, frequency per zone (according to the standard anatomic nomenclature described by the STC) and the size of injuries present in green turtles (*C. mydas*) in Tortuguero, Costa Rica. We evaluated the turtles during nest cover or hiding phase, and measured the injuries in situ. In addition, we made a photographic record with night mode photos (infrared or red light). For the classification of injuries, we considered as “mating” injuries, those found in the anterior portion of the animal, where males hold to females during copulation; “bite” injuries are considered as wide irregular shaped marks;

"notch" injuries are vertical lesions along the edge of the flipper; "tag evidence" injuries are found in frequent tag places, and can be found as holes of open or missed tags (OTH, old tag hole) and cuts in the edge of the flipper due to tore tags (OTN, old tag notch); finally, we named "scars" to old wound evidences in the skin or carapace. In this manner, we evaluated 99 turtles, from which 90.1% (n=89) presented at least one lesion. Mating injuries (82.35%) were the most frequent type, followed by notches (15.88%) and tag evidences (8.82%). We found a higher frequency of injuries in zones 3 (42%) and 7 (41%) (Anterior zone of the carapace) and in zones 2 (29%) and 8 (26%) (Right and left front flipper, respectively); likewise, we registered the biggest injuries in the zone 2, with mean measures of 4.5 cm (and up to 13 cm long). The results indicate that the most affected areas in female turtles are the front flippers and carapace, specifically in the area that is in contact with the claws of the males during mating. Serious injuries could be potential spots of infections. Therefore, the description of injuries can be used as a health indicator, as well as for monitoring the healing process in nesting females. This is a pioneer method in nesting beach programs, and represents an important tool in the study of the condition and health of sea turtles. Keywords: Tortuguero, sea turtles, green turtle, *Chelonia mydas*, injury.

OVIDUCAL HYPOXIA ARRESTS EMBRYONIC DEVELOPMENT AND CONSTRAINS THE EVOLUTION OF VIVIPARITY IN CHELONIANS*

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The evolution of reptilian viviparity is thought to have involved increasingly extended periods of oviducal egg retention, allowing embryos to develop to advanced stages. It is likely that viviparity never evolved in chelonian lineages because embryos enter preovipositional arrest in the oviducts and remain in this state until after the eggs are laid, regardless of the duration of egg retention. It has been presumed that this process occurs in response to an as yet unidentified limiting factor. A large proportion of leatherback turtle embryos fail to resume development after eggs are laid and die in a state of preovipositional arrest. The global leatherback hatching success rate is ~50% and it is therefore imperative to identify the mechanisms involved in preovipositional arrest so we can begin to understand why so many embryos die during this developmental stage. This comparative study aimed to identify how oviducal oxygen (O_2) availability affects embryonic development in the green sea turtle (*Chelonia mydas*) and 3 species of freshwater turtle; the western oblong turtle (*Chelodina oblonga*), the eastern longneck turtle (*Chelodina longicollis*) and the Murray River turtle (*Emydura macquarii*). To do this we did the following: (1) assessed the effects of O_2 on early stages of embryonic development, (2) identified oviducal oxygen tension (PO_2) in gravid females, and (3) determined the rate of O_2 diffusion in oviducal secretions. Oviducal O_2 availability and the impact of hypoxia on embryonic development were assessed for all 4 species. Eggs of each species were allocated immediately after oviposition to either a normoxic (155 mmHg O_2) or a hypoxic (~7.6 mmHg) treatment for 3, 6 or 9 days. Embryonic development of all species progressed normally in normoxia, but in hypoxia development remained arrested and recommenced upon subsequent return to normoxic conditions. Oviducal PO_2 was also measured in all four species. Mean oviducal PO_2 was 5.9 ± 2.5 mmHg in *C. oblonga* (n=8); 1.6 ± 1.2 mmHg in *C. Longicollis* (n=7); 5.3 ± 2.1 mmHg in *E. macquarii* (n=3); and 2.9 ± 1.4 mmHg in *C. mydas* (n=11). This is the first study to directly determine the PO_2 environment of reptilian embryos in the oviduct. Furthermore, O_2 diffusion

was measured in green turtle oviducal secretion samples. The rate of PO_2 increase in solution over 10 minutes of exposure to 100% O_2 was significantly lower in oviducal secretion (1.9 ± 0.6 mmHg/min) than in saline controls (14.2 ± 2.1 mmHg/min, $F=64.3$, $P < 0.01$). These results imply that reduced diffusive ability of oviducal secretions creates or contributes to an extremely hypoxic environment in the oviduct that constrains embryonic development in turtles. Evidently, the onset of preovipositional arrest in response to hypoxia during early developmental stages precludes the evolution of viviparity in chelonian lineages and the failure of a large proportion of leatherback embryos to develop beyond this stage may be linked to this process. There is a pressing need to further identify the effects that maternal influences have on the survival and success of their embryos. Thank you to the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and the International Sea Turtle Symposium for generous donations that permitted conference attendance.

THE EFFECTS OF INCUBATION TEMPERATURE ON PREOVIPOSITIONAL ARREST AND SUBSEQUENT EMBRYONIC DEVELOPMENT IN MARINE AND FRESHWATER TURTLES*

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Turtle embryos can arrest development while in the oviduct and remain in this state of preovipositional arrest for several hours after oviposition. After this time, the mechanisms involved in the recommencement of active embryonic development once eggs are in the nest are unknown, although it is thought to occur in response to an environmental stimulus. Suggested triggers include exposure to atmospheric oxygen, water inundation and temperature. Instances in which the embryo fails to begin developing after a period of arrest results in embryonic death. Embryonic death reduces hatching success and an estimated global loss of ~50% of viable leatherback embryos has been recorded, the majority of which die when they are in a state of preovipositional arrest. This study aimed to identify whether eggs failing to break preovipositional arrest and recommence development after laying did so as a result of incubation temperature. Determining how temperature affects this type of developmental arrest will strengthen our understanding of reptilian embryonic development and provide information on the potential impacts that temperature has on early stage development in a climate experiencing large-scale global temperature shifts. We conducted a comparative study of sea turtle (*Chelonia mydas*) and freshwater turtle (*Chelodina oblonga*, *Chelodina longicollis* and *Emydura macquarii*) species to investigate the role that temperature plays in the maintenance of preovipositional arrest. We devised a series of temperature treatments in which eggs were incubated at high, medium and low temperatures, as experienced in natural nests. Eggs were monitored daily and the time to appearance of the white spot on the eggshell was recorded. Formation of the white spot was considered to mark the breaking of preovipositional arrest and the resumption of embryonic development. Observations continued until all eggs had either developed a white spot or were determined to be dead, in which case they were dissected to identify developmental stage at death. For *Chelonia mydas* eggs, we found that the time for developmental arrest to break and for eggs to form the characteristic white spot was independent of temperature range from 24°C to 32°C, but the hatching success was significantly lower at lower temperatures. The developmental stages that embryos died at differed significantly between

the 24°C and 28°C treatments ($P < 0.01$), with the majority of embryos in the 28°C treatment dying at later stages of development. Hatchlings from eggs incubated at lower temperatures were significantly lower in mass and smaller in carapace size. Our results show that while temperature does not appear to play a direct role in breaking preovipositional arrest, it has a highly significant impact on the capacity of eggs to progress to the later stages of embryonic development. We will discuss the significance of these results in the context of the comparative data from the more temperate freshwater turtle species and draw conclusions on the role that predicted shifts in global temperatures may have on the normal developmental progression of reptilian embryos that undergo developmental arrest.

DEVELOPMENT OF AN RNAI-BASED METHOD TO SILENCE SOX9 IN TURTLES USING A GONAD CULTURE SYSTEM*

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Many species of oviparous reptiles lack sex chromosomes and display temperature-dependent sex determination (TSD). In these species, the differentiation of gonads into ovaries or testes depends on the incubation temperature of the eggs during a critical period of embryonic development known as thermo-sensitive period (TSP), during which, an irreversible molecular process that leads to male or female differentiation is established. The autosomal Sry-related gene, Sox9, is a transcription factor that has an important role in testis differentiation in mammals. In several reptiles such as *A. mississipiensis*, *T. scripta* and *L. olivacea*, Sox9 has been found to be differentially expressed in gonads showing an important up-regulation during the TSP at male promoting temperature (MPT), consistent with the idea that Sox9 plays an important role in the commitment of the bipotential gonad to a testicular fate. However, in spite of numerous studies involving Sox9 as a testis determinant in species with TSD, it remains unclear how Sox9 functions during this event. One of the main strategies used to study the role of a gene is termed loss-of-function and it involves gene silencing to evaluate the role of a particular gene in a certain biological background, trying to link genotype to phenotype. RNA interference (RNAi) is the process by which double stranded RNA induces the silencing of endogenous genes through the degradation of its correspondent mRNA. In the present work, we developed an RNAi based method for silencing Sox9 in a gonad culture system for *T.scripta* and *L. olivacea* providing a useful approach to elucidate the role of Sox9 in sex determination / differentiation in these turtles. We hypothesize that knocking down Sox9 at MPT would result in gonads with female characteristics such as a thick cortex and fragmented medullar cords, confirming its role during testis differentiation. In order to develop a protocol to culture the gonads and knockdown Sox9, we worked first with *T. scripta* embryos and once we achieved the knockdown we applied the same method on *L. olivacea*. Small interference RNAs (siRNAs) were designed from specific regions of *T. scripta* and *L. olivacea* Sox9. Gonads were dissected as soon as embryos entered the TSP and grown in culture. We designed a dosage curve with three different doses of siRNA and transfections were performed according to the Lipofectamine protocol. The transfected gonads were incubated at 26ºC for 24 and 72 h. siRNA transfection resulted in a dose-dependent decrease of Sox9 protein in the gonads as shown by Western Blot and immunohistochemistry for *T. scripta* and *L. olivacea*

respectively. These results indicate that it is possible to knockdown endogenous genes in an organ culture system; however it was not possible to observe a phenotypic effect due to the short time that the gonads remained in culture. Nevertheless this represents a novel approach to investigate the role of important genes involved in sex determination /differentiation in organisms with TSD such as *T. scripta* and *L. olivacea*. I would like to thank the 32 ISTS committee for their recognition through the travel grant that made possible my assistance to the symposium.

PHYSICAL AND RADIOGRAPHIC EXAMINATION OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) BYCATCHED BY BOTTOM TRAWLING IN SOUTHERN ADRIATIC SEA (ITALY)

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Sea turtles are subject to incidental capture in a variety of fisheries with different primary target species. Fishing bycatch has been designated as a relevant threat for sea turtles' populations, and bottom trawling, together with longline fishing, has been indicated to have the highest responsibility for sea turtles mortality. A number of authors report that a high percentage of the animals accidentally caught in fishing nets have some degree of trauma, which can occur in turtles when they become entangled in fishing nets. The present paper reports data collected during routinely controls of 115 loggerhead sea turtle (*Caretta caretta*) incidentally caught by bottom trawlers in the Southern Adriatic Sea (Italy) between November 2010 and September 2011. Approximately 25 bottom trawlers collaborate with the WWF Rescue Centre of Molfetta (BA) in rescuing bycatched sea turtles, which are subsequently referred to the Faculty of Veterinary Medicine of Bari for clinical evaluation, X-ray examinations, eventual surgery, and hospitalization of critically ill animals. 67% of the examined turtles have been classified as sub-adult by curved carapace length (42-70 cm). Physical observation revealed the presence of skin lesions (22%), shell lesion (10%), head lesion (6%), shell fractures (2%), skull fracture (2%), and fishing line entanglement injuries to limbs (2%), while the radiographic examination assessed the presence of intestinal impaction (20%), hooks (6%), limb fractures (4%) and pneumonia (3%). All the reported findings can be associated with human activities, with the exception of impaction, but only a small percentage can be directly ascribable to the bottom trawling, while all the others appear to be accidental. Nine turtles were found comatose or moribund in nets by fishermen, and died while being transported to the Rescue Centre, so they were not presented to veterinary observation. Unfortunately, we have no data on the total of turtles found dead in the nets during the observed period, probably because of the fishermen's reluctance to report the capture of dead turtles, thus the amount of the direct mortality is unspecified, and the real impact of bottom trawling on the conservation of loggerhead sea turtle's populations in Southern Adriatic Sea remains unknown. Acknowledgments: we would like to thank the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service and U.S. National Marine Fisheries Service for their generous support.

DETERMINATION OF AUDITORY CRITICAL RATIOS OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)

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Marine animals rely on hearing for many activities crucial to their individual survivability and that of the species as a whole. Communication with conspecifics, navigation, finding prey, or locating potential mates are vital life history aspects that may be compromised by increased human activity in the marine environment. Sources of anthropogenic noise include; exploration and extraction of oil and other minerals, dredging, explosions, and boat traffic, both commercial and recreational. Sea turtles frequent areas of high human activity throughout their life cycle. It has been documented in a coastal foraging area for juvenile sea turtles, as human presence increased, so did the underwater noise level by two orders of magnitude (26 dB) within a sea turtles hearing range. To understand the impacts of increased human activity and noise levels on marine turtles, it is important to better understand the auditory capabilities of these animals. Auditory evoked potentials (AEP) and behavioral audiograms have both been conducted on several species of sea turtles to determine hearing ranges and sensitivities. A recent study has shown that both techniques provide comparable results and are reliable for testing sea turtle hearing. Various studies show that sea turtles' peak hearing sensitivity is at low frequency levels, between 200-700 Hz. An examination of sea turtles' hearing in the presence of a background noise would provide better insight into their capabilities in their natural environment and what may compromise it. Critical ratios, the difference between a sound and background noise required for detection, have been investigated in other species, including marine mammals, but have yet to be collected for sea turtles. To further explore the auditory capabilities of sea turtles, psychoacoustic behavioral methods were used to investigate the underwater masked hearing thresholds of two loggerhead turtles (*Caretta caretta*) housed at Mote Marine Laboratory & Aquarium in Sarasota, FL. The subjects previously participated in behavioral and AEP audiograms, allowing for a better assessment of the overall auditory capabilities of loggerhead sea turtles. A two alternative, forced-choice paradigm experiment was designed and trained using operant conditioning and positive reinforcement techniques. The turtles were trained to station on a bite bar apparatus, with two response paddles located on either side of the apparatus; one representing sound present and the other sound absent. Two speakers are attached to the research platform, 0.5 m under the water and 1 m from the turtle. A constant broadband white noise (90 dB) was presented for the duration of the session from one speaker and the tonal stimuli presented from the second speaker. Testing is conducted using a modified staircase method, requiring an 80% correct response to stimulus present trials and less than 40% false alarm rate over the course of a 10 trial block to 'pass' and attenuate. Frequencies currently being tested are 200 Hz and 400 Hz, potentially 100 Hz. Preliminary results suggest slightly higher but comparable critical ratio to other marine animals highlighting a possible compromise of the sea turtle's auditory sensory system when anthropogenic noise is added to the environment.

HUSBANDRY TRAINING AND ENRICHMENT FOR A BLIND SEA TURTLE

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Hang Tough is a sub-adult green sea turtle (*Chelonia mydas*) that was brought to Mote Marine Laboratory & Aquarium in 1992. Hang Tough was admitted into Mote's Sea Turtle Rehabilitation Hospital and received extensive treatment for severe head trauma from a human induced injury. This animal was deemed blind and non-releasable and later became a permanent resident at Mote Aquarium. Being blind and in an unfamiliar environment, Hang Tough was easily frightened and seemed cautious of all interactions with animal care staff. Feeding had to be done by hand and at times Hang Tough was frantic, which was dangerous for both himself and staff. In 1999 Mote was granted permission to begin a training program with Hang Tough. Initially an auditory cue, a dog clicker, was introduced as a bridge. A combination of this bridge and creating a bond between staff and the animal through increasing positive tactile interactions significantly reduced Hang Tough's panic events and made handling him easier and less stressful. Hang Tough now participates in daily husbandry training session. Hang Toughs repertoire of husbandry behaviors includes surface stationing, passive restraint holds, flipper restraints, platform stationing and stretcher training. All of these behaviors have been trained using operant conditioning and successive approximations to reach the final positioning. The husbandry behaviors allow for voluntary blood draws from the back of the neck, voluntary weights, better access to body and flippers for basic check-ups or other veterinary procedures and safe removal from the tank and transport. An enrichment program was introduced at the same stage as the husbandry training program. A study conducted by Mote Marine Laboratory & Aquariums animal care staff was the first to show that enrichment is also beneficial for captive reptiles. This study showed that Environmental Enrichment Devices decreased stereotypical pattern swimming and resting, while increasing random swimming and focused behavior. Incorporating novel enrichment devices and husbandry training sessions into the daily care of Hang Tough considerably changed this turtles overall behavior. Hang Tough is now less frightful, not as easily spooked, and will seek out animal care staff and handler interactions. Hang Toughs health can be better monitored without causing further stress to either the animal or staff. Prior to the implementation of the programs, the concession was to maintain Hang Tough in a small cylindrical tank for his own safety. The success of the training and enrichment programs is highlighted by Hang Tough's move into an 18,000 gallon (68,000 l) habitat that was designed specifically for him in 2009. Hang Tough's story continues to inspire the many guests that visit our Aquarium each and every year.

Behavior and Movements

DIVING BEHAVIOR OF JUVENILE LOGGERHEAD TURTLES IN CAPTIVITY: DIVE DURATION, DIVE DEPTH AND SWIMMING ACTIVITY IN HEAD- STARTED SEA TURTLES IN CANARY ISLANDS (SPAIN)

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The loggerhead sea turtles are adapted to the marine environment by acquiring a number of features, like their high diving capacity. The studies related to diving behavior of marine turtles have been conducted mostly with adult females. This is due to the great migrations that they perform, and the consequent difficulty of studying the species, except when they come ashore to nest. In our case, we were able to develop the study thanks to the head-starting programs carry out in a huge Experimental and Conservation program to re-establish the loggerhead nesting population in Canary Islands (Spain). In the present study, we controlled the dive duration, dive depth and swimming activity of forty loggerhead turtles during their first weeks of life, twenty future males and twenty future females. We supposed the dive duration as the time between two breaths, the dive depth as the maximum depth that the turtle reached in every diving, and the swimming activity as the type of movement in every diving. We divided the depth into five '10 centimeters' ranges, from the surface (0 cm) to a maximum depth of 50 cm. We categorized three different swimming activity types: moving, still in surface or still in deep. More than 13,000 dive records were collected by visual observations between November 2009 and January 2010. The data were analyzed with respect to day moment, sex, nest, individual weight and water temperature. We found significant differences in dive duration according to the moment ($n=11,482$; $p < 0.001$), temperature ($n=11,482$; $p <0.001$), weight ($n=11,482$; $p <0.001$), and sex ($n=38$; p-valor < 0.001). We didn't find significant differences according to the nest ($n=11,482$; $p > 0.05$). The data obtained shown that the time spend on the surface and the swimming activity varies depending on the moment of the day. Acknowledgements: The first author would like to thank the International Sea Turtle Symposium and the following organizations for the travel support: International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service.

MOVEMENTS OF HAWKSBILL TURTLES *ERETMOCHELYS IMBRICATA* AT GORGONA NATIONAL PARK AND THE COLOMBIAN PACIFIC USING SATELLITE TRACKING

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Hawksbill turtles recruit into benthic foraging habitat from their pelagic phase at sizes between 20 and 40 cm curved carapace length. After this initial recruitment they show fidelity to localized areas for extended periods with some making geographical shifts to similar

habitat type. On August 25 and 26, 2010 two juvenile hawksbill turtles were captured on La Azufrada (2° 57.343' N – 78° 10.573' W) coral reefs at Gorgona National Park. This 618 km² protected area located 56 km off the coast, is the only place where a small hawksbill population is found all over the year in the southwestern Colombian Pacific. A satellite-linked Kiwisat 202 (Sirtrack Pty Ltd) Platform Terminal Transmitter (PTT) was attached to the carapace of each of the two turtles using Professional Anchoring Epoxy (Sika Anchor Fix - 3). Location classes LC 4, 3, 2, 1, A and B of the ARGOS system were used to plot the movements. The online data collation and data filtering resource of the Satellite Tracking Analysis Tool (STAT) from Seaturtle.org was used for data manipulation. The first turtle named Antonia measured 40 cm CCL and weighed 6.5 kg. This turtle was released 2 kilometers away from La Azufrada in another coral reef known as Playa Blanca. The second animal named Manuela measured 42.6 cm CCL and weighed 8.0 kg. This turtle was taken to the mainland town of Guapi where the second PTT was deployed on it. Subsequently, Manuela was released at the coastal community of Chico Perez, 60 km away from Gorgona. In this presentation we will show how Antonia moves in just two days from Playa Blanca to La Azufrada where she was originally caught. Maps and distance traveled by Manuela will demonstrate how she crossed from the continent back to La Azufrada in nearly 25 days. Numerous recaptures of flipper tagged hawksbill turtles (including multiple recaptures) between years indicate at least some individuals from this near shore island show strong site fidelity to localized areas. Satellite tracking data together with flipper tagging illustrates how juvenile hawksbills exhibit fidelity to their habitats at least during long periods of time. These observations present an interesting insight into the behavior of benthic foraging juvenile hawksbill turtles. Gathered information is useful for conservation management of this threatened species at Gorgona National Park and along the Eastern Pacific. Researchers are planning to continue tracking juvenile hawksbills captured in Gorgona and in the Pacific coastline to determine the distribution of their developmental - foraging grounds and migratory routes while in Colombia. We thank the Colombian National Parks System, NFWF, USFWS, Conservation International, CIMAD, the Colombian Science and Technology Institute (COLCIENCIAS), communities of Guapi, Chico Peréz, WWF and volunteers for the financial and logistic support. This research was conducted under permit DTSO 0029 from the Colombian National Parks.

SATELLITE TRACKING OF HAWKSBILLS IN THE ARABIAN / PERSIAN GULF: IDENTIFICATION OF NESTING FREQUENCY, MIGRATORY TRAJECTORIES, DISTRIBUTION OF FORAGING GROUNDS, AND IMPACTS OF SHORT-TERM CLIMATIC EVENTS

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Substantial numbers of Hawksbill turtles (*Eretmochelys imbricata*) reside in the Arabian / Persian Gulf and Sea. Nesting aggregations are found on many islands off Iran, Saudi Arabia, Qatar, the United Arab Emirates and Oman, and mainland nesting occurs in Qatar and Oman. The total nesting population might exceed 1000 animals per year, although there are still unknowns in this regard. In partnership with local government authorities and environmental organisations in the region, Emirates Wildlife Society in association with WWF and together with the Marine Research Foundation are implementing a three-year satellite tracking project. The Marine Turtle Conservation Project, which will track up to 75 post-nesting female turtles, aims to identify migratory trajectories to discover bottlenecks and areas in need of conservation and management action. By tracking the turtles, we were also able to identify nesting frequency through subsequent visits to nesting sites by each female as a proxy for overall reproductive output at a regional level; and the spatial distribution of foraging grounds and proportion of time animals spend at each site. As an unexpected result of our work we have also been able to record the impacts of short-term climatic events, in particular sea surface temperature rise in summer months, on foraging behaviour. We present here the interim findings of our work. We intend to use this data to inform governments of the key priority areas in need of safeguarding in the Gulf and the Arabian Sea, as currently conservation and protection action is only afforded turtles when they are on land. We recognise that the accelerated development pressures at the regional level will likely restrict the outright protection of certain sites, and we will consider this when discussing with decision makers a range of spatial and temporal conservation measures. This is the first of such large-scale regional initiatives to understand the conservation needs

of Hawksbills in the region, which have been identified as data-deficient in recent global assessments.

JUVENILE HAWKSBILL SEA TURTLE (*ERETMOCHELYS IMBRICATA*) DEVELOPMENTAL HABITATS IN GUANACASTE, COSTA RICA*

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Hawskbill sea turtles (*Eretmochelys imbricata*) are rare nesters along the Pacific coast of Costa Rica, yet reports by divers of individuals in shallow coastal waters in rocky points and outcrops is common. Little is known regarding the ecological aspects of this species in these shallow coastal habitats. From August of 2009 to June of 2011, a total of 18 hawksbill sea turtles were captured in Punta Coyote and one in Cabo Blanco, Southern Nicoya Peninsula. All turtles were tagged with external flipper tags. Twelve of these turtles were tracked using VEMCO acoustic telemetry, and one (the turtle from Cabo Blanco) with a Sirtrack Kiwistat satellite transmitter. Most turtles captured were immature, and showed high fidelity to particular rocky points or outcrops. Main food sources include sponges (*Geodia* sp.) and ascidians (*Rhopalaea birkelandi*), as well as small amounts of macroalgae and other invertebrates. Turtles spend most of their time at areas with higher food abundance within their home ranges. Explorations and visual surveys revealed that hawksbill se turtles are using many other discrete rocky reefs along the Nicoya Peninsula. These results highlight the importance of establishing new marine protected areas and the expansion of existent ones based on foraging habitats, particularly to protect these resident juvenile populations from unsustainable commercial fisheries operations such as shrimp trawling and gillnetting.

HOME RANGE ESTIMATES AND HABITAT USE FOR SUBADULT AND ADULT GREEN TURTLES SHARING FORAGING GROUNDS WEST OF THE MARQUESAS KEYS, FLORIDA, U.S.A.*

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Inwater Research Group, Inc.

Six green turtles were hand-captured west of the Marquesas Keys and GPS Fast-loc transmitters (Wildlife Computers model MK-10) were deployed on one adult male and one adult female, one large subadult male and one large subadult female, and two smaller subadults of unknown gender. Straight carapace length ranged from 70.4 cm to 101.5 cm, mean was 86.9 cm, SD ± 11.7 cm. Transmitters were programmed to provide as much data as possible initially because we were unsure about the ability of these small transmitters to remain on such large turtles for long periods of time. The units were programmed to collect identical data for the first month, at which time half of the units were programmed to continue on that cycle and the other half were programmed to collect data every fourth day to

conserve battery life. Transmission ranged from 57 to 234 days despite the intense data collection during the first month. Habitat use was examined using ArcGIS. Turtles spent a good deal of time over continuous and patchy seagrass areas and to a lesser degree, over hardbottom habitat. High density areas were determined using kernel density estimates (KDE) (Schofield et al. 2010, Hart and Fujisaki 2010). Core areas were those containing 50% KDE. These ranged from 0.37 to 11.88 km^2 (mean 3.18 km^2, SD 3.68 km^2). Four of the six turtles had two core areas. One of the smaller subadults covered 146 km^2 in its travels (nearly to Everglades National Park and back) and was moving east along the inside of the reef south of the Marquesas Keys when the transmitter ceased. This turtle produced many core areas. The large subadult male stayed in a relatively small area for the entire time that it was tracked and therefore produced only one core area. Home range estimates, (based on 95% KDE) for all turtles ranged from 1.29 to 131.91 km^2 (mean 16.19 km^2, SD 25.37 km^2), suggesting that most of these turtles are residents in a fairly small area west of the Marquesas.

LARGE-SCALE MOVEMENTS, HIGH-USE AREAS, AND FORAGING ECOLOGY OF WESTERN PACIFIC LEATHERBACK TURTLES, *DERMOCHELYS CORIACEA*

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The western Pacific leatherback turtle (*Dermochelys coriacea*), one of three genetically distinct stocks in the Indo-Pacific region, has declined markedly during past decades. This metapopulation nests year-round at beaches of several western Pacific island nations and has been documented through genetic analysis and telemetry studies to occur in multiple regions of the Pacific Ocean. To provide a large-scale perspective of their movements, high-use areas, and habitat associations, we report and synthesize results of 126 satellite telemetry deployments conducted on leatherbacks at western Pacific nesting beaches and at one eastern Pacific foraging ground during 2000–2007. A Bayesian switching state-space model was applied to raw Argos-acquired surface locations to estimate daily positions and behavioral mode (either transiting or area-restricted search) for each turtle. Monthly areas of high use were identified for post-nesting periods using kernel density estimation. There

was a clear separation of migratory destinations for boreal summer vs. boreal winter nesters. Leatherbacks that nested during boreal summer moved into Large Marine Ecosystems (LMEs) of the temperate North Pacific Ocean or into tropical waters of the South China Sea. Turtles that nested during boreal winter moved into temperate and tropical LMEs of the southern hemisphere. Area-restricted search occurred in temperate and tropical waters at diverse pelagic and coastal regions exhibiting a wide range of oceanographic features, including mesoscale eddies, coastal retention areas, current boundaries, or stationary fronts, all of which are known mechanisms for aggregating leatherback prey. Use of the most distant and temperate foraging ground, the California Current LME, required a 10–12 month trans-Pacific migration and commonly involved multiple years of migrating between high-latitude summer foraging grounds and low-latitude eastern tropical Pacific wintering areas without returning to western Pacific nesting beaches. In contrast, tropical foraging destinations were reached within 5–7 months and appeared to support year-round foraging, potentially allowing a more rapid return to nesting beaches. Variation in curved carapace length (CCL) and curved carapace width (CCW) among deployment locations and destination type was evident in the morphometric data. Winter nesters in this study, which foraged relatively closer to the nesting beaches, were documented to have greater CCL and CCW than summer nesters that moved to more distant tropical and temperate regions. Regardless of nesting season, turtles that moved to temperate destinations had significantly greater CCW than turtles that moved to tropical destinations. Assuming there is foraging site fidelity, this would indicate that temperate foragers increase their body weight to a much greater extent before returning to nesting beaches. Based on these observations, we hypothesize that demographic differences are likely among nesting females using different LMEs of the Indo-Pacific. The differences in movements and foraging strategies underscore the importance of and the need for ecosystem-based management and coordinated Pacific-wide conservation efforts.

POST-RELEASE MONITORING OF KEMP'S RIDLEY SEA TURTLES IN THE NORTHERN GULF OF MEXICO IN THE AFTERMATH OF THE BP DEEPWATER HORIZON OIL SPILL*

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A dramatic increase in the number of stranded sea turtles was observed in the northern Gulf of Mexico during 2010 and 2011. This led to an investigation and enhanced monitoring by the National Marine Fisheries Service (NMFS). After the Deepwater Horizon Oil Spill occurred in April 2010, the Institute for Marine Mammal Studies (IMMS) in Gulfport, MS, was designated as a stranding response center for dolphins, sea turtles, and manatees. This allowed IMMS to devote critical resources to collect turtle carcasses for NMFS assessment and provide care for live stranded turtles. Logistics for the response as well as techniques used to clean oiled turtles will be discussed. In 2010 and 2011, over 500 dead turtles were collected in Mississippi, and approximately 90 live turtles from both Mississippi and Alabama were admitted for rehabilitation at IMMS facilities. The vast majority of dead and live stranded sea turtles in this region have been Kemp's ridleys. Satellite transmitters were utilized to track movements of a subset of released turtles (n=12). Six of these turtles were released in Mississippi waters, 2 miles south of West Ship Island, during the fall of 2010,

and the other six were released off Cedar Key, Florida in the spring of 2011. Tracking paths showed that the turtles released in Mississippi stayed in the general area of the Mississippi Sound until departing in a southerly direction, migrating away from both their stranding location ($r=0.54$, $p<.01$) and their release location ($r=0.48$, $p<.01$). In contrast, although Kemp's Ridley sea turtles are found in Florida waters, four out of six turtles released in Florida quickly began migrating up the coastline towards their stranding site in Mississippi ($r=-0.40$, $p<.01$). These results indicated that the turtles potentially possess some sense (either innate or learned) of the location of their spring and summer grounds and will return to those specific grounds regardless of their release location. IMMS is working with the Mississippi Department of Marine Resources to incorporate these data into an effective management plan for sea turtles in the northern Gulf of Mexico.

LONG-TERM RESIDENCE OF JUVENILE LOGGERHEAD TURTLES TO FORAGING GROUNDS: A POTENTIAL CONSERVATION HOTSPOT IN THE MEDITERRANEAN

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Identifying highly frequented areas is a priority for sea turtle conservation. Although juveniles represent the bulk of the population, a minority of studies have investigated their movement patterns. We tracked six large juvenile loggerhead turtles that were found and released in an important foraging ground in the Mediterranean, the Tunisian continental shelf. Tracking data were obtained via satellite for periods ranging from 120 to 225 days and allowed the identification of high use areas. All turtles generally performed apparently non-directed, wandering movements in waters with a wide range of seafloor depths. They showed clear residential behaviour to the region with no evident seasonal pattern. Core areas of residence were in the neritic zone or on the edge of the continental shelf, largely overlapping among individuals, and were much smaller than residential oceanic areas reported elsewhere. When integrated into current knowledge, these results suggest an ecological-behavioural model of a gradual shift from a pelagic-vagile to a benthic-sedentary life style with progressive reduction of home ranges. They also highlight an area of the continental shelf and offshore waters as potential core foraging ground for large juvenile loggerhead turtles in the Mediterranean informing future spatial management for loggerhead turtles.

AN ISOSCAPE FOR LOGGERHEADS ALONG THE ATLANTIC COAST OF THE UNITED STATES*

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Loggerhead nest numbers in Florida, the largest rookery for this species in the Western Hemisphere, have been declining since 1998 for unknown reasons. Several hypotheses have been proposed to explain this decline. In order to discriminate among them, it is crucial to identify key foraging grounds and increase our understanding of the link between foraging ecology and reproductive output. The most accurate method to identify feeding areas is satellite telemetry; however, the prohibitive cost limits the number of individuals that can be satellite tagged. In recent years, the use of intrinsic markers such as stable isotopes to study the migratory patterns and foraging ecology of migratory species has increased. Despite the widespread use of this technique in marine systems, gradients in stable isotopes (isoscapes) at the base of the food web have been described only at broad scales. Few regional maps of marine isoscapes are available, limiting the isotopic method in marine systems. In light of this limitation, the best way to interpret the carbon signature of top predators is to calibrate isoscapes using top predators themselves. Our objectives were to (1) build a marine isoscape for loggerheads along the U.S. Atlantic coast and (2) infer the foraging grounds used by a large number of loggerheads nesting at the Archie Carr National Wildlife Refuge, which accounts for ca. 25% of all loggerhead nests in Florida. Between 2008 and 2011, we collected tissue samples for carbon and nitrogen stable isotope analysis from 22 nesting females fitted with satellite tags as well as from an additional 150 untracked females. Telemetry identified three major migratory pathways and associated foraging areas: (1) a seasonal continental shelf-constrained North-South migratory pattern between Virginia and North Carolina, (2) a year-round residency in southern Atlantic foraging areas and (3) a residency in the waters adjacent to the breeding area. Both δ13C and δ15N signatures differed among groups associated with foraging areas. We found a North-South latitudinal gradient in δ13C isotopic values, with northern individuals being the most 13C depleted and southern samples the most 13C enriched. This latitudinal gradient may play a relevant role in explaining differences in isotopic signatures among females nesting at the Carr Refuge. To test the latitudinal gradient hypothesis, we collected tissue samples for stable isotope analysis from loggerheads at foraging grounds along the U.S. Atlantic Coast. The foraging grounds sampled were: the US Mid-Atlantic offshore region, the Atlantic Coast of Central Florida and the Key West National Wildlife Refuge. Our preliminary results support the isotopic pattern and latitudinal gradient we identified using satellite telemetry and confirm that stable isotopes can be used in lieu of satellite telemetry to identify areas of conservation priority along the Atlantic coast of the USA for sub-adult and adult loggerheads of the NW Atlantic population. Our research offers a basic framework for a loggerhead isoscape in the NW Atlantic and calls for collaboration among researchers to build a more robust and

complete isoscape for this threatened species. Acknowledgements: This study was funded by several grants awarded from the Sea Turtle Grants Program. The Sea Turtle Grants Program is funded from proceeds from the sale of the Florida Sea Turtle License Plate. Learn more at www.helpingseaturtles.org. Additional funding were provided by Disney Vero Beach Resort, Disney Animal Programs, Disney Cruise Lines, Inwater Research Group, Atlantic Marine Assessment Program for Protected Species (AMAPPS) and the Coonamessett Farm Foundation with the assistance of Viking Village Fisheries and the F/V Kathy Ann along with the sea scallop industry through their research set aside program. Attendance of SAC to present this work at the 32nd International Sea Turtle Symposium was funded in part by International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and the International Sea Turtle Symposium.

MIGRATION AND DIVING PATTERNS OF A PONDNET POST-RELEASE LOGGERHEAD TURTLE FROM EASTERN TAIWAN

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Sea turtles migrate through the ocean in a three-dimensional scale. That is, dives for long periods, only surfacing briefly to breathe. Several studies showed that, the diving behavior changes as the turtle migrates into different hydrodynamic regimes. Most evidence had been obtained from leatherback turtles as they always conduct cross ocean migrations. Satellite telemetries of pondnet by-catched loggerhead turtles in Eastern Taiwan from 2002 till 2008 showed that, most turtles meandered on the continental shelves east of China, with few migrating into the West Pacific Ocean. However, little is known about their diving behaviors. In this study, we deployed a SRDL on a pondnet by-catched mature female loggerhead turtle from this site on February 28, 2011, and tracked it until the message vanished on April 19. Results showed that the turtle migrated southbound, across the southern tip of Taiwan, then eastbound across the deep water region, reached the coastal waters of China, and further southbound along the coast. Her last message was on the Straits between Hanin Island and Lai-Jou Peninsula. She migrated 50 days and swam 4725.4 km. Based on a 500 m bathymetry feature we separated the migration route into three sections; coastal, deep water and shelf. Analysis showed that, there was no difference in the migration speeds among the three sections. Six dive patterns; U, V, S, W, shallow and others were identified. The turtle performed mainly U and other dives in the coastal section, suggested rest and mix diving patterns. She performed S and shallow dives in deep waters, suggested explore and surface swimming dive patterns. On the continental shelf, she performed mainly the shallow dive, suggested swam in the surface waters. Comparisons of the maximum dive depth showed that even though the turtle dove down to 240 m in deep water, on average she dove to deeper water in the coastal section than in the shelf section. Results of this study showed that, in spite that the migration speeds were similar, turtles performed different diving patterns in different hydrodynamic regimes.

POST-NESTING MIGRATORY ROUTES OF GREEN TURTLES (*CHELONIA MYDAS*) IN RELATION TO SEA SURFACE TEMPERATURE IN TAIWAN

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Green turtles (*Chelonia mydas*) are the most common species of sea turtles nesting in Taiwan. Each year between two to nineteen turtles nest in the region. Some previous studies show that sea surface temperature (SST) can influence sea turtle migration from the nesting beach to foraging grounds, whereas others have shown the opposite results. In this study, nine post-nesting migratory routes of green turtles from Taiwan tracked between 1994 and 2004 were analyzed to assess the relationship between sea surface temperature (SST) and green turtle movement. Satellite-derived SST and telemetry data were mapped and examined with GIS. Results showed that green turtles spent most of the time on the continental shelf, with rare trips into the open ocean. Movement restricted primarily to the continental shelf may relate to the warmer water in this zone, higher food availability and difficulty crossing into the open ocean due to the strong Kuroshio Current. Additionally, staying on the continental shelf may increase interaction with fisheries, therefore creating a need for further investigation.

NEARSHORE ORIENTATION PREFERENCE OF LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) HATCHLINGS IN KYPARISSIA BAY, GREECE

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Orientation behaviors of loggerhead sea turtle (*Caretta caretta*) hatchlings' initial offshore migration in the Atlantic Ocean have been well described and involve visual, mechanical, and geomagnetic mechanisms. The Greek nesting population of *C. caretta* is genetically distinct from Atlantic sea turtles, and little is known about their initial dispersal movements in the Mediterranean Sea after hatching. The goal of this study was to examine the initial swimming paths of hatchlings from Kyparissia Bay, the second largest nesting ground in the Mediterranean. We hypothesized that loggerhead hatchlings would exhibit course corrective behavior and orient towards a similar direction. This study was conducted over 13 nights in the 2011 hatching season. Directional and distance data were obtained by a shore-based observer who monitored hatchling swimming paths (n=91 hatchlings) with a high-powered spotting scope up to a maximum distance of 206 meters offshore. Distance and direction data were collected at one-minute intervals for an average of 26 min per hatchling. Speed and direction of the local currents during hatchling dispersal into the ocean were also obtained. Hatchling path, swimming speed and local current data were plotted. Path characteristics were then correlated to potential environmental orientation cues including longshore current velocity. The characteristics of each path were examined for "entire path" average bearing and speed, as well as "initial" and "final" average bearings and speeds. Our results indicate a preferred mean direction that hatchlings traveled, which adds to the

understanding of Greek *C. caretta* hatchling movements post-emergence and may be useful for management and conservation purposes. The presentation of this poster has been made possible through generous donations by the following organizations: International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service.

TRACKING ALL LIFE STAGES: 130 SATELLITE TRACKS DEPLOYED IN THE INDIAN OCEAN PROVIDE INVALUABLE SPATIAL KNOWLEDGE AND HIGHLIGHT NEW CHALLENGES FOR SEA TURTLE BIOLOGY AND CONSERVATION*

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More than 130 satellite tags have been deployed in the South-West Indian Ocean during the last 3 years making up one of the most comprehensive and innovative satellite tracking program on sea turtle. Here, we present the experimental design and the essential results of this spatially explicit study. Firstly, to study the dispersal of juveniles at oceanic stage, we equipped 10 green turtles (<2 years old) with ultra-light tracking devices. Swimming capabilities could be a key for the survival of juveniles during the first years of their life-stage. In addition, we tracked 16 juvenile loggerheads (50-70 cm) accidentally captured in the open ocean by drifting long liners. A majority of individuals undertook a trans-hemispheric migration with individuals traveling more than 11,000 km. Such impressive migrations could support the hypothesis of a transoceanic developmental cycle of the loggerhead in the Indian Ocean. We also characterized the home ranges of juvenile green turtles at neritic stage. For that purpose, we used 11 high precision Fast-Loc satellite tags. Last but not least, on nesting female green turtles we deployed more than 100 tags to compare post-nesting migration patterns on 6 rookeries during and out of the nesting peak to see whether they used the same feeding ground according to season. Migration pathways exhibited a marked spatial dispersion. Nevertheless, we were able to point out preferable migration corridors priority zones. Turtles from each rookery visited a broad range of feeding sites, occasionally shared between rookeries. For the record, the EEZ of 11 countries have been visited by turtles and a significant number used MPA as foraging ground, highlighting the importance of an international strategy to ensure the conservation of this endangered animal. This massive tracking datasets constitutes a goldmine that has -and will continue to have- major implications on the study of the biology of sea turtles in the region and worldwide. Linking this great amount of data generated in relation with the forthcoming oceanographic measurements, the known regional genetic structure as well as the dispersal modeling of hatchling will be the next step of our analyses.

PRELIMINARY RESULTS ON POST NESTING FINE SCALE MOVEMENTS OF OLIVE RIDLEY SEA TURTLES IN THE GULF OF FONSECA, HONDURAS

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Punta Raton is the most important nesting site to date, for Olive Ridley sea turtles on the Pacific coast of Honduras. Although a nesting beach conservation project has been carried out in the area since the 1970s and a systematic tagging program has been conducted for the last 5 years, little is known about the movements and activity of females in the gulf waters during the interesting periods. In order to study their post nesting, fine scale movements, we tracked three females ranging from 61 to 65.6 cm minimum curved carapace length with GPS-VHF telemetry. After successful nesting, we attached 20 cm balsa wood buoys containing a GPS data logger, a VHF transmitter and a chemical glowstick to each turtle's carapace by way of a 30 m nylon cord tether with a safety release at the end proximal to the turtle. We followed the animals in a small skiff for 2, 4 and 10 hours, respectively. The first female swam to the west for the first 1.3 h, then turned to the southwest until the end of the trial, covering a total of 3.18 km. The second female headed north for 2.0 h but afterwards shifted southwest, swimming in that direction for another 2.0 h and covering a total distance of 6.88 km. After swimming perpendicular to the shore for 0.7 h, the third turtle followed a straight, stable trajectory to the southwest during more than 5.0 h, then slowed down and remained in the same area until the end of the trial, covering a total of 15.21 km. The average speed was 1.59, 1.72 and 1.52 km/h, respectively, and the maximum recorded speeds were 4.28, 6.99 and 4.57 km/h. The goal of this preliminary study was to evaluate the adequacy of using floating buoys to assess the fine scale movements of females from this population during the interesting period, as well as levels of nesting site fidelity. Results of these three trials suggest that these types of buoys are useful tools that easily allow following and locating target turtles both by day and night. However, we are uncertain that the attachments last long enough to measure nest site fidelity levels. The large amounts of floating debris observed in the gulf waters, as well as the presence of numerous artisanal fishing nets in the area, are likely to cause entanglement and detachment of the buoy within several hours or days. This research has been funded by ProTECTOR and the Department of Earth and Biological Sciences, Loma Linda University. Jesse Senko offered useful advice and support, improving the field work. I am especially thankful for the Travel Award granted by the International Sea Turtle Symposium to attend the 2012 meeting and present this project. This grant is supported by generous donations from the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service.

A LABORATORY EVALUATION OF HATCHLING LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) PERFORMANCE IN RESPONSE TO DIFFERING CONTROLLED INCUBATION TEMPERATURES*

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Sea turtles have a temperature based sex determination system. For the Northwest Atlantic loggerhead sea turtle (*Caretta caretta*), apparent population-wide female-biased hatchling sex ratios contrast with observations of juvenile populations, where sex ratios have remained constant at about 2 to 1 female-biased over the past 30 years. It has been suggested that some unknown factor is affecting loggerhead survival resulting in an unexplained differential loss of ~60% of female hatchlings per year. One theory to explain this hatchling mortality is tested in this project, that incubation temperature affects traits that influence survival. Furthermore, there may be differential survival between male and female hatchlings. We conducted laboratory experiments to test for an effect of incubation temperature and sex on performance of loggerhead hatchlings. We tested 68 hatchlings produced from eggs incubated at 8 different constant temperatures ranging from ~27ºC to ~32ºC. Following their emergence from the eggs, we tested righting response, crawling speed, and conducted a 24-hour long hatchling swim test. Data indicate an effect of incubation temperature on righting response time and crawling speed. The analysis of the 24-hour swim test is ongoing, but results analyzed to date will be presented. Differences in performance of hatchlings incubated at high temperatures are important in light of projected higher sand temperatures due to climate change, and could indicate increased mortality from incubation temperature effects. Acknowledgements: We would like to thank the PADI Foundation and the South Carolina Scientific and Cultural Education Fund for funding this research. Also thank you to the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service for providing a travel grant to attend ISTS.

THE INFLUENCE OF WATER MASS CHARACTERISTICS AND ILLUMINATION ON LEATHERBACK SEA TURTLE DIVE BEHAVIOUR AT HIGH LATITUDES: INSIGHTS FROM HIGH-RESOLUTION TAG DATA*

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Canadian waters host one of the largest seasonal aggregations of leatherback turtles (*Dermochelys coriacea*) in the Atlantic. Assessing and explaining the distribution of leatherbacks in time and three-dimensional space in their marine habitat is essential for the recovery of this endangered species, as interactions with human activities, including fishing, are a leading cause of mortality among sub-adult and adult turtles. This study presents spatial and temporal patterns in leatherback distribution that may identify environmental variables that shape habitat use. Satellite- linked temperature-depth-recorders were deployed on three female leatherbacks off Halifax, Nova Scotia in 2008 (n=2) and 2009

(n=1) and high-resolution time (0.5 Hz), depth (±1m), water temperature (±0.1ºC), and geographic location data were retrieved over periods of 10-80 days while the turtles were resident in Canadian waters. There is evidence that leatherbacks target the thermocline when diving and this suggests prey-related water mass associations. Furthermore, there are strong indications of systematic low- and high- frequency periodicities in the dive indicating diurnal and dive-related cycles in time at depth. The diurnal signal suggests that daylight shapes leatherback dive behaviour at high latitudes, and indicates that turtles may rely on visual cues for foraging.

SATELLITE TRACKING OF SEA TURTLE IN BANGLADESH MARINE WATERS

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Marinelife Alliance, is a conservation and research organization working for marine life particularly on sea turtle, cetacean, coral reefs and water birds along the coast and marine waters of Bangladesh. As part of the sea turtle research we started satellite tracking sea turtles to explore their critical offshore biological information needed to apply conservation measures to save them. Most of the offshore scientific information about this rare animal is unknown to us and each year thousands of sea turtles die due to bycatch in Bangladesh marine waters. Sea turtles are highly migratory and share international waters including many countries marine territories which increase their chance of being caught by various types of fishing nets spread over the vast marine waters. Bangladesh is signatory of regional and international conventions and treaties to save endangered sea turtles. To save these global flagship species we need to uncover the migratory routes through which they come to breed and lay eggs in our long sandy beaches each winter, the coastal habitat they use during nesting season and the pathways to long distance migrations at post nesting period. To understand this critical information we attached SPOT5 Satellite transmitters (PTT) on an olive ridley turtle for the first time in Bangladesh. All the PTT of Wildlife Computers with output power 0.25 Watt, set in the 12h/24h Transmission Duty Cycle and speed limit to 0.5 m/s. The first olive ridley named URMEE laid her last clutch on Sonadia Island on the 28th night and the PTT was attached on the evening of 29 March, 2010. We lost the signal after March of 2011. So far we understand the travel paths of the ridley during the last 12 months since April 2010 and 359 days transmission. We received 1662 localization signals. The transmission ended at a distance of 822 kms and the longest displacement was 1645 kms from the release point Sonadia of Bangladesh. It traveled the deepest part of the Bay of Bengal and northern part of Indian Ocean around 3739 meters near Sri Lanka. It spent 22, 139, 20 and 166 days in the territorial waters of Bangladesh, India, Sri Lanka and international waters respectively. This tracking is ongoing and we will find comprehensive information on migration and return route of a nesting olive ridley and a green turtle during 20011-12 season.

DETERMINING TRANSMITTER DRAG AND BEST-PRACTICE ATTACHMENT PROCEDURES FOR BIOTELEMETRY STUDIES ON MARINE TURTLES*

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Electronic transmitters or biologging devices (e.g., time-depth recorders, VHF radio and ultrasonic transmitters, satellite tags, and video cameras) are important tools that are used to identify appropriate conservation management actions for recovering marine turtle populations. Currently, all marine turtles in U.S. waters are listed as threatened or endangered under the U.S. Endangered Species Act of 1973. Electronic transmitters attached to the carapace of marine turtles, however, can increase the hydrodynamic drag and affect lift during locomotion. In this study we quantified the drag force induced by the attachment of biotelemetry systems to marine turtles using the transmitters and methods of attachment reported in the scientific literature. We tested over 20 different biotelemetry systems in 10 different configurations or positions on five casts made from leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*) and olive ridley (*Lepidochelys olivacea*) turtles (40.5 to 147.0 cm straight carapace length). The casts and biotelemetry systems were tested in the Boundary Layer Wind Tunnel at the University of British Columbia at wind speeds of 0.1 to 19.4 m s-1 (equivalent to swim speeds of 0.13 to 1.25 m s-1). We found that drag coefficients of the casts ranged from 0.126 to 0.192 placing marine turtle body forms intermediately between diving mammals and birds. The various tags and attachment configurations caused increases in drag force of 1% to 173%. The greatest increases in drag coefficient came from the squared, large antenna, radio tags (47% to 53% drag increase) on the juvenile turtles (< 50 cm SCL), the TDR drogue and Crittercam (67% to 111% drag increase) on the adult hard shell casts, and harness-style attachment methods on the leatherback casts (78% to 112% drag increase). Increases in drag force can cause a direct and proportional increase in power output if turtles are to maintain swimming speed. Alternatively, the turtles can reduce their swimming speed. Therefore, the increased drag caused by the tags has many implications for the migratory energetics and welfare of the outfitted turtles. It is important that researchers using biotelemetry devices in their research strive to minimize the added drag caused by the devices, thus ensuring the applicability of the research data to tag-free turtles in the wild and lessening the adverse effects to the turtles. To lessen the drag effects, the frontal area of the tags should be reduced, the tags should have a teardrop shape and low profile, the antenna length and diameter minimized, and the tags should not be placed at the peak height of the carapace.

LISTENING AROUND THE CLOCK: ACOUSTIC TELEMETRY REVEALS DIEL MOVEMENT AND ACTIVITY AREAS OF GREEN SEA TURTLES, *CHELONIA MYDAS*, IN A HIGHLY URBANIZED FORAGING ENVIRONMENT*

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Conservation of green sea turtles, *Chelonia mydas*, in foraging areas is contingent upon identifying high use areas and temporal variability in use patterns. This is particularly important in foraging areas that occur adjacent to urban or densely populated areas. The degree of coincidence between turtles and humans may affect turtle habitat use, but the spatial and temporal scales on which these interactions occur remain poorly understood. Green turtles resident to San Diego Bay, California USA, a highly urbanized temperate foraging area, were known to show site fidelity to the warm effluent of the South Bay Power Plant leading up to the facility's decommissioning at the end of 2010. Resident turtles have also shown fidelity to eelgrass pastures in the southern portion of the Bay. From 2009–2011, we used acoustic telemetry to investigate the fine-scale movements of 16 green turtles ranging in size from 54.9-102.5 cm straight carapace length. On 49 occasions, turtles were tracked for periods >2 hours during dawn (n=12), day (n=17), dusk (n=12), and night (n=10). We calculated a suite of metrics for turtle movements: 1) average speed (km hr^{-1}), 2) activity area (km^2 hr^{-1}), 3) movement straightness index (MSI; displacement/total distance traveled), and 4) average turn angle (TA; degrees). A generalized linear model, in which time of day was treated as a repeated measure within individual turtles, was used to test for differences in each movement metric. All tracked turtles stayed within the shallow (max depth ~ 5m), southern portion of San Diego Bay, where annual water temperatures ranged from 11.1 – 29.9ºC. Daytime tracks ranged across the entirety of south San Diego Bay, including areas of known eelgrass (*Zostera marina*) distribution and along the effluent channel of the South Bay Power Plant. Turtles traveled at significantly higher speeds during day (0.67 ± 0.07 km hr^{-1}) and dusk (0.77 ± 0.10 km hr^{-1}) than during night (0.38 ± 0.03 km hr^{-1}). Turtles also exhibited significantly lower MSI values (low linearity) during daytime (0.19 ± 0.04) than dawn (0.52 ± 0.11), dusk (0.45 ± 0.09), and night (0.43 ± 0.09); similarly, turn angles were significantly higher (low linearity) during daytime (99.9 ± 3.38º) than dawn (80.2 ± 5.77º) and dusk (81.3 ± 6.25º). Non-linear movement is generally associated with foraging behaviors and daytime tracks coincided with areas containing known diet items (primarily invertebrates and eelgrass). Nocturnal activity areas (0.02 ± 0.01 km^2 hr^{-1}) were significantly smaller than dawn (0.06 ± 0.02 km^2 hr^{-1}) and dusk (0.07 ± 0.02 km^2 hr^{-1}) and were generally restricted to the South Bay Power Plant effluent channel and jetty. The higher linearity of movement during dawn and dusk suggests that turtles transitioned between diurnal and nocturnal activity areas during crepuscular periods. Ongoing research will monitor potential changes in the movement behaviors and activity areas of green turtles following the decommissioning of the South Bay Power Plant. In characterizing the spatial ecology of green turtles in San Diego Bay, our study helps to assess the data gap of how turtles use urbanized foraging areas and changing coastal ecosystems.

THE INFLUENCE OF TEMPERATURE ON HABITAT USE: EAST PACIFIC GREEN SEA TURTLES (*CHELONIA MYDAS*) IN SAN DIEGO BAY, SAN DIEGO, CALIFORNIA*

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Thermal effluent from industrial sources and power plants is commonly discharged into both freshwater and marine environments. The heated discharge creates an unnatural thermal environment in the local habitat that greatly affects the ecosystem and its inhabitants. Organisms in these thermally affected areas experience physiological and/or behavioral thermoregulatory changes as direct results from the increased temperatures of these areas. Species associated with areas of thermal effluent appear to adapt locally to these sites, as evidenced through long-term studies. Additionally, ecosystem composition at these sites changes in terms of species richness and abundance. Concern for management of these areas has come into focus as many sources of thermal effluence face decommissioning at present or in the not-so-distant future. The South Bay Power Plant in San Diego, California discharged warm-water effluent into San Diego Bay (SDB) in an area designated as a unit of the San Diego National Wildlife Refuge called South Bay. East Pacific green sea turtles (*Chelonia mydas*) inhabiting SDB have been routinely observed in the South Bay Power Plant outfall area since the 1960s. Turtles likely utilized the outfall area to take advantage of the significantly warmer water for thermoregulatory purposes. Local government and non-governmental organizations (NGOs) successfully argued that the South Bay Power Plant should be decommissioned due to negative environmental effects and outdated technology. On 31 December 2009, two of the plant's four generators were permanently shut down with complete decommissioning of the Plant on 31 December 2010. Closure of the South Bay Power Plant has removed this non-natural source of warm water, and bodes the question of how green turtle movement and behavior in the Bay will change. Beginning summer 2009, regular tracking efforts of tagged green turtles in SDB have revealed that their movements are centered at the power plant outfall area and nearby eelgrass beds of South Bay. To determine whether turtles associate with areas based on temperature, three types of telemetry have been employed: passive acoustic monitoring, active acoustic monitoring and time-depth recording. Acoustic receiver stations deployed in SDB passively recorded turtle movement spatially and temporally. Active tracking, involving a weekly boat-based survey, monitors for turtles across the entire Bay. Data from time-depth recorders (TDRs) have provided information regarding vertical movement of turtles in SDB, complimenting the horizontal movement information obtained through passive and active tracking. Temperature data collected in conjunction with telemetry activities demonstrate fine-scale variability in temperature-based habitat usage, tide, time of day, and season. Preliminary data analysis suggests that turtles demonstrate a thermal preference range and may be associating with local habitats in this range. Characterizing the behavioral responses of green turtles in SDB will improve our understanding of how a population of long-lived marine vertebrates will be affected in a thermally dynamic environment that is changing at a rapid rate – a gap in ecological knowledge.

RESIDENCY AND MOVEMENTS OF GREEN TURTLES (*CHELONIA MYDAS*) AND HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) TAGGED IN COCOS ISLAND NATIONAL PARK USING ACOUSTIC TELEMETRY*

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Cocos Island National Park is located approximately 550 km from Costa Rica. Its strategic position as the first point of contact with the North Equatorial Countercurrent makes Cocos Island an ideal laboratory for studying biological processes. Six sea turtle tagging expeditions were held between March 2009 and March 2011, each consisting of 7 days during which 80 green turtles (*Chelonia mydas*) and 3 hawksbill turtles (*Eretmochelys imbricata*) were captured by scuba diving. Of these, 12 green turtles and one hawksbill were tagged with acoustic transmitters. Acoustic receivers were deployed in 4 strategic points around the island: Manuelita, Dirty Rock, Small Dos Amigos, and Alcyone. Acoustic receivers logged a total of 8857 detections. The presence of 3 turtles was recorded in Alcyone, 10 in Dirty Rock and 11 in Manuelita. No turtles were detected in Small Dos Amigos. Greatest activity was recorded during the day. Two turtles showed high fidelity to Manuelita and Dirty Rock. Acoustic telemetry is an inexpensive option to track turtle movements in remote locations.

NEW INSIGHTS TO THE IN-WATER BEHAVIOR AND MOVEMENTS OF OCEANIC STAGE NEONATE SEA TURTLES*

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Seventeen neonate loggerhead (*Caretta caretta*) sea turtles were satellite tracked using small-scale solar powered satellite tags. Turtles were released in the Atlantic off the coast of southeast Florida (USA). Average age of the turtles was 169 d (±53 d SD); turtles ranged in size between 11 to 18 cm straight carapace length (average: 14 ± 2 SD). These turtles represent the smallest sea turtles to be satellite tracked to date. Turtles were remotely tracked for an average of 87 d (±55 d SD; range: 27 - 219 d). Based on sea surface temperature (SST) data derived from the HYbrid Coordinate Ocean Model (HYCOM), turtles were observed to remain within SSTs ranging from 17˚C to 29˚C (mean: 23˚ ± 3˚C). These temperatures differed from temperatures recorded by the satellite tags' sensors: 24˚C – 32˚C. Except for the turtles' initial release location, turtles spent 4 d or less within Continental Shelf waters with one exception (approximately 21 d). After leaving Shelf waters the turtles remained east of the 200 m isobath for the duration of their tracks. The turtles were all released within the Gulf Stream and remained within this current for a minimum of one to three weeks. Twelve turtles remained within the current or in association with the broader Atlantic Gyre system throughout their track duration. Travel times from southeast Florida to

waters offshore of Cape Hatteras, NC were less than 2 to 3 weeks; the turtles' northeast and eastern movements slowed once in the northern Atlantic. While some turtles oriented using bearings similar to those predicted by Lohmann *et al*. (1996) our data indicate that on a smaller, localized scale, neonate loggerheads may temporarily deviate from the classic Carr (1987) oceanic stage Atlantic migratory routes and the Lohmann *et al*. (1996; 1999) orientation models. Turtles did not select the fastest routes to hypothesized nursery areas in the eastern Atlantic (e.g., Azores). Turtles were observed to exit the Gulf Stream for extended periods, and/or swim against or across the current. Funding and support for this project was provided by the Large Pelagics Research Center Extramural Grants Program, National Marine Fisheries Service Southeast Fisheries Science Center and the National Academies Research Associateship program, the Florida Sea Turtle Grants Program, the Disney Worldwide Conservation Fund, The Philanthropic Collaborative, Ashwanden Family fund, Nelligan Sea Turtle Fund, Save Our Seas Foundation, J. Abernethy, and personal funds.

HOW LONG DOES A DIVE OF SEA TURTLES LAST? NEW PERSPECTIVE FROM PRECISE ACCELERATION DATA*

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The objectives of this study are to determine how dive duration of sea turtles is regulated by dive activity and inspired air volume in lungs before the dive, and also how post-dive surface duration by dive activity and dive duration. To do this, we used four juvenile hawksbill turtles (*Eretmochelys imbricata*). In the experiments, a data logger with depth and acceleration sensors (M190-D2GT for hawksbill, Little Leonardo Co., Japan) was attached on the center of carapace. Then, we obtained 5-day period of the dive data of the turtles. In the present study, we used the DBA dynamic body acceleration (DBA, defined in Wilson *et al*. 2006) as an index of the amount of activity of turtles during a dive. In addition, the instantaneous depth when flipper beat frequency was below the dominant stroke cycle frequency (DFBD, defined in Yasuda & Arai 2009) was used as an index of an index of the oxygen volume in the lung of the turtle at the beginning of the dive. The DFBD means the depth at which turtles begin to conduct passive glide swimming, which is assumed to be proportional to the air volume in the lung inspired at the sea surface before the dive. As the results of this study, the dive duration of sea turtles was significantly regulated by dive activity and inspired air volume in lungs before the dive, which demonstrates that dive duration inversely decreases with an increase in dive activity, while linearly increases with larger inspired air volume. This study also revealed that post-dive surface duration of sea turtles increases linearly with longer dive, but exponentially with higher activity during the dive.

IDENTIFYING FORAGING LOCATIONS OF LOGGERHEAD TURTLES IN THE NORTHWEST ATLANTIC BY COMBINING STABLE ISOTOPES AND SATELLITE TELEMETRY*

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Understanding the implications of differential habitat use and movement patterns on the population demographics of endangered marine fauna is key to understanding how environmental changes will impact populations. Combined use of stable isotopes and satellite telemetry has proven to be useful in identifying foraging areas and understanding movement patterns of highly migratory animals. In this study, we used stable isotopes (δ13C and δ15N) and satellite telemetry to determine the foraging locations and movement patterns of adult female loggerheads (*Caretta caretta*) in the Northwest Atlantic (NWA). Skin tissues were collected from 104 turtles at 6 nesting areas along the US east coast during nesting seasons 2003, 2004 and 2005. Twenty-two turtles were tracked with satellite transmitters to assess their movement patterns following breeding. Our results show significant correlations between both δ13C and δ15N and the latitude of the foraging grounds to which the turtles migrated. Also, we identified three main geographic locations with characteristic oceanographic processes used by loggerheads in the NWA. Furthermore, a preliminary application for which we integrated our results with published isotope data allowed us to assign turtles from 6 nesting areas to one of the three geographic locations identified. Our results show a latitudinal trend in the foraging location of nesting turtles. The majority of turtles nesting in northern beaches tend to forage in higher latitudes while turtles nesting in southern beaches tend to forage in lower latitudes. This study shows that stable isotopes can be used to infer the foraging location origin of loggerhead turtles in the NWA. By identifying the geographic origin of nesting turtles, we can begin to understand how environmental factors affect population demographic parameters. Our study represents the first steps towards assessing the utility of stable isotopes as a tool to understand patterns of migratory connectivity between foraging grounds and breeding areas for loggerheads in the NWA. We wish to thank Barbara Schroeder, Allen Folley, and Brian Stacy for the collection of samples at Florida Bay. We also thank the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service. Please acknowledge these donors and the International Sea Turtle Symposium for support to attend this symposium.

POST-REPRODUCTIVE MIGRATION OF AN ADULT MALE LOGGERHEAD FROM CRETE REVEALED BY SATELLITE TELEMETRY

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Most information regarding sea turtle biology is about the nesting and at-sea behavior of adult females and the development of hatchlings. Healthy adult male sea turtles are difficult to study because they rarely leave the water. As of 2007, only three male loggerheads had been tracked globally using satellite telemetry, with only one individual studied in the Mediterranean. Here, we present the first-ever post-reproductive tracks of a male loggerhead turtle caught in the near-shore waters of Greece. Greece contains the most important nesting beaches in the Mediterranean for loggerheads. The third most populated nesting beaches in Greece, averaging approximately 300 nests per season, are found at Rethymno, on the island of Crete. In late May of 2011, one week prior to the start of the loggerhead nesting season, we acquired a male off the coast of Rethymno through collaboration with a local fisherman. We attached a satellite transmitter to this individual and tracked it for 143 days. This turtle embarked on its post-reproductive migration on June 20, 2011, over a month in advance of the end of the nesting season. It first travelled approximately 1200 km to the Gulf of Gabes, Tunisia, residing there for one and a half months before continuing through the Strait of Sicily approximately 1000 km into the western Mediterranean Sea. While in the Gulf of Gabes, this individual foraged within a localized area similar to other satellite tracked females; however, in the western Mediterranean, a more nomadic foraging behavior was exhibited. Regardless of location, foraging seemed to occur within the benthic zone, as dives reached similar depths in both the Gulf of Gabes and the western Mediterranean Sea. Furthermore, the male was able to take much longer dives (>90 minutes) more regularly than what has been observed in the past by non-overwintering female loggerheads from Crete. This is also the furthest movement for a satellite tracked male turtle from Greece. The satellite track extended well into the western Mediterranean and is the first of its kind from a loggerhead originating in the eastern Mediterranean. These novel behaviors help to improve our understanding of this broad ranging generalist sea turtle. This particular male behaved with far more individual variation than is seen during female post-nesting movements and is indication that more research is required on the behavior of adult male loggerheads in the Mediterranean Sea.

POST-NESTING STRATEGIES OF LOGGERHEADS FROM CRETE REVEALED BY SATELLITE TELEMETRY*

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Loggerhead turtles (*Caretta caretta*) are broad generalists relative to sea turtle species in terms of feeding, foraging and nesting locations. However, whereas generalist behavior may contribute to resilience, recent research indicates that a warming climate could dramatically affect the loggerhead and its food sources. The purpose of our study was to determine current or possible future adaptations for loggerhead turtles in the Mediterranean as they respond to a rapidly changing environment. Greece contains the most important nesting beaches in the Mediterranean for loggerheads. Rethymno, Crete hosts the third most populated nesting beaches, averaging approximately 300 nests per season. During the 2010 and 2011 nesting seasons in Rethymno, we successfully attached satellite transmitters to 19 adult female loggerheads after their final nesting event. We determined reproductive status and potential for laying additional clutches through ultrasonagraphy: each turtle was scanned with a portable ultrasound machine immediately after egg laying. After the season's final nesting we tracked turtles until they settled into their foraging site. There were two general strategies for post-nesting movements. Most loggerheads traveled long distances to their foraging grounds, but some took up residency adjacent to their nesting beaches. Among the long distance travelers, there were three distinct migration patterns. The first was a westward migration from Rethymno ending at the Gulf of Gabes, Tunisia; the second was a northward migration into the Aegean Sea; and the third was an eastward migration around Crete, then southwest towards the North African coast. Thus, there was more variation in migratory pathways and foraging sites of loggerheads from a single nesting population than otherwise expected. The variety of migratory patterns may be a hedge against changes brought about by rapid climate changes. However, global warming will likely have a severe impact on the food source of loggerheads with higher water temperatures and lower pH. The Gulf of Gabes appears to be the most important foraging ground for loggerheads from Rethymno. As the southernmost foraging area, it will experience the effects of climate change first. It is not yet possible to predict the responses of all Crete loggerheads to the warming climate, however, their generalist behavior, the use of multiple foraging site locations, and their breadth of migratory patterns within the Eastern Mediterranean may make them more resilient in the face of negative impacts of a rapidly changing environment.

ON THE DISPERSAL OF LEATHERBACK TURTLE HATCHLINGS FROM PACIFIC MESO-AMERICAN NESTING BEACHES*

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So little is known about the early life history of leatherback turtles (*Dermochelys coriacea*) from hatchling to adulthood that this period has been termed the “Lost Years”. For critically endangered eastern Pacific leatherback populations, continued and rapid declines underscore the urgent need to develop conservation strategies across all life stages. We investigate leatherback hatchling dispersal from four Meso-American nesting beaches using passive tracer experiments within a Regional Ocean Modeling System (ROMS). The evolution of tracer distribution from each of the nesting beaches showed the strong influence of eddy transport and coastal currents. Modeled hatchlings from Playa Grande, Costa Rica, were most likely to be entrained and transported offshore by large-scale eddies coincident with the peak leatherback nesting and hatchling emergence period. These eddies potentially serve as “hatchling highways” providing a means of rapid offshore transport away from predation, and a productive refuge within which newly-hatched turtles can develop. We hypothesize that the most important leatherback nesting beach remaining in the eastern Pacific (Playa Grande) has been evolutionarily selected as an optimal nesting site due to favorable ocean currents that enhance hatchling survival.

BEHAVIORAL RESPONSE OF GREEN SEA TURTLE HATCHLINGS TO COLD WATER

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Young sea turtles in the open ocean are assumed to be drifting by ocean currents. However, in the case of nesting sites of Japan, if they were just drifted passively in the open ocean, many hatchlings would drift along the strong current of Kuroshio and Kuroshio extension Current and arrive at the northern part of north Pacific where the water temperature is below their thermal temperature. This indicates the possibility that hatchlings do not just drift passively, but swim actively to avoid low temperature. In this study, we conducted two tank experiments to reveal the behavioral response of green turtles to water temperature. We used fourteen green turtles (*Chelonia mydas*) at the age of three months. In the first experiment, we examined the change in the activity level in the tank when turtles were

exposed to water at various temperatures (13, 15, 18, 20, 23, 25 and 25ºC) every 30 minutes. During the experiment, we measured the number of stroke at each temperature. As a result, the number of stroke felt down significantly when the water temperature was below 15ºC. Second experiment was conducted to confirm whether turtles avoid low temperature. We settled turtles in the center of the rectangular tank in which the sea water (around 25ºC) flows from one side of the tank, and the cold sea water (5ºC) from the another side. Turtles are allowed to swim freely in the tank. Then, we monitored the behavioral response to cold water. The result of this experiment suggests that green turtle juveniles escape from the waters below around 22ºC. Our results indicate the possibility that the green turtle juveniles change their migration route in response to cold water.

LOST AND FOUND: EVIDENCE DESCRIBING SURFACE-PELAGIC TO BENTHIC RECRUITMENT BY JUVENILE KEMP'S RIDLEY SEA TURTLES (*LEPIDOCHELYS KEMPII*)*

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The "lost-year(s)" open-sea juvenile stage of Kemp's ridley has remained mysterious and is represented by little empirical information describing the behavior, distribution, and habitat use of these young turtles. This uncertainty has included the end of the open-sea life stage; there has been no direct observation supporting hypotheses on how the ecological transition between pelagic/oceanic surface waters and benthic/neritic habitats might take place. In this paper, we present evidence that some juvenile ridleys undertake a rapid, direct transition between surface-pelagic and benthic habitats in the eastern Gulf of Mexico. Evidence includes 1) behavioral observations of oceanic-stage juvenile ridleys (175–276 mm SCL, n=38) within surface-pelagic Sargassum habitat in the eastern and northern Gulf, 2) vertical and horizontal movements of surface-pelagic ridleys assessed from depth recorders (n=3) and satellite telemetry (n=10), 3) growth rates of surface-pelagic ridleys based on seasonal date/size and date/mass relationships, 4) size frequency comparisons between adjacent (eastern Gulf and southeast Florida) surface-pelagic and benthic habitats, and 5) the first recorded satellite telemetry track of a juvenile ridley moving from the open-sea into coastal habitats. Evidence supports the hypothesis that surface-pelagic juveniles are transported to the eastern Gulf and drift within pelagic Sargassum while they grow approximately 80 mm SCL over a four-month period. At the end of this period (September), juvenile ridleys averaged 260 mm SCL, which matched the sizes of the smallest ridleys from adjacent coastal habitats. A single satellite track suggested active swimming, rather than passive drift, during recruitment to coastal waters.

USING SATELLITE TELEMETRY TO INFORM CONSERVATION STRATEGIES FOR THE SOUTH ATLANTIC LEATHERBACK

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Satellite telemetry has transformed our understanding of the movements and behaviours of sea turtles. The cost of undertaking such work poses a considerable challenge for gaining knowledge on some regional sea turtle populations where resources are lacking (e.g. finance, logistics and expertise). Collaborative approaches between governmental, non-governmental and research organisations provide a valuable way to enhance regional capacity for carrying out such work. Here we describe the movements of an under-studied population of leatherback turtles (*Dermochelys coriacea*) nesting in northern Gabon (equatorial West African coast), a country that hosts the worlds' largest population of this species. We used satellite telemetry (Wildlife Computers; MK10-AF) to describe patterns of habitat utilization during the internesting period for eight leatherback turtles nesting at Pongara National Park. Turtles were tracked for 54 ± 20 days and dispersed widely from the nesting beach, extending offshore as far as 175 km and occupying an area of ~2,000 sq km (50% density kernel estimate). Satellite transmitters also provided detailed knowledge on depth utilisation and dive behaviour. The observed patterns of habitat utilization indicate the need for wider spatial scale planning, particularly in view of the overlap between sea turtle habitat use and regional threats. The major threats include extensive oil exploration and extraction activities and industrial fisheries. Our results help to inform management recommendations and mitigation measures, such as the use of Turtle Excluder Devices (TEDs) and time-area closures in fisheries, protected area zoning, and the development of guidelines for the seismic surveying industry.

Conservation, Management and Policy

RAPID ASSESSMENT OF SEA TURTLES CONSERVATION NEEDS IN EASTER ISLAND IN THE SOUTH PACIFIC

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The South Pacific is one of the major migratory routes and foraging habitats of four species of sea turtles (*Caretta caretta*, *Chelonia mydas*, *Dermochelys coriacea* and *Lepidochelys olivacea*). Chile's coastal range harbors some populations of sea turtles that have received little attention. Eastern Island (27°7`10"S 109°21`17"W) is one of the most remote places of the world and lies 3,510 km (2,180 mi) west of continental Chile. The island has a triangular shape (163.6 km^2 area) and is about 24.6 km long by 12.3 km at its widest point. Human pressure on natural resources such as fishing and tourism may affect sea turtles in the island. The aim of the present study was to conduct a rapid assessment of the current conservation status of the groups of turtles in the main bays and ports, local attitudes towards turtles and future needs for research and conservation. This study was conducted in July 2011. A survey to 23 local people reported the presence of hawksbill turtle (*Eretmochelys imbricata*), a species previously not recognized in the Chilean territory. The species are considered beneficial to local tourism. Green sea turtles were observed in the two main bays Hanga Roa and Hanga Piko. We could identify several threats against turtle's conservation, namely meat consumption by fishermen, marine pollution, ship strikes and capture for consumption, which need to be studied further. Our rapid assessment indicate the importance of Easter Island as foraging habitat for sea turtles, especially green turtles in the remote South Pacific and a potential place for long-term monitoring of these species.

SEA TURTLE CONSERVATION IN THE COLOMBIAN PACIFIC REGION

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The Pacific and Caribbean coasts of Colombia provide important nesting and feeding areas for five species of sea turtles. Many conservation initiatives have been developed along both coasts. The current state of knowledge on sea turtles in the Colombian Pacific was presented in a report by the "Conservacion Ambiente Colombia Foundation" to the Permanent Commission for the South Pacific (CPPS). During the process many persons involved in the subject were consulted to provide information on local actions and results, and in addition a workshop was organized to conduct a SWOT analysis and propose supplementary recommendations. In the Colombian Pacific activities focus on three protected areas and their zones of influence. Field work is developed by National Parks personnel (such as the National parks of Gorgona and Sanquianga), academics, local

communities (such as the Caguama Asociation in the department of Chocó) and non-governmental organizations (such as Cimad in the Gorgona National Park and Guapi, and the Natura Foundation in Bahia Solano-Chocó). The activities are principally aimed at monitoring nesting zones for the olive ridley sea turtle *Lepidochelys olivacea* and the green sea turtle *Chelonia mydas*, like at the Palmeras Beach in the Gorgona National Park, Naranjos and Mulatos Beaches in the Sanquianga National Park and La Cuevita Beach, which is the influence zone of Utria National Park. In Gorgona and Utria feeding areas are reported for the black turtle (*C. mydas*) and the hawksbill sea turtle (*Eretmochelys imbricata*). Additionally there are studies on genetic composition of populations, telemetry by satellites, feeding ecology and tagged monitoring during many years in the Gorgona National Park. The only rehabilitation center for sea turtles is localized in Guapi, Department of Cauca, which is called “Ceretoma” and is operated by Cimad. The results in the three areas differ in quality and reliability due to the differences in availability of resources and personnel involved in the conservation activities. Other initiatives were developed in Tumaco by Conservacion Ambiente Colombia Foundation, in Chocó by the University of Antioquia and in some localities of Cauca, Valle and Chocó by the WWF to change traditional hooks (J) for circle hooks in bottom fisheries. Furthermore, the questioned participants identified the need for active participation and strengthening of the commitment and management by Regional Environmental Authorities as articulators of regional and local efforts, highlighting the active participation of the National Parks Unit. In addition it was urged to developed the following actions: 1) Border cooperation for issues related to fisheries and bycatch; 2) Onboard observers in (semi-) industrial fishing vessels; 3) Standardization of methodologies and training for local communities; 4) Information system with actualized data; 5) Strengthening of environmental education. A copy of the report for Colombia can be found on: http://redtortugasmarinascolombia.ning.com and http://cpps.dyndns.info/cpps-docs-web/planaccion/biblioteca/

“THREATS MATRIX”: A CRITICAL ANALYSIS OF THE MAIN THREATS ON SEA TURTLES IN THE GULF OF VENEZUELA*

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Recently, there has been an increase in endangered species conservation efforts by national and international NGOs, governmental institutions, and universities. However, these efforts are focused on reducing the pressures on threatened populations, without taking into account some threats and their different impacts in time and area. The focus of the conservation projects for sea turtles can change depending on the zone where the project takes place. In the Gulf of Venezuela (GV) the socio-economic and cultural situations of coastal communities impacts sea turtle populations in different ways, depending on human population density, traditional uses and regional impacts. In this research for the GV we analyzed a matrix based on the main five global threats to sea turtles as recently

proposed by the IUCN/SSC Marine Turtle Specialist Group: a) fisheries bycatch, b) take, c) coastal development, d) pollution and pathogens, and e) climate change. For this, we systematically evaluated historical data (dissertations, technical memorandums, abstracts, field data, NGO and governmental institution internal reports) and we conducted semi-structured interviews with scientific personnel who had recognized expertise. The threats matrix was presented as a list of indicators that could have been (or not) assessed previously in the GV, and the obligatory hierarchy with a global perspective, but based on the local reality of threats and use values of sea turtles in the GV. Cases with poor information or only with recent data (last 15 years) were classified as "Data Deficient (DD)". Finally, we built a Portfolio Approach in order to assess the impact of the threats on each species. Hawksbill (*Eretmochelys imbricata*) was the species with highest threat level, followed by green turtle (*Chelonia mydas*), loggerhead (*Caretta caretta*) and leatherback turtle (*Dermochelys coriacea*). For the olive ridley (*Lepidochelys olivacea*) a 90% level of DD classification resulted in this species not being included. *C. mydas* is the most abundant species in the GV, and all evaluated threats affect it. However, considering the global threat levels and the cultural valuation for the hawksbill turtle, this species is more vulnerable, due to the restricted reef patches available for its feeding and from illegal trade in hawksbill products which can produce valuable income. Take is the most extended threat in the zone (affecting all 5 species), followed by bycatch (impacting mainly loggerheads, through artisanal longlines); the remaining three elements of coastal development, pollution and pathogens and climate change were classified as "not sufficiently evaluated", although we highlight the possible impact of coastal development on historical populations of sea turtles, due to the dredging of the navigation canal during the 1950´s. Other threats in the area have not been systematically evaluated but should be.

CONSERVATION AND MANAGEMENT OF THE LEGAL GREEN TURTLE FISHERY IN THE REGION AUTONOMA ATLANTICO SUR (RAAS), NICARAGUA*

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Since 2007, the South Atlantic Autonomous Regional government has implemented annual resolutions to define management regulations and roles and responsibilities of authorities for the green turtle fishery. We assessed the 2010-2011 green turtle fishing season by evaluating the implementation of the regional government resolution. Results indicate that the established quotas, closed season, access to the fishery and other regulations were not respected by fishers, and communal leaders did not assume their roles and responsibilities or if they did they were assumed poorly. In addition, government management and enforcement authorities demonstrated poor commitment to the implementation of management regulations and face financial and technical limitations to meet their responsibilities. We present results from our assessment of the 2010-2011 season, limitations of the Nicaragua resource management system, principal drivers to overexploit the resource, and recommendations to achieve a more successful management regime for a sustainable green turtle fishery. Acknowledgements: I would like to thank the following

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THE STATUS OF MARINE TURTLES CONSERVATION IN VIETNAM AFTER 7 YEARS OF CONDUCTING THE NATIONAL ACTION PLAN AND CHALLENGES TO MEET IN THE FUTURE

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Marine turtle conservation has been taken into account by Vietnamese government since 2004 by approved the Marine turtle conservation national action plan until 2010. According to this plan, several activities should be done, include raising awareness of local fishermen on nesting and foraging grounds, minimizing the impacts on nesting beaches and living habitats, reducing the mortality rate of bycatch fishing and protecting the hatchlings from rookeries, etc. After 7 years of implementarion, the most successful achievement of the action plan is the rising awareness program at several important provinces (Quang Ninh, Quang Tri, Quang Ngai, Binh Dinh and Phu Yen), which has been attracted the participation of thousands fishermen, pupils, local government officers, and media in various conservation activities such as training courses, volunteer works, and the marine turtle conservation's knowledge contests etc. Nevertheless, despite the efforts of governmental agencies and NGOs, the number of nesting marine turtles has been reduced rapidly in both species and rookeries. According to our researches from 2009 to 2011 at 12 coastal provinces (including some offshore islands like Spratly, Ly Son, Tho Chu, Bach Long Vy), currently only three species of marine turtles are still nesting on Vietnamese coastline (with the absent of Olive ridley turtle) at six rookeries, compare to four species and nine rookeries in 2002. Green turtle shows the largest population with about 300 nesting individuals per season (more than 80% of total population concentrated in islands of Con Dao archipelago). Both hawksbill turtle and leatherback turtle populations are very small, each species has less than 10 females per season in the North and Central provinces of Vietnam. Therefore, it is necessary to develop a new marine turtle conservation action plan in Vietnam to adapt with the threats now and in the future.

THINKING OUTSIDE OF THE BEACH – AN INTERDISCIPLINARY STUDY OF TURTLE TOURISM-RELATED MOTORBOAT USE IN TORTUGUERO, COSTA RICA*

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My study addresses local concerns about turtle tourism-related motorboat use and impacts in an unconventional place—freshwaters adjacent to an important sea turtle nesting beach: Tortuguero, Costa Rica. Tortuguero has seen a significant amount of research on sea turtle biology, behaviour, reproductive ecology, use of habitat, and migration, but most research has focused on the beach where sea turtles nest. The transportation-side of turtle tourism is not a typical research focus, and as such, it has not been evaluated in a holistic academic investigation or impact assessment. In my interdisciplinary Masters study, I combine physical and social science methods, to address knowledge gaps about tourism impacts 'off the beach' in Tortuguero. This is a locally-driven study since motorboat-related impacts are a known local concern. Tourism increases to the area (e.g. Tortuguero National Park ticket sales have increased from 45,232 visitors in 2001, to 114,888 visitors in 2010) have been accompanied by growing local concerns about negative impacts of increased tourism development. Worries about motorboat use and its impacts are among these. Tortuguero is located on a narrow strip of rainforest between ocean beach and freshwater lagoon. Without roads or cars, both the community and the tourism industry are heavily reliant on motorboat-based transport. Local freshwaters are home to fishes, caimans, crocodiles, crustaceans, birds, freshwater turtles, and the endangered West Indian Manatee – all of which are desirable as parts of the local ecosystem and as tourist attractions. My study examines various aspects of motorboat use including: boat traffic patterns; local perceptions of boat use and associated impacts; and the re-suspension of sediments. As such, it represents a novel addition to literatures on motorboat use; water-reliant tourism; and turtle tourism in Tortuguero and beyond. My research combines three distinct data collection methods. During the months of June-August 2011 (green turtle nesting season), I collected: 1) physical science data about boat traffic patterns, using a custom Boat Observations and Traffic Evaluations (BOTEs) protocol, for 100 hours of day and nighttime monitoring; 2) physical science data on sediment re-suspension, from weights and analyses of Total Suspended Solids (TSS) in the form of residues from 129 filtered water samples; and 3) social science data, via 44 semi-structured interviews and participant observation. I will present a summary of my methods and results, focusing on common themes from the interviews and the relationships between these and the physical data that I collected. I will discuss management implications and the importance of 'thinking outside of the beach' when researching turtle tourism and its impacts—an essential undertaking in seeking a balance between tourism and conservation. Thank you to UNBC, International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and the International Sea Turtle Symposium for enabling me to attend this year's Symposium through their generous donations!

CRITICAL HABITAT DESIGNATION FOR PACIFIC LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*) OFF THE U.S. WEST COAST – IT'S ALL ABOUT THE JELLIES

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Leatherback sea turtles are listed globally as an endangered species under the U.S. Endangered Species Act (ESA). In early 2012, NOAA's National Marine Fisheries Service (NMFS) designated nearly 42,000 square miles of ocean waters off the U.S. west coast as leatherback "critical habitat." A portion of this area has been closed to drift gillnet fishing since 2001 (annually from August 15 to November 15) to protect leatherbacks that could be incidentally taken in the fishery; however, this critical habitat designation now requires NMFS to more closely consider the impacts of federal activities on the prey of leatherbacks – sea jellies, rather than impacts on individuals. Considering the current research regarding the bioenergetic needs of leatherbacks traveling thousands of miles from the western Pacific to the waters off California, Oregon, and Washington, NMFS identified specific areas that contained leatherback prey species, primarily scyphomedusae of the order Semaeostomeae (Chrysaora, Aurelia, Phacellophora, and Cyanea), of sufficient condition, distribution, diversity, abundance and density to support individual as well as population growth, reproduction, and development. NMFS reviewed available data from aerial surveys, observations, satellite telemetry studies, fishery interactions, as well as recent research which has revealed areas where leatherbacks tend to occur for an extended period of time, suggesting that such areas are likely important for foraging. Given the above definition of the prey and its occurrence in certain areas as well as the identification of areas consistently used by leatherbacks in the late summer and fall, NMFS identified seven activities conducted, authorized or permitted by federal agencies in these areas that may have negative effects on sea jellies and therefore may require specific management. These activities include: power plant operations, liquid nitrogen gas facilities, agriculture pesticide application, tidal-wave energy projects, oil spill response, desalination plants, and issuance of National Pollutant Discharge Elimination System permits. As part of the critical habitat designation process, NMFS was required to consider the economic costs of designation, (including the costs of modifying an activity to avoid or reduce impacts to sea jellies) and compared those costs to the benefit of designating areas as leatherback critical habitat. In all of the marine areas NMFS considered, the conservation benefit of designating critical habitat outweighed the economic costs of modifying an activity as well as any potential (but unlikely) impacts on national security. This is the first time that the U.S. has designated critical habitat in the offshore marine environment to protect leatherback prey, mainly brown sea nettles, so the impact of the designation to current and planned activities off the west coast is relatively unknown. Recent and planned research to elucidate the health of leatherbacks through collection and evaluation of samples taken from turtles and their prey

should help determine whether heavy metals, pesticide residues, marine biotoxins and pathogens accumulate in sea jellies and subsequently bioaccumulate in leatherbacks. This could help NMFS in assessing impacts of activities on leatherback prey and help guide modifications to projects that may be necessary to protect prey.

MANAGEMENT UNITS VS. REGIONAL MANAGEMENT UNITS: DUELING PERSPECTIVES FOR CONSERVATION?*

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Conservation management of marine turtles requires an understanding of what constitutes a population, where the boundaries of a population are in terms of rookery locations, what feeding grounds are used by those turtles and the migratory routes they use in getting between these sites. Much of this information has been obtained over several decades from tagging data, and within the past 20 years major contributions have been incorporated from genetic studies and satellite tagging. For many populations we have defined their geographic boundaries and have considerable information about the locations of all life stages, but for other populations there remain many knowledge gaps. Early applications genetic studies led to the definition of populations as Management Units to emphasize to managers that these were groupings of turtles that functioned independently within management time frames. This meant that if rookeries in one Management Unit were in decline, it was not expected that turtles from other Management Units would supplement this loss or colonise abandoned beaches. Once defined, then genetic studies of feeding grounds or of turtles caught as bycatch or in harvests, can be used to estimate the proportion of turtles coming from different Management Units. This combined approach provides managers with the information needed to prioritise actions based on threats to nesting beaches and feeding grounds for each population. Additionally, genetic studies allowed an assessment of the historic lineages of turtles within populations and identified major splits within species, such as between Indo-Pacific and Atlantic green turtle populations. These major divisions have been recognized as Evolutionary Significant Units. More recently there has been a move towards a new level of grouping called Regional Management Units that are being proposed as the focus for management planning and prioritization of actions. Typically these new units sit somewhere between Management Units and Evolutionary Significant units. These have been identified for all marine turtle species and shown as large areas on global maps. Where Management Units have been defined, the Regional Management Units often encompass multiple Management Units and are mapped to include their feeding grounds. Although purported to provide valuable guidance for managers, this new approach threatens to undermine some of the advances made in marine turtle management by de-emphasizing the importance of managing at a population level and assessing threats from a population's perspective. This presentation will discuss various proposed Regional Management Units for different species in relation to their corresponding Management Units and consider the value of the contrasting approaches for addressing management issues.

TURTLE CONSERVATION VIA MULTI STAKEHOLDER PARTNERSHIP FOR SUSTAINABLE TURTLE ECOTOURISM IN MALACCA, MALAYSIA

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Malacca is iconic for its historical heritage especially when it was included in the UNESCO World Heritage List in 2008. Malacca is also home to the second largest nesting population of hawksbill turtles (*Eretmochelys imbricata*) in Malaysia with annual average 400-450 nestings. Hawksbill turtle nesting areas in Malacca are threatened primarily by development for urban sprawl, industries and tourism. Along the 3 km beach stretch of Pengkalan Balak-Padang Kemunting, approximately 25 chalets operate. Some chalet operators have started unsustainable tourism practices due to high turtle landings in the area. Turtle excursions, namely turtle watching and hatchling release, are done without proper guidelines, and results in tourists overcrowding, flash photography and uncontrolled torchlight use as well as harassment when in some cases nesting turtles exhibited stressed behavior. Light pollution is also on the increase as more tourism infrastructure is being built in close proximity to nesting beaches. WWF-Malaysia has embarked on a multi-stakeholder partnership to address the issue of unsustainable turtle tourism practices along the Pengkalan Balak-Padang Kemunting nesting beach. The multi-stakeholder approach brings together Ismah Beach Resort as the first resort operator to embark on responsible turtle tourism in Malacca, the Department of Fisheries and WWF-Malaysia. This approach is not novel to the turtle conservation world as it has proven to be one of the effective forms of intervention in many parts of the world. However, within the context of Malacca, this is indeed unconventional as the state government and the tourism industry have yet to consider sustainable turtle tourism models. The multi-stakeholder partnership was launched by the state representative in Ismah Beach Resort in October 2011. This poster presentation will highlight the strategies that were taken to get buy-in from the various stakeholders including the local community and describe a 3-year action plan for a successful and sustainable turtle tourism model that can be replicated at other nesting sites facing similar threats. The action plan includes developing guidelines and protocols for turtle excursions, light mitigation measures to ensure a turtle friendly beach, training of local nature guides and an outreach programme to increase awareness of the local coastal communities in the area and tourists who visit. Lessons learnt from the project thus far will also be discussed. This work is supported by WWF-Netherlands and this presentation was funded by WWF-Malaysia as well as International Sea Turtle Symposium, International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service and U.S. National Marine Fisheries Service.

ENVIRONMENTAL LICENSING: A TOOL FOR SEA TURTLE CONSERVATION AT THE NORTHERN BAHIA STATE COAST, BRAZIL*

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During the seventies, society in general started to pay more attention towards development's negative impacts on Nature. Around the world, each government started to regulate enterprises in order to minimize their social and environmental harmful effects. In Brazil, the legal structure that aims this conciliation is the Environmental Policy, which establishes a series of regulations, and attributions gathered on the National Environmental System (SISNAMA) in 1981, and becoming one of its tools for the environmental licensing process. One of these regulations determines that potential impacting enterprises near sea turtle nesting areas, need to be evaluated by Centro Tamar, which is a government branch specialized in sea turtle conservation and protection, and connected to the Ministry of Environment. Through this evaluation it is possible to work together with the licensing agencies analyzing the proposed development projects and planning mitigation measures, such as locational alternatives and technological solutions, to adjust and alter the projects. In 1980 Tamar began its sea turtle monitoring and conservation activities. Today, after 30 years of research, conservation, interaction with coastal communities, and with the gathered expertise, there is a better comprehension of these animals' life cycles. The Northern Coast of Bahia State has worldwide known nesting sites for *Caretta caretta*, *Eretmochelys imbricata*, and *Lepidochelys olivacea*. It is also a beautiful stretch of the country's coastline. Until the year 2000 the region was sparsely occupied with very few small localities and a low population density. After that, large real state and touristic complexes arrived and land occupation grew faster. This has been a major State plan to improve local economy and has been heavily implemented. Since this coast is an important sea turtle rockery, all projects began to be analyzed to avoid damages to the nesting beaches. The outputs of all the knowledge accumulated reviewing projects and dealing with different situations are a group of tools and strategies to mitigate and avoid negative impacts on sea turtles. Sensitivity maps, lighting manuals, beach use guide were created as a way to publicize and give guidance to entrepreneurs as well as agencies personnel during the steps of creating a project and obtaining the environmental permits. In extremely important or high sensibility zones, creation of Protected Areas is being recommended. It is essential to maintain monitoring and presence to ensure correct attendance to guidelines and procedures, as well as to solve unpredicted situations. These activities have contributed on the capacitation of sea turtle specialists to act in hands on environmental management. Open communication with stakeholders has allowed the establishment of directives, packages of measures and control actions that, if properly followed, we believe will ensure sea turtle conservation in the region.

LOGGERHEAD REINTRODUCTION PROGRAM IN CANARY ISLANDS*

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In the eastern basin of the Atlantic Ocean there is only one loggerhead (*Caretta Caretta*) nesting colony, the Cape Verde loggerhead population. There are evidences of sporadic nesting activities in the African coast, but there are no accurate data. Increase the number of loggerhead colonies in this side of the Atlantic could give an important step in global loggerhead conservations efforts. The loggerhead nesting population of Cape Verde is one of the most important colony in the world, and the second most important in the Atlantic, after the Florida colonies. A very hard Conservation and Protection effort is being carried out since 1998, by the NGO CV Natura 2000 and NGO ADS, through the Cape Verde and Canary Governments, the European Union projects, and MTCF – NOAA - (in the last 3 years) supports, among others. Cape Verde and Canary Islands are oceanic archipelagos in the Macaronesia region, with very similar conditions: volcanic origins, flora and fauna characteristics, climate and oceanographic conditions, etc. Cape Verde has the only loggerhead nesting colony in the area, and Canary Island has evidences of marine turtle nesting activities in their oriental islands in the past. The similarities between both archipelagos, the evidence of marine turtle nesting activity in the Canary Islands, and the dangerous conservation status of the marine turtles around the world, had resulted in the development of a huge Experimental and Conservation Program to re-establish the loggerhead nesting colony in the oriental islands of Canary Islands.This program has three key points: 1) Conservation and protection efforts in the origin population, the Capeverdian loggerhead nesting colony; 2) Research in long-distance turtle eggs translocation and important incubation experiments; and 3) Head-starting programs to increase the survivor possibilities and decrease the number of eggs removed from the origin population (Cape Verde). In 2006, a viability study started with 160 eggs (3 nests) collected at Boa Vista Island, Cape Verde, to experiment the incubation conditions of the Canarian beaches (Cofete beach, Fuerteventura), by exposure of the eggs to Canarian sand. Also laboratory experiments (200 eggs) were carry on. The 85.4% of the eggs disposed in the canarian beaches hatched successfully and the hatchlings shown a very good health. From 2007 to 2010, from 800 to 1000 eggs per year (8-14 nests, less than 0,2% of nests disposed in the area) were removed from low success beaches of Cape Verde population to the Canary Island beaches (200 eggs/year to laboratory experiments, and 500-800 eggs/year to beach incubation). Canarian beaches showed a high hatching success (from 65.3% in 2009 to 86.6% in 2010). Head-starting programs were carried on with all neonates hatched in Canary Islands, and there has been a very important tool to study the little known behavior of first years of these animals. We thank all the members of NGO CV Natura 2000 and the volunteers, monitors and people involved in the Conservation programs of sea turtles in Cape Verde and Canary Islands, and also the principal supporters: Cabo Verde Government, Canary Islands Government, Cabildo de Fuerteventura, University of Las Palmas de Gran Canaria and the European Union (PELAGOS project).

COMMUNITY DRIVEN AWARENESS AND ADVOCACY INITIATIVES IN RESTORING SEA TURTLE POPULATIONS AND MANAGEMENT OF THE MARINE ENVIRONMENT: EXPERIENCES FROM KENYA*

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Developing successful sea turtle conservation initiatives has to involve communities as a way to invoke their consciousness as well as increase their capacity to manage and conserve their natural resources. Community based initiatives also give projects local ownership and acceptance and largely contributes to their sustainability. The Kenya Sea Turtle Conservation and Management Trust has over the years employed a community-based approach in its conservation interventions. Local Turtle Conservation Groups (TCGs) formed all along the coast are the bedrock of these initiatives, carrying out activities such as habitat rehabilitation, sea turtle data collection, in situ nest protection, tagging and release as well as community education and awareness. The groups also collect data on the Kilograms of litter collected from the beaches during clean-ups and numbers of mangroves planted. A project was initiated to develop and implement a comprehensive and targeted public education, awareness and advocacy program to enhance community contribution and participation in the conservation of sea turtles. Education and awareness carried out though this project reached many indigenous populations and greatly built the capacity of community groups involved in marine conservation activities. Based on the importance of adopting community-based conservation approaches, the Turtle Conservation Groups were studied to find out what makes some successful than others in performing common conservation activities. From the project, it was learnt that coastal communities that depend entirely on marine resources for their livelihoods are often a strong force in depletion of sea turtle populations. Apart from the indigenous knowledge on sea turtles by local coastal communities limited information is known and available to the general public leading to little effort to conserve these species. Appreciation of the value and the need to conserve sea turtles resulted from adequate and consistent public awareness and education programs which aimed to change people's attitude towards conservation. It was also clear it is important to initiate and support income generating projects that are pegged on conservation. Such enterprises include those hinged on ecotourism, such as tour guided boat rides, mangrove board walks, bee keeping, crab culture and camping in mangrove ecosystems. Alternative livelihood options address poverty issues and motivate local communities to sustainably conserve the environment. Long terms organizational capacity, self-governance skills and sustainable natural resource management skills were found to be the core strategies for the conservation project sustainability. The Turtle Conservation Groups who were the main implementers of the project within the communities benefited through training on awareness and advocacy skills, leading many to adopt turtle awareness programs which will ensure continuity of awareness campaigns. The trainings on turtle monitoring, patrols and recording, has helped to ensure that the already existing monitoring programs were therefore strengthened and improved.

SEA TURTLES IN CUBA: THIRTY YEARS OF RESEARCH AND CONSERVATION

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Of the seven species that inhabit the world, five are found in the Cuban shelf. Some nest and feed regularly, for example, the green turtle (*C. mydas*), loggerhead (*C. caretta*) and hawksbill (*E. imbricata*), which are the three most frequent and abundant species, while others, such as the leatherback (D .*coriacea*) and olive ridley (*L. olivacea*) are found only rarely. However, little was known about any of these species in Cuba 30 years ago. In 1981, the Fisheries Research Center, the then Ministry of Fishing Industry, began research on sea turtles. Since that date there has been a steady accumulation of data that has increased the knowledge of the biology of these species, which was first used in resource management, to implement closed seasons, minimum legal sizes and catch quotas, until the fishery closed in 2008. The information that has been collected, including statistics, sampling, field observations, tagging etc. has also enabled the systematic publication of various reports and scientific papers that show the progress achieved. This paper presents the main achievements of this project over the last 30 years.

ANALYSIS OF THE IMPACT OF ARTISANAL FISHERIES ON SEA TURTLES AT THE PENINSULA OF SAN CARLOS, GULF OF VENEZUELA

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The peninsula of San Carlos is located on the south of the Gulf of Venezuela (GV) and its main economic activity is tourism and artisanal fishing. There is detailed information on the impacts of industrial fisheries, due to efforts to regulate and understand these activities; however there is little known about artisanal fishing, as a result of the lack of governmental control and there are still major questions about their impact on sea turtle populations. In this manner, the present investigation aims to describe the impact of artisanal fisheries on sea turtles in the Peninsula of San Carlos (10°59'21.64"N and 71°36'45.82"W), in the southern coast of the Gulf of Venezuela. We conducted semi-structured interviews with 20 fishermen from 8 different fishing ports. Based on the testimony of the fishermen, the principal fishing gear is artisanal trawling, and a small percentage of the fishermen (15%) works also with longlines. The 50% of fishermen report incidental captures of subadult individuals of green turtle (*Chelonia mydas*), followed by 45% of loggerhead turtle (*Caretta caretta*), 40% of hawksbill (*Eretmochelys imbricata*) and 30% reported sightings of leatherback turtles (*Dermochelys coriacea*) in the north of the GV. Additionally, 95% of fishermen said that turtles that survive are released. The reports of encounters with sea turtles are higher in San Carlos when comparing with studies developed in nearby

communities, such as Zapara Island and Toas Island, which can be related to the fishing gear; using trawling nets in San Carlos and gillnets in Zapara Island and Toas Island. In addition, the fishing area for fishermen who inhabit the peninsula of San Carlos is greater than the area commonly used by fishermen from nearby, covering more remote and less exploited areas, and thus increasing the radius of impact on populations of sea turtles that feed in the area. On another hand, previous research in this zone has showed that the incidence of bycatch increases in longlines, due to the relation between the diet of different species of sea turtles and the bait used, as it is the case of the loggerhead. The work and direct involvement with the fishing communities are vital in reducing the impact of fisheries on threatened species. This paper confirms the importance of the Gulf of Venezuela as feeding grounds in the life cycle of these turtles, which leads to the necessity of implementing viable conservation plans to ensure the well-being of both sea turtles and fishermen. Keywords: artisanal fishery, sea turtles, coastal community, Gulf of Venezuela, conservation.

SITUATIONAL ANALYSIS OF SEA TURTLE CONSERVATION EFFORTS IN GUATEMALA*

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The Guatemalan National Sea Turtle Strategy (ENTM in Spanish) was elaborated by the government's National Council of Protected Areas (CONAP) in 2002 in order to standardize and strengthen sea turtle conservation activities in the country. The ENTM was organized around five themes: 1) Promoting research and monitoring of sea turtle populations on both coasts of Guatemala, 2) Promoting the correct application of national and international laws for the protection and management of sea turtles, 3) Developing formal and non formal education and outreach programs, 4) Building capacity within Guatemala for the conservation and management of sea turtles, and 5) Management and coordination of sea turtle conservation activities. Much has changed since 2002. The Interamerican Sea Turtle Convention (IAC) has come into force, and Guatemala became a signatory in 2003. The Central American Free Trade Agreement (CAFTA-DR) has also come into force, and its Environmental Cooperation Agreement encourages member countries to insure that its national and international legislation is being enforced. The touristic frontier has advanced, and hotels and travel agencies are increasingly sponsoring sea turtle conservation activities. Mining, oil exploration, industrial fisheries and infrastructure projects are increasingly threatening sea turtle populations and nesting habitat. Since 2002, neighboring El Salvador has been discovered to be the most important nesting site for the highly endangered East Pacific hawksbill sea turtle. With the support of the MAREA project (MAREA/USAID) and the Eastern Pacific Hawksbill Initiative (ICAPO), CONAP, the Wildlife Rescue and Conservation Association (ARCAS), Akazul and other conservation organizations in Guatemala undertook this analysis to evaluate the present state of sea turtle conservation efforts in the country. The objectives of this evaluation were: 1) To analyze the effectiveness of sea turtle conservation actions in Guatemala within the framework of the ENTM and with particular attention paid to the donation and sale of eggs, and 2) To evaluate the

effectiveness of the current management and conservation system in Guatemala, especially in terms of socio-economic and ecological sustainability in the short and long terms. The Situational Analysis was based on an interview survey with important stakeholders in communities on the Pacific and Caribbean coasts, including hatchery managers, egg collectors, egg buyers, fishermen, educators, CONAP employees and enforcement officers, and included visits to markets and border crossings. ICAPO (www.hawksbill.org) supported survey activities specifically aimed at determining the presence of nesting or foraging hawksbills on the Pacific coast. The results of this analysis were compiled into a report in February, 2011 and submitted to CONAP so that they may serve as an important input to updating the ENTM and justifying the egg collection exception under the IAC in order to help Guatemalan sea turtle conservationists meet the challenges of the future.

THE SEA TURTLE EGG DONATION SYSTEM IN GUATEMALA

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Sea turtle conservation in Guatemala is an uncoordinated, decentralized and underfunded activity with a variety of actors operating independently. The government lacks the resources to centralize conservation efforts though this has had the beneficial effect of inviting the involvement of NGOs, businesses, schools and community groups. The conservation strategy used is almost exclusively that of hatcheries which are maintained on a shoe-string budget, manned by undertrained staff and relying on voluntary donations by local egg collectors. Guatemala is one of the only countries in Latin America that still allows sea turtle egg collection on a national basis. Although there is a ban on leatherback and hawksbill egg collection, under an informal arrangement established in the 1980's, local egg collectors are allowed to collect olive ridley eggs as long as they donate 20% of each nest to a local hatchery. This donation system is entirely voluntary as the government lacks the resources to properly enforce it. In recent year, the sea turtle conservation environment in Central America has changed and has spotlighted Guatemala's donation system. In 2003, Guatemalan became a signatory of the Interamerican Sea Turtle Convention (IAC) which stipulates that an "exception" - such as the harvesting of eggs - must be justified. Tourism has also expanded, and many hotels and travel agencies support turtle conservation activities, and visiting tourists and overseas donors purchase eggs under "sponsor-a-nest" programs. Neighboring El Salvador was discovered to be the most important nesting site for the highly endangered East Pacific hawksbill sea turtle, and partially as a result of this, an all-out ban has been put into place there. However, this ban depends on donor funding to offset economic losses by egg collectors, and its long-term financial sustainability is uncertain. With the support of the MAREA project (MAREA/USAID) and the East Pacific Hawksbill Initiative (ICAPO), ARCAS, CONAP, Akazul and other conservation organizations recently undertook a Situational Analysis to evaluate the present state of sea turtle conservation efforts in Guatemala. The objectives of this analysis were: 1) To analyze the effectiveness of sea turtle conservation actions in Guatemala within the framework of the National Sea Turtle Strategy with particular attention paid to the egg donation system, and 2) To evaluate the effectiveness of the current management and conservation system in

Guatemala, especially in terms of socio-economic and ecological sustainability in the short and long terms. The Analysis was based on an interview survey conducted at over 30 communities on the Caribbean and Pacific coasts, markets and border crossings, including interviews with important stakeholders such as hatchery managers, egg collectors, egg buyers, fishermen, educators and enforcement officers. Using the results of the Situational Analysis as well as historical crawl count and hatchery data, this paper analyses the egg donation system in terms of its conservation effectiveness as well as its long-term socio-economic sustainability. Its findings will be used to reformulate the National Strategy and elaborate a management plan for egg collection under the IAC.

MORE THAN A DECADE OF EFFORTS IN THE CONSERVATION OF SEA TURTLES IN THE DEPARTMENTS OF MAGDALENA AND LA GUAJIRA, COLOMBIA'S NORTHERN CARIBBEAN

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Since its inception in 1995, the Sea Turtle Foundation of Santa Marta (FTMSM) has developed work aimed at the conservation of sea turtles in the northern Colombian Caribbean, from various management approaches to conservation which are: support for research communication and public disclosure, strengthening grassroots organizations and local communities, training and environmental education and resource management. As a result, partnerships have been established and secured the cooperation of private enterprise, environmental authorities, national NGOs, fishermen, community leaders, farmers, and community associations related directly or indirectly with sea turtles. Between 1995 and 2010 on 108.5 miles of nesting beaches for *Caretta caretta*, *Eretmochelys imbricata*, *Dermochelys coriacea* and *Chelonia mydas,* 32,000 eggs were collected and more than 25,000 hatchlings were released with an average total emergence of more than 73%. Fishermen and public officials also have been trained in sea turtle management techniques and conservation of sea turtles and recorded more than 20 nesting females. Participation by children, youth and adults raised awareness and educated them. Ten research projects were conducted with students from different universities. This work collects results from more than 10 years of conservation activities.

LOCAL FINANCING FOR SEA TURTLE PROTECTION: PAYMENT FOR ENVIRONMENTAL SERVICES*

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Funding sea turtle protection activities in the Mexican Caribbean is an ongoing challenge. In Akumal, “the place of the turtle” in Maya; the nesting, hatching and foraging sea turtles provide tourism, recreation and education services to the local economy, making sea turtle observation an integral part of visiting Akumal. Centro Ecológico Akumal (CEA) has

developed a program to engage the local tourism industry in protection measures where hotels provide a monthly donation to the organization's protection program and the authorized snorkel tours offer a per person donation. While Akumal is not a protected area, the mixed public / private policy tools available allow CEA to establish this innovative Payment for Environment Services (PES) mechanism. The marine waters are federal territory and sea turtles are protected under federal endangered species laws, whereas the private properties along the bays in Akumal, including CEA, have rights and responsibilities in beach management. Although the federal government may be the original "seller" of the environmental goods, the local hotels, tour operators and visitors "capitalize" on the turtle and coral species. The program CEA developed is based on requirements in the federal beach concessions, endangered species protection laws, marine recreation tourism regulations and private property laws. The Akumal PES is voluntary; an agreement among the many buyers (snorkel tour operators, dive shops, hotels) and Centro Ecológico Akumal, through a management program and signed agreements. The management program regulates snorkeling tour activities in Akumal Bay and serves as the basis for defining the payment for biodiversity-conserving management practices. Another goal is that it serves to promote biodiversity-conserving businesses by sharing data on implementation of the agreements and the annual sea turtle nesting data with all stakeholders. Ecosystem services have been defined, measured and assessed, (this information can be updated and more complete). Buyers have been identified (have been benefiting from the service already). A marketable payment value has been determined, as well as an overall value for the juvenile and sub-adult green and hawksbill turtles in Akumal bay as well as the nesting and hatching loggerhead and greens. The current legal policy framework regarding boating, aquatic tourism activities, land ownership, federal zone management, among others, were used as the basis of the rules for the Akumal Bays Management Program, with the long-term objective to create a Sea Turtle Refuge. The Akumal Bays Management Program now has yearly operation plans and budgets, and allows for local businesses to be profitable and work within the legal framework (many activities carried out before this program was established were illegal operations; boats were not registered, captains did not have training or licenses, trading was carried out on federal zone space, overfishing, and many other questionable activities. To date, this program has largely funded marine protection measures, but is now being expanded to directly fund protection activities carried out by our 16 year old sea turtle program as well. We will present this process, its achievements and challenges and potential for funding 100% our annual Sea Turtle Protection activities.

IS THE "NO FISHING ZONE" OF COCOS ISLAND NATIONAL PARK BIG ENOUGH FOR RESIDENT BLACK TURTLES?*

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Satellite tags provided information on movements of 12 black turtles captured around Cocos Island, a Costa Rican National Park in the eastern Pacific, located approximately 500 km southwest of the Costa Rican mainland. Cocos Island is also designated as a United Nations International Biosphere Reserve, and its marine waters are currently protected by a 12 nautical mile no-fishing marine protected area. Most individuals captured and tracked were sub-adults, indicating Cocos Island marine waters are used as developmental habitat. Turtle movements will be analyzed to determine whether the current 12 nautical mile no-fishing

marine protected area is large enough to protect turtles from capture by longline and purse seine vessels that heavily fish along the perimeter of the marine reserve.

IS THE LOGGERHEAD SEA TURTLE DECLINING IN THE WESTERN MEDITERRANEAN?*

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Sea turtles are cosmopolitan marine species that have recently experienced an important reduction in their populations due mainly to human-related activities. The loggerhead turtle (*Caretta caretta*) is the most abundant sea turtle species in the western Mediterranean. The local stocks are composed mostly of juveniles coming from East Mediterranean and Atlantic nesting populations. The loggerhead turtle stocks in the western Mediterranean have been impacted sharply by human activities, particularly fisheries, over the last decades. The main goal of the present study was to investigate long-term changes of the loggerhead turtle stocks in waters off the Valencia Community and surrounding areas (East Spain waters). We analysed spatiotemporal changes in local stocks of this endangered species by comparing results from previous studies, and long-term datasets with data gathered from stranding records and necropsy of animals, surveys at sea and interviews with fishermen. Based on current evidence and data recorded in the recent years, we hypothesize that local stocks are declining and, therefore, conservation measures are urgently needed. Previous estimates at sea undertaken by the University of Valencia in 2000-2003 indicated a population of over 18,900 loggerheads in waters of Valencia and Murcia regions (some 32,000 km^2). Moreover, from 1994 to 2006 we recorded a mean number of 48 strandings per year in the Valencia Community coasts (518 km of coastline), most of them of juvenile size (mean CCL ± SD= 53.6 ± 12.6 cm). However, in recent years (2007-2010), a significant decrease has been detected, both in the annual number of strandings (particularly in 2009 and 2010, with only 24 and 18 strandings respectively) and in the average size of stranded turtles (mean CCL ± SD= 43.8 ± 12.4 cm, $p < 0.001$). Both parameters may be indicators of a potential decline of local stocks of this species in the western basin of the Mediterranean. Ongoing aerial surveys at sea and interviews with fishermen at ports of the Valencia Community (East Spain) seem to confirm the reduction of local stocks. Here we assess the effect of several threats over local turtle stocks on an appropriate temporal scale to provide empirical information in order to design and implement conservation measures. We pay special attention to the effect of pollution and fisheries. Research in loggerhead turtle conservation status in the Western Mediterranean becomes essential due to the double origin and stratification of the local stocks. Conservation measures are predicted to affect directly the conservation status of different nesting populations in different localities of this charismatic and ecologically important species. This study is supported by the EU project RESET-ECO FP7-PEOPLE-2009-RG, Prometeo2011/040 of Generalitat Valenciana, project CGL2011-30413 of the Spanish Ministry of Sciences and Innovation, and project UV-INV-AE11-42960 of the University of Valencia.

EVALUATING THE EFFECTS OF COASTAL SQUEEZE ON TURTLE NESTING SITES IN THE MIDST OF SEA LEVEL RISE: A CASE STUDY OF ARCHIE CARR NATIONAL WILDLIFE REFUGE

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A major threat to sea turtles is climate change, which poses several future concerns for sea turtle populations globally. Climate change has introduced warming trends that have affected ecosystems throughout the world. Eighty percent of the increase in atmospheric temperature is expected to be absorbed by the oceans and thus cause thermal expansion. Already, ocean temperatures are 0.7 degrees Celsius warmer than they have been in the last 400,000 years. The Archie Carr National Wildlife Refuge (NWR) is of exceptional importance due to the high density of sea turtles that nest there in the summer months. Of the five marine turtle species that frequent Florida waters; loggerheads, leatherbacks, and green turtles nest on the Refuge. Archie Carr NWR consists of four separate segments that together make up 20.5 miles (approximately 33 kilometers) of beach. A combination of local socioeconomic, physical, and biological conditions will determine the true extent and impact of sea level rise on Archie Carr National Wildlife Refuge. The possibility exists that sea level rise will lead to reduced availability of nesting habitat. Furthermore, the ability of the Refuge to determine where nesting densities could shift due to coastal squeeze will greatly determine the future success of the nesting populations on Archie Carr National Wildlife Refuge. As human populations struggle to protect oceanfront property from erosion, sea turtles are losing their nesting beaches. Protection of the coastline involves hard-armoring (seawalls, gyrones, etc) techniques that effectively reduce the amount of beach available. These hard armoring techniques are already in use in the U.S. and the Caribbean and have led to “coastal squeeze” which is the result of the beach not being able to progress further inland, leaving a smaller amount of space available for turtles to nest in the future. This could cause major issues in areas that have high nesting densities. In these areas coastal squeeze could bring about a high incidence of overlapping nests, which would greatly decrease nesting success. As sea level rises, females run higher risks of exposure to human development impacts and nests to salt water inundation. Using GIS data provided by the Archie Carr National Wildlife Refuge as a tool for the calculation of the effects of sea level rise scenarios (0.2, 0.5, and 0.9 meters), I will determine what areas of the refuge will be most affected and how this will relate to future nesting density shifts. Data will also be used to determine if land parcels that are labeled as highest priority for acquisition are situated in areas that could help with possible future nesting density shifts. High-risk areas will be identified and compared to existing areas targeted for future acquisition. By considering future sea level rise, planned development, available parcels, and nesting densities an optimized parcel acquisition map can be prepared that will assist the Archie Carr National Wildlife Refuge with future management plans.

SEA TURTLE CONSERVATION AND ECONOMIC ALTERNATIVES IN CENTRAL AMERICA*

Juan Carlos Villagrán

USAID Program for Management of Aquatic Resources and Economic Alternatives

The USAID financed Regional Program for the Management of Aquatic Resources and Economic Alternatives (MAREA), is aimed at reducing threats posed by unsustainable fishing practices and coastal development by laying the foundation on right based mechanisms approach to achieve strengthened coastal-marine resources management, focusing on endangered marine species associated with fishing and conservation practices in Central America. The program target fisheries and species of significant conservation and economic importance. These species are Caribbean and Pacific spiny lobsters, groupers, queen conch, mangrove cockles, sea turtles and sharks. MAREA has begun drafting and implementing management plans for sea turtles at Regional and local level. These plans not only include technical aspects on the management of the species and its populations, but also include critical social and economic issues such as, livelihood, and conflict resolutions. They also consider institutional strengthening and administrative and financial mechanisms to secure management plan or program effectiveness and continuity on the long term through public–private alliances and networks. In 2011, through subcontractor Sea Turtle Conservancy (STC), initiated protection and monitoring of leatherback and hawksbill nests at Chiriquí, Roja, Escudo de Veraguas and Bluff beaches in Panama. A strengthened a work alliance with the Ngobe Bugle indigenous territory, resulted in greater participation and local ownership of beach management and protection efforts. Also in 2011, MAREA contracted WIDECAST to complete the bi-national protection effort that included the beaches of Moín, Matina and Cahuita in Costa Rica, as well as the San San Pon Sac beach in Panama. WIDECAST has implemented protection of nests and hatchlings, application of climate change adaptation measures at nesting beaches and begun promoting economic alternatives (sustainable tourism and craft work) related to sea turtles. More recently in June 2011 through ICAPO (Eastern Pacific Hawksbill Initiative), USAID/MAREA began hawksbill monitoring and conservation activities in the Gulf of Fonseca. Similarly, this effort combines nesting beach protection in the Bay of Jiquilisco in El Salvador and Estero Padre Ramos in Nicaragua, the development of economic alternatives through a program of scientific volunteers and the provision of tourism services by the communities. Initial results of program efforts up to September 2011 indicates that approximately 7,400 nests of endangered sea turtles were protected, corresponding to the following species: leatherback (6,040 nests); hawksbill (1,851 nests) and green (10 nests). Next steps will focus on the two most endangered species in the program's work sites: leatherbacks and hawksbills in the Cahuita-Bocas del Toro site and Pacific hawksbills in the Gulf of Fonseca – with the goal of protecting aproximately 700,000 hatchlings in 2012. Comprehensive conservation approaches to be used include in-situ and ex-situ egg and nest protection, forage and nesting site monitoring and recovery plans. A strategy and route of implementation will be worked out to create and consolidate public-private partnerships in order to provide sustainability for conservation activities and productive economic alternatives link with sea turtle conservation, such as scientific volunteering and the production of crafts made of alternative materials.

AN ASSESSMENT OF THE STATE OF THE WORLD'S SEA TURTLES PROGRAM

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The State of the World's Sea Turtles (SWOT) Program is a collaboration of hundreds of individuals and institutions around the world including Conservation International (CI), Duke University's OBIS-SEAMAP, and the Marine Turtle Specialist Group (MTSG) of the International Union for Conservation of Nature (IUCN). The SWOT Program was created in 2004 with the goal of creating a dynamic, global-scale, geo-referenced database of all sea turtle species, a network of people who generate and use the data to guide conservation efforts, and targeted communications and outreach strategy, centered around an annual report, to diffuse information on sea turtle conservation and science to people who can make a difference for conserving turtles and pursuing improved ocean health. Over the past seven years, SWOT has grown to include more than 550 data providers and has published and distributed six SWOT Reports with award-winning maps on global sea turtle nesting distribution for the seven sea turtle species. This study evaluates the effectiveness of the SWOT Program and its tools in order to determine whether SWOT has been successful in advancing sea turtle research and conservation. Specifically, the study determines how SWOT members are using SWOT products and how they can be improved to better contribute to sea turtle research and conservation. A web-based survey was created using Qualtrics survey software. Surveys were distributed through the SWOT Team, CTurtle, and IUCN-MTSG listservs. The survey questions gauged participants' knowledge, behaviors, and attitudes towards the SWOT Program. Over 170 surveys were completed and thirty-three countries were represented in the survey. Survey results are reported here. We conclude by providing a series of recommendations for improved or new tools that can help the SWOT Program better serve its constituents and sea turtle conservation efforts in the future. In this way our study assists the CI Marine Flagship Species Program (MFSP) in identifying opportunities for improvement, and guiding future directions of the program.

COMMUNITY BASED CONSERVATION & SEA TURTLES: TOOLS APPLIED IN COMMUNITIES FROM THE GULF OF VENEZUELA*

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Community Based Conservation (CBC) provides high impact conservation models, particularly when working with threatened species such as sea turtles, which are key species

for marine ecosystems, as well as a resource for the subsistence of several coastal communities. The core hypothesis of the CBC proposes base models to be developed and adapted according to socio-economic and cultural realities of each community. In this sense, for the last 14 years the NGO "Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela" (GTTM-GV) has focused its efforts in the sensibilization of coastal-indigenous communities located in the Gulf of Venezuela (GV) (southern Caribbean), by applying different conservation strategies and measures. In this research we analyzed the main tools applied in the conservation efforts of sea turtles in the GV. Reaches, effectiveness, and success in 9 of these coastal communities were identified. Then, we carried out a historic-systematic study, focusing in the recognition of the applied conservation tools that presented the following characteristics: applicability, replication and measurable indicators. As a result, we identified 6 major tools: Information, Capacitation, Co-responsibility, Inclusion, Monitoring and Incentives. The first three of them stand out because of their interdependence, and are fundamental in order to achieve a successful conservation process; from these, the Information (through talks and informative media) presents the lowest impact (25% success), mainly because of barriers such as native's language and deficiencies in reading and writing skills. However, this tool is essential in order to advance in the application of others more effective, like the Capacitation through direct coaching of fishermen, related with sea turtles (e.g. rescue, rehabilitation, release, fishing methods), and the Co-responsibility. The latter, has demonstrated to have the major impacts and success; by granting direct responsibilities (e.g. leading rescues, taking photos, tagging, collecting biological data) we have detected a real attitude change, resulting in the increase in 67,87% of sea turtle releases in the past two years. Likewise, the Inclusion of fishermen in scientific researches (2 as main author, and 18 as coauthors) has encouraged their commitment with the sea turtle conservation. On another hand, within the context of indigenous communities (Wayúu culture) in the GV, the socio-economic and cultural reality difficults the acceptance of conservation strategies, due that the subsistence of families frequently struggles against the life of the animal. In order to diminish this problem, we offer them non-monetary Incentives (basic needs items: food, cleansing, communication) for the rescue of sea turtles, strengthening this relationship by asking them to name, tag and release the turtle. As to Monitoring (2-12 weeks/year of presence in the zone), it is the most difficulty tool to implement, mainly due to frontier security problems (e.g. kidnap, illegal drugtrade); however, we consider that the achievements, measured by the effectiveness of the other tools, have demonstrated the success of the CBC program developed in the GV. Their constant evaluation and adaptation to the socio-economic and cultural changes will define successful medium- and long-term results. Keywords: Tools, Community Based Conservation, Sea turtles, Coastal-indigenous communities, Gulf of Venezuela.

FOUR FAR-FETCHED YEARS: ADVANCES AND FUTURE DIRECTIONS OF THE EASTERN PACIFIC HAWKSBILL INITIATIVE*

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The natural history of the hawksbill turtles in the eastern Pacific remains an unsolved mystery. The challenges of identifying and arming initial clues first began as recently as 2007. The current movement to understand and conserve the population known as the Eastern Pacific Hawksbill Initiative has advanced at a blistering pace, a fact that would not

be the case if it weren't for a number of surprising and timely scenarios. After more than 30 years of sea turtle research, which had led to an almost entire void of information on hawksbills in the region, key discoveries occurred simultaneously and independently in Mexico, El Salvador and Ecuador. Effective promulgation of these initial findings was fundamental to garnering early support from researchers throughout the region, which further catalyzed efforts to understand and conserve the species. In the movements first four years various conservation projects have been established, an entirely new life-history paradigm has been identified, an important body of literature has been established and the perilous situation facing the population has been acknowledged by the broader sea turtle conservation community. Despite these advances, substantial work is needed to more effectively understand, assess and manage the population. While investigations are currently underway, continued and increased efforts to identify high-priority hawksbill conservation areas are urgently needed. Areas of particular interest include the Darien Gap region shared by southern Panama and northern Colombia, as well as the central Pacific coast of Mexico, among others. While some of these areas might be considered well explored by sea turtle researchers, if the findings to date have taught us anything, it is that the through cryptic habitat use and low densities, the species is able to remain undetected literally "under our noses". While currently considered one of the most endangered sea turtle populations on the planet, there is now a renewed hope for recovery. This can only be achieved through the continued use of effective collaborations and ongoing sharing of information and ideas.

Ecology and Evolutionary Biology

ASCENSION ISLAND HAWKSBILLS- WHERE DO THEY HAIL FROM?*

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The existence of neritic juvenile hawksbills in Ascension Island (AI) habitats has remained enigmatic since they do not nest there and the nearest nesting sites are in Brazil (2,300 km to the West) and coastal islands off West Africa (2,500 km to the East). In order to identify

potential origins and possible avenues for contributions from breeding populations from both sides of the Atlantic basin and from the Indian Ocean, we used two approaches: molecular analyses and particle drift modeling. Tissue samples from 18 hawksbill juveniles (35-64 cm CCL) opportunistically caught by sport divers were processed with standard molecular techniques. The 740bp mtDNA control region haplotypes exhibited sequences characteristic of both Western (14 EiA01, 1 EiA62; 83% of total) and Eastern Atlantic (2 EiA70/EiA48, 1 EiA49; 17%) hawksbill lineages that are highly divergent as reflected in high the π values obtained (0.237). Preliminary mixed stock analyses comparing these results with available haplotype profiles of Wider Caribbean, Brazilian, and Principe rookeries and considering relative population abundances suggested Barbados (59%) and Brazil (11%) as primary sources, with insignificant contribution from Principe (1%). To test these findings and generate alternative hypotheses of transport routes to AI foraging grounds, we modeled the dispersal of pelagic juvenile hawksbills through the Atlantic and Indian Ocean basins using the surface current output from the Global Hybrid Coordinate Ocean Model (HYCOM). The program ICHTHYOP (v.2) was used to release thousands of "virtual turtles" around Ascension Island and then track their backwards trajectory using a numerical scheme to determine the turtles' previous location based on surface current velocity the day preceding. In this way, the source location of turtles around AI could be inferred along with the daily registers of age and temperature at each position en route. In contradiction to the initial genetic estimates no turtles followed routes to Ascension from the Caribbean Sea. Instead, the simulations suggest that turtles would predominantly arrive at AI from the west coast of Sub-Saharan Africa, by way of the Benguela Current. This current is fed by the South Atlantic Current, from the western South Atlantic basin, and the Agulhas Current, from the Indian Ocean. These findings suggest that the sole source of Western Atlantic haplotypes is likely to be Brazil. This is consistent with the fact that haplotype EiA62 has only been reported in Brazil. Moreover, the strong contribution of turtles from coastal regions of Sub-Saharan Africa implicates the Principe rookery as major source of hawksbills in AI waters. The presence of hawksbill turtles originating in extremely distant regions indicates that the site might represent a geographic and genetic trans-oceanic meeting point for this endangered species, linking hawksbill turtle populations of South America, West Africa and, perhaps, western Indian Ocean.

STATUS OF THE HAWKSBILL TURTLE *ERETMOCHELYS IMBRICATA* IN THE WEST COAST OF THE GULF OF VENEZUELA: 14 YEARS OF RESEARCH*

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The Hawksbill Turtle (*Eretmochelys imbricata*) is the second species of sea turtles with larger number of individuals in the Gulf of Venezuela (GV); its distribution in this well known foraging ground is determined by the availability and location of small patches of coral reefs and marine sponges' communities, their main dietary components. As we know, hawksbill

turtle populations are highly threatened, where the illegal trade of their products and sub-products represents their main threat to survival. In the GV, this species population does not escape from this reality; illegal trade and consumption of sea turtles in general is still a frequent activity without any regulations. Since 1997 a large number of records of sea turtles have been collected along the western coast of GV, in order to analyze the status and threats that these species face in the region. We compared 14 years of records and research in order to assess the actual status of hawksbill turtle's populations in the GV. From 2007 to 2011, we collected a total of 27 measures of hawksbill turtles captured or stranded in different localities of GV. For this period, we obtain an average in sizes of 38.53 ± 17.16 cm curved carapace length (CCL) and a mode of 51 cm, this indicates that most of individuals are representatives of juvenile stages (55.56%), followed by sub-adults with 25.93%, hatchlings with 11.11 %, and finally 7.41% for adults stages. From 1997 to 2006, class sizes of hawksbill turtles in the GV showed a tendency in the proportion of sub-adults and adults individuals, with sizes larger than 60 cm CCL, representing a 67.25% (n=38). The capture of hawksbill individuals has been reported in several localities of GV, reporting a high percentage for the upper (25.93%) and medium (70.37%) regions in the Venezuelan Guajira; these coastal - marine zones have been identified as key areas for the conservation of sea turtles, which supports in 92% (35.604 ha) of its extension the main ecosystems (seagrass beds and coral reefs) for foraging and development for this species. Local tags recapture of hawksbill turtles' individuals is very low (n=3), compared to the green turtle (n=11), however, these values and the high incidence of juveniles stages, suggest that the GV represents a recruitment area and migration route for hawksbill turtles and other sea turtles. Although the human pressures throughout these coastlines are a common activity, the inclusion of fishermen and indigenous communities have has a notable increase through the years, allowing these associations (scientific-natives) represent a positive outcome for the recovery and conservation efforts for this critically endangered species.

WHERE ARE THE GREEN TURTLES NESTING ON THE MAIN HAWAIIAN ISLANDS COMING FROM?

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Historically green turtle nesting has occured in the northwestern archipelago at French Frigate Shoals (FFS), although occasional green turtle nests are being seen more frequently on the main inhabited islands (MI) of Hawaii in recent years. Due to logistical constraints, monitoring the nesting activity on the main islands has been mostly confined to nest observation, and it is not clear how many different females are laying these nests. Using genetics we have determined that nesting in the MI is by a relatively small and possibly related number of females, and we were able to reconstruct the female's genotypes from analysis of the hatchling genotypes from serial clutch sampling. We used mitochondrial (mt) DNA sequencing combined with nuclear DNA analysis with 15 microsatellite markers to evaluate the relatedness of the MI nesters to the French Frigate Shoal nesting population, as well as a small population of captive green turtles (originally from FFS) that have been breeding at Sea Life Park (SLP) on Oahu for over 30 years. Our dataset includes 11 females and 6 males that live at SLP, a subset of 10 females from the FFS nesting population, 6

females from the Isla Revillagigedos nesting population, approximately 120 offspring that have been released from SLP between 2001 and 2007, and 11 MI nesters that were treated as offspring for our analysis. We also used data from 20 nesting females from Micronesia also treated as offspring as an outgroup for our analysis. Our results suggest that the females nesting on the main inhabited islands of Hawaii are most related to the captive SLP green turtles, raising the possibility that they might be some of the offspring that were originally released from SLP as juveniles many years ago. Analysis with larger sample sizes is underway to test this hypothesis further.

MITOCHONDRIAL CONTROL REGION ANALYSIS OF GREEN TURTLES FORAGING AT PALMYRA ATOLL, CENTRAL PACIFIC

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Although green turtles (*Chelonia mydas*) are relatively abundant at the remote Palmyra Atoll National Wildlife Refuge in the Central Pacific, they remain globally endangered. This small atoll serves as a foraging ground that is likely connected to other regional areas, but the population distribution of these turtles is still unclear. In this study we analyzed turtles caught at Palmyra between July and September over a 4-year period (n2008=41; n2009=49; n2010=47; n2011=84). Morphological data including straight carapace length, weight, and sex when apparent were also collected. A segment of the mitochondrial control region (~862 bp) was sequenced and aligned with all known Pacific haplotypes. Previously unknown haplotypes were named and included in the genetic diversity analysis. The CMP20 haplotype, which is found in rookeries throughout the Pacific, was the most common sequence at Palmyra. The CMP22 haplotype, which has not been detected in Australasian rookeries, was the second most common sequence of the Palmyra turtles. Three of the Palmyra turtles had the Eastern Pacific green turtle CMP4 haplotype, whose reported distribution among rookeries is restricted to Mexico and the Galapagos. We calculated nucleotide diversity (π) and haplotype diversity (h), and performed exact tests of population differentiation between the four years, and between juveniles and male adults identified by their long tails. We found no significant genetic difference between the groups of turtles caught each year. With these new population genetics studies we are developing a more thorough knowledge of foraging populations and their connection to rookeries and other feeding grounds. Understanding this connection is central to understanding the life history of these turtles and therefore will play a key role in informing effective management plans.

UNUSUAL SEXUAL DIMORPHISM FOR *LEPIDOCHELYS OLIVACEA* SEA TURTLE IN CONGO*

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Sexual size dimorphism (SSD) brings important informatio on life-history of species. The data from sea turtle by-catch have been combined with the data from nesting population in the Republic of Congo to estimate the male and female olive ridleys' adult body size. It was then possible to look for sexual size dimorphism (SSD) in this species. Curved carapace length distribution in male and female olive ridley turtles from the bycatch and females from nesting beaches bring forward a male biased SSD, olive ridley males being larger than females. This male biased SSD is contrasting with the female biased or no biased SSD commonly observed in sea turtles. This result is discussed in the light of evolutionary theories. Many mechanisms and factors may be involved in the observed SSD. Its establishment can be due to proximate and/or ultimate factors. These factors can be a conjunction of intrinsic and extrinsic factors: genetic, environmental factors (feeding sources). Both male and female could drive the SSD, according to the context and the strength of the evolution advantage conferred by a difference in size in male or female. Smaller male could be an advantage for maneuverability during mating and displays as in raptorial birds. Larger male could be an advantage in the case of male combat. Larger female could produce more offspring. Nevertheless in a food restriction context, smaller female could exhibit better reproductive performances. The reason why olive Ridley males are larger than females is not obvious, it could be due to particular behavior during mating, or the their particular food regimen, to particular link between female size and reproductive performance or to a differential survival rate in male and female, possibly in link with a imbalanced exposure to predators or threats (bycatch). Whether this male biased SSD is a local pattern or shared in other olive Ridleys' population around the world would help to answer to these questions.

A LONG WAY FROM HOME: FIRST CONFIRMED RECORDS OF THE EAST PACIFIC GREEN TURTLE (*CHELONIA MYDAS AGASSIZII*) IN NEW ZEALAND*

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During a population study of green turtles (*Chelonia mydas*) in New Zealand, stranding and salvage data examined between 2004 and 2010 revealed 15 green turtles (32% of all stranded or salvaged green turtles) exhibiting distinct morphological characteristics that were atypical to greens normally encountered. The distinctive features included a higher domed carapace anteriorly with a clear taper of the posterior margins over the hind flippers and a very dark (almost black) colouration of the carapace and a dark to pale grey ventral (plastron) surface. For eight of the turtles where tissue samples were collected, mtDNA

analysis subsequently confirmed them as East Pacific green turtles (*Chelonia mydas agassizii*). This research describes, for the first time, the occurrence of the East Pacific green turtle in the New Zealand region of the south western Pacific. All records were from northern New Zealand (north of latitude 37° S) with most (14) reported from neritic habitats on the north east coast of the North Island. Records occurred in all months throughout the year apart from February, March and September with no apparent peak in strandings observed. Of the turtles recovered for necropsy, biological data including size, sex and maturity and dietary component data were collected. Anthropogenic impacts were also investigated, with four turtles (27%) clearly exhibiting human related mortality i.e. two were incidentally caught (and drowned) in fisheries activities while two were presented with severe boat strike injuries. The mean curved carapace length was 67.8cm (range: 54.4 - 92.3cm, n=11). Gut content analysis revealed red and green algae species accounted for the majority of the dietary components with smaller quantities of seagrass and invertebrate material. Evidence provides an insight into the feeding ecology of the East Pacific green turtle in New Zealand and supports a wider foraging distribution than previously recognised for this species. As such, implications for conservation management becomes evident where an extension of the known range and associated migratory behaviour of the East Pacific green turtle will require more coordinated management between nations.

HATCHLING SEA TURTLE CARAPACE: A GOOD OPTION FOR DNA OBTENTION

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The sea turtle genetic research is commonly made using dead sea turtle hatchling or embryo tissues, and when a sample from live hatchling is needed, most of the researchers opt for taking blood samples. The use of a small piece of the carapace from live hatchlings had been mentioned as a reliable source of DNA, but only a few researchers have used this kind of tissue. In this work we want to compare the amount and quality of DNA that can be obtain from small samples of hatchlings´ carapaces and from bigger samples taken from rear flippers of dead hatchlings and developed embryos found inside the nest once the hatchlings were gone. 51 DNA extractions were made using the Qiagen DNeasy blood & Tissue kit (27 carapace samples and 24 dead hatchling samples), once the DNA was obtained, a Nanodrop was used to get the DNA concentration and purity (260/280 absorbance). The mean weight of carapace samples was 5.06 mg (±1.29) while the flipper tissue was 14.62 mg (±4.22); there was a significant difference between both weights. The DNA concentration obtained for both kinds of tissues was not significantly different, neither the purity of the samples despite the weight differences. These results suggest that a small piece of carapace can provide enough amount of DNA, with a proper purity, to do molecular analysis just like with bigger samples of dead hatchling tissue, but without the risk that the tissue sample may be degraded at the moment of sampling. Taking live hatchling carapace samples can be a better option for genetic studies since it isn´t require experienced personnel to take the samples, the scalps or biopsy punches are not expensive, sampling is fast and easy, and the cut in the carapace may be useful as a permanent “tag”. All these

advantages are important to consider when a big amount of samples are needed, or to prevent that no dead sea turtle where left in the nest.

GLOBAL PHYLOGEOGRAPHY OF GREEN TURTLES, *CHELONIA MYDAS**

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Phylogeography can help us reveal the historical processes that may shape the contemporary geographic distributions of individuals. Studying the phylogeography of endangered species is an important tool in the prioritization of areas of high value for conservation. The previous global phylogeography of *C. mydas* dates back 20 years, using RFLP and limited sampling and revealed a fundamental phylogenetic split distinguishing all green turtles in the Atlantic-Mediterranean from those in the Indian-Pacific Oceans. In recent years a number of studies have revealed regional phylogeographic patterns. However these studies were limited to turtles from restricted regions of their geographical range, limiting the information on how current distribution was formed. Here we re-evaluate the global phylogeography of *C. mydas* using 4400 mtDNA control region sequences from 101 rookeries. We identified major phylogeographical breaks separating management (MUs) units within each of the major ocean basins but also MUs from within the Pacific Ocean (western, central and eastern). Globally there were eight well-supported clades on the phylogenetic trees. While the eight divergent clades show a strong phylogeographic pattern with strong ties to major ocean basins, the phylogeographical structure within ocean basins is diminished by the occurrence of several common and widespread haplotypes. This work also provides new insights that are vital for defining Discrete Population Segments (DPS) or evolutionary significant units (ESU). These are units of conservation below the species level that is often defined on unique geographic distribution and mitochondrial genetic patterns and important tools in improving conservation and management of this endangered species. Finally, this information provides the backdrop for new and more comprehensive analysis of foraging grounds.

DEFINING OLIVE RIDLEY TURTLE MANAGEMENT UNITS IN AUSTRALIA AND ASSESSING THE POTENTIAL IMPACT OF MORTALITY IN GHOST NETS

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In Australia the olive ridley sea turtle (*Lepidochelys olivacea*) has received little research attention and monitoring compared to other species of marine turtles. The Australian

populations are relatively small and their distribution is limited to remote areas in the northern part of the country. Previous global genetic studies of olive ridley populations showed that the Australian breeding population at the McCluer Island Group is genetically distinct from olive ridley populations breeding in Malaysia, Sri Lanka, India and the eastern Pacific. However, nothing is known about the genetic stock structure among Australian olive ridley rookeries. High predation of eggs by feral pigs, goannas and dogs has led to a severe decline in the number of nesting females at some rookeries. Of particular concern is the small nesting population on the Western Cape York Peninsula and without immediate conservation action this population faces extinction. The results presented in this paper establish that there are at least two independent Management Units of olive ridley turtles nesting in Australia and raise the profile of the small breeding population nesting along the north-western Cape York Peninsula by identifying this stock as unique. In addition, results from 35 turtles caught in ghost nets across the Gulf of Carpentaria revealed that 71% of the haplotypes (comprising 57% of the samples) had not been observed in any rookery and their nesting origin is therefore unknown. Obtaining samples from other regional olive ridley rookeries is needed to determine the origins of stranded turtles or those caught at sea. This research highlights the need for better information on olive ridley population structure in the region.

ENERGY DENSITY AND TROPHIC LEVEL OF GELATINOUS ZOOPLANKTON WITHIN NERITIC CENTRAL CALIFORNIA WATERS (USA)

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Leatherback sea turtles (*Dermochelys coriacea*) of western Pacific nesting origins make 10-12 month trans-Pacific migrations to temperate foraging grounds of the California Current. Parts of this high-use coastal shelf habitat from Central California to Washington (USA) has been designated the Leatherback Conservation Area. As such, there is a need for additional information on the biology of leatherbacks as well as of their prey species. Adult leatherbacks begin to arrive in early summer (June-July) when water temperatures reach 14-16 degrees C and large aggregations of gelatinous zooplankton develop (e.g., Cnidaria, Ctenophora, and Tunicata). Within these neritic west coast waters, leatherbacks feed almost exclusively on *Chrysaora fuscescens*, but are also known to occasionally consume other large jellies, including *Aurelia labiata* and *Chrysaora colorata*. In this study we collected samples of sea nettles (*Chrysaora fuscescens*), purple stripe (*Chrysaora colorata*), egg-yolk (*Phacellophora camtshatica*), and moon (*Aurelia* sp.) jellies to determine their energy density (bomb calorimetry analysis) and trophic status (compound specific nitrogen stable isotope analysis of amino acids (CSIA-AA)). Samples were collected and analyzed to determine variation in energy density and trophic status between and within seasons, over size (mass and bell diameter), and between species and body parts (e.g., bell, oral arms, and manubrium/stomach/gonads). Variation in energy densities was estimated using a hierarchical model. The water content of the four sea jelly species ranged from 95.6-96.2% of body mass with little variation between species. The percent ash by dry mass ranged from 67.8-76.1% with *Chysaora* sp. having the lowest ash content. The energy density was highest for *Chrysaora* sp. (0.16 ± 0.02 kJ g^{-1} WM) and lowest for *Aurelia* sp. (0.08 ± 0.02 kJ

g^{-1} WM), there was also variation in the body parts of the jellies with the stomach, manubrium, and gonads having the highest energy density and the bell the lowest. Interestingly, *Chrysaora* sp., while having the highest energy density, was feeding at the lowest trophic position (TPAA) based on CSIA-AA (TPAA = 2.2 -2.7) compared with *Phacellophora* sp. (TPAA = 2.9) and *Aurelia* sp. (TPAA = 2.8 - 3.0). Adult leatherbacks, with maintenance costs of 2.2 x 10^4 kJ day^{-1}, would need to consume 100 to 275 kg of sea jellies per day depending on prey items or 25% to 68% of their body mass in sea jellies daily to meet maintenance costs. Indeed these data are useful for better understanding the biology and energetics of sychypomedusae in the California current. When combined with empirical data on leatherback biology, energetics, and trophic status, these data further strengthen our knowledge of the ecosystem roles of leatherbacks along the U.S. West Coast.

SPATIAL VARIATION OF SEX RATIOS ALONG THE MEDITERRANEAN COAST OF TURKEY*

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Temperatures of loggerhead nests and sand temperatures on Turkish beaches were recorded and the sex ratio of dead hatchlings and embryos were determined by gonad observation and sex ratios for the other hatchlings were estimated by measuring temperatures of the nests and by analyzing of the incubation durations and the period of emergences asynchrony. Sand temperatures and air temperatures were not directly related to the nest temperatures. The air temperatures were warmer on the eastern beaches but nest temperatures were not changed accordingly. The sand temperatures were much more variable on different parts of the beach as sandy, shady and stony parts. The sex ratio of hatchlings obtained from dead hatchlings showed remarkable differences between the zones of the beaches and nest depths. The dead hatchlings collected from the first and last emergences of nests were also different in sex ratio by having higher sex ratio of females in the first night emergences and higher males in the last night emergences. After examining air and sea water temperatures, we found that beaches in the west of Mediterranean coasts of Turkey were cooler than those in the east. Beaches on the west produce higher proportions of male hatchlings than those in the east. It was found that nests built at the beginning and the end of the season produced more males than the others. The nests close to sea produced more males than those far from the sea. All the beaches gathered the sex ratio results, obtained from published and unpublished data, are female dominated. The water and air temperatures were warmer on most eastern beaches that mainly used by green turtles as nesting grounds but slightly cooler at the more western beaches mainly used as nesting ground by loggerhead turtles. One possible explanation of the differences of both green and loggerhead turtles on these beaches might be the water and air temperatures together with sex ratio results might show that sea turtles keep using the beaches as nesting grounds if they able to produce both sexes.

COMPARISONS OF MARINE TURTLE BY-CATCH AND STRANDING MITOCHONDRIAL DNA; ARE STRANDINGS A GOOD INDICATOR FOR UNDERSTANDING THE GENETIC STOCK COMPOSITION OF MARINE TURTLE BYCATCH?

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Waters off the U.S. Pacific coast have been identified as key foraging grounds for leatherback and green turtles, whereas the presence of olive ridley and loggerhead turtles is less understood. While in the marine environment, each species routinely faces natural and human induced threats that may lead to fisheries interactions and strandings. To determine nesting origins and potential impacts to a given stock, tissue samples for genetic analysis were taken from marine turtles bycaught in US fisheries (58 loggerheads, 1 green, 5 leatherbacks and 2 olive ridley's) as well as from live and dead strandings (7 loggerheads, 44 greens, 16 leatherbacks and 12 olive ridley's). The purpose of this study is to determine if strandings provide a good indicator for understanding the genetic stock composition of marine turtle bycatch. Mitochondrial DNA (mtDNA) analysis was performed on a total of 145 tissue samples: 56 collected between 2002 and 2004 from turtles bycaught in the California based Pelagic Longline Fishery (CA LL), 10 samples collected between1997and1999 for the California/Oregon Drift Gillnet Fishery (CA/OR DGN) and 79 samples collected from turtles stranded along the U.S. Pacific coast (California, Oregon, Washington, and Alaska) between 1994 and 2011. The CA/OR DGN fishery operates within the California current and the U.S. EEZ in more coastal waters than the CA LL fishery, which operates further out into the central North Pacific. We determined the stock origin of the sampled turtles by matching the mtDNA control region sequences with baseline information from key Pacific nesting populations. We compared stock composition for the turtles sampled in the pelagic areas (CA LL bycatch) and the more coastal areas (CA/OR DGN bycatch), with the strandings. Preliminary results suggest that loggerhead strandings and by-caught animals from both fishery areas originate from nesting beaches in Japan, leatherback strandings and bycaught animals originate from nesting beaches in the western Pacific, and both green and olive ridley strandings and bycaught animals originate from eastern Pacific nesting beaches, indicating that each of these species' stocks generally inhabit a wide area of the northeast Pacific. Although our sample size is limited, we feel that strandings may provide a good proxy for determining potential stock interactions with fisheries in this region. Our results provide information that will help to further the understanding of marine turtle migration, oceanographic influences on movements, and stock structure of foraging assemblages in the Pacific.

THE GENETIC STRUCTURE OF THE MEDITERRANEAN GREEN SEA TURTLE (*CHELONIA MYDAS*) POPULATION*

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The majority of the Mediterranean green sea turtle population is concentrated in its Eastern Basin. This population is highly threatened by extinction due to massive hunting and anthropogenic impacts during the last century, and is considered to be critically endangered. Only few hundreds of nesting females are left in the Mediterranean rookeries. High conservation efforts are taking place to save the species from extinction. Revealing the genetic structure of the population will enhance our understanding of trends within the population and increase effectiveness of our management programs in the region. A great deal of effort has been invested in the attempt to characterize the genetic variability of sea turtle populations worldwide. So far, the common haplotyping system has been based on sequence analysis of a segment of the mitochondrial DNA (mtDNA) control region (D-loop) as an indicator. This method indicates that genetic variability is practically nonexistent in the Mediterranean sea-turtle population. A singular common haplotype, CM-A13, was observed in all but three individuals out of hundreds of samples. In this study a new method of genetic characterization has been applied, based on a unique pattern within the mtDNA that consists of short tandem repeats (STRs) with varying numbers of copies. It was with this new haplotyping system that we have analyzed nesting turtles from the coasts of Israel, Turkey and Cyprus, and stranded green turtles found on the Israeli Mediterranean coastline. The analysis of Israel's turtle samples using the new method revealed ten different haplotypes, whereas a sum of thirty four different haplotypes were found from all samples analyzed in this study, representing most of the green sea turtle population of the Eastern Mediterranean basin. An in-depth and broader understanding of the genetic structure would prove to be doubtlessly valuable. Mapping out the phylogepgraphic structure may enable further insights to understanding aspects such as breeding habits, migration and nesting patterns in sea turtles along the coastline of Israel and the entire Mediterranean. Such data will also assist if needed, with planning of future captive-breeding programs, by maintaining a genetic variability to ensure survival of the green sea turtle.

VARIATION IN REPRODUCTIVE OUTPUT OF LEATHERBACK TURTLES NESTING IN THE NORTHWEST COAST OF PAPUA, INDONESIA*

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The purpose of this study was to create a reliable method for determining foraging regions of leatherback turtles (*Dermochelys coriacea*) based on stable nitrogen and carbon ratios in skin tissue of nesting females, and to compare within-season reproductive output of turtles that foraged in distinct regions. Food availability can influence reproductive output and the timing of reproduction of many oviparous taxa. In marine turtles, the interaction between food availability and reproduction has not been widely investigated. As capital breeders, leatherback turtles obtain resources needed for reproduction in distant foraging locations. Leatherback turtles that nest in the northwest coast of Papua, Indonesia during April to September migrate to temperate (Northeast Pacific and North Pacific Transition Zone) and tropical (South China Sea) foraging regions. Results from a previous study, which analyzed skin samples taken from satellite-tracked turtles, indicated that turtles that foraged in the eastern Pacific have greater δ15N values than those that foraged in the western Pacific. We hypothesize that turtles that foraged in the greatly productive temperate region have greater within-season reproductive output than turtles that foraged in the lesser productive tropical region. Stable nitrogen and carbon ratios of leatherbacks with known foraging locations were used in a discriminant analysis, and the resulting functions were used to classify turtles sampled in 2010 and 2011. Results indicated that the majority of the nesting population foraged in temperate foraging locations. As predicted, turtles that foraged in the Northeast Pacific had greater δ15N. Turtles that foraged in the South China Sea were distinguished from those that foraged in the North Pacific Transition Zone by their lesser (more negative) δ13C. The discriminant functions correctly classified about 80% of original grouped cases. Measures of within-season reproductive output were compared, and preliminary results will be presented. Understanding how foraging location affects reproductive output will provide insights into the life history and dynamics of this population. We thank the International Sea Turtle Symposium, International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service for providing a generous travel grant award. Funding and logistical support for this study were provided by the Bird's Head Leatherback Program of State University of Papua, U.S. National Oceanic and Atmospheric Administration – National Marine Fisheries Service, Dr. Earl H. Myers and Ethel M. Myers Oceanographic and Marine Biology Trust, PADI Foundation, and Friend's of Moss Landing Marine Laboratories' Signe Memorial Scholarship.

CHARACTERIZING OCEANIC FORAGING GROUNDS OF LOGGERHEADS AND GREEN TURTLES IN THE ATLANTIC USING TRACE ELEMENTS AND LEAD ISOTOPES

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Knowing where sea turtles spend their "lost years" in the ocean has been a major challenge in sea turtle biology. For all but one species (the loggerhead, *Caretta caretta*), the location of these developmental areas, the duration of time turtles spend in these areas, and how these oceanic areas connect with the neritic (over continental shelf) foraging grounds remain unknown, resulting in many management and conservation challenges. Over the last four years we have been analyzing the elemental signature of oceanic layers of green turtles recently recruited to neritic foraging areas to determine if they are coming from different oceanic regions in the Atlantic. However locating these different oceanic regions has not been an easy task. In order to solve this problem we collected scute samples of 9 loggerheads and 2 green turtles smaller than 25 cm SCL from the Azores, a known oceanic foraging ground in the Atlantic. We conducted trace elements and lead isotope analyses of the scute of these organisms to determine the elemental composition of this tissue and obtain a baseline signature of this oceanic region. We used this information to make comparisons of the elemental signatures of the scute of turtles in the Azores with the oceanic layers of scute of green turtles captured in different neritic foraging grounds in the Atlantic and determine whether these two species share the same oceanic region during their "lost years". This research was funded in part by a Boyd Lyon Sea Turtle Fund Scholarship, the Florida Sea Turtle License Plate Grants Program, the PADI Foundation, The Explorers Club Exploration fund, and Sigma Xi Grant.

GENETIC ISOLATION OF AN EASTERN ATLANTIC STOCK: HAWKSBILLS NESTING IN PRÍNCIPE ISLAND

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Mostly because of extensive exploitation over centuries, the hawksbill turtle is currently a critically endangered species. Only after prolonged protection and monitoring, improvements in both status and knowledge have been gained; with some regional populations exhibiting encouraging signs of incipient recovery. However, very little is known about hawksbills in western Africa where sea turtles in general remain under persistent and significant threats. One of the major African hawksbill populations nests in Príncipe Island

where year-round foraging aggregations of juveniles, subadults and adult males are also observed. To gain insight into the population's genetic structure and provide essential baseline data to establish its relationships with regional stocks, we analysed mitochondrial DNA (mtDNA) sequences of nesting females, foraging adult males and females, subadults and juveniles. We found that the Príncipe nesting population was fixed for a single haplotype (EATL), which has been reported earlier in foraging aggregations but had no known rookery source prior to this study. We found that the Príncipe Island nesting colony is genetically distinct from breeding populations in the western Atlantic and phylogenetically linked with Indo-Pacific hawksbill clades. Mixed stock analyses revealed that the eastern Atlantic appears to be the primary foraging area for Príncipe hawksbills (75%) while most of the foraging juveniles in Príncipe waters originate from the Príncipe rookery (84%). Furthermore, our results confirmed the occasional westward transoceanic movement by hawksbills originating from Príncipe Island. The presence of Caribbean haplotypes at low frequencies (<5%) suggests that eastward transatlantic movements by juveniles to distant foraging and developmental habitats also take place. Our results underscore the high degree of isolation and vulnerability of this eastern Atlantic stock and highlight the urgent need to consolidate international cooperation across regional boundaries.

HEAD–STARTING TECHNIQUES COMPARISON BETWEEN LOS ROQUES ARCHIPELAGO NATIONAL PARK'S HAWKSBILL SEA TURTLE HATCHLING (*ERETMOCHELYS IMBRICATA*) AND REPORTS RECORDED IN THE GULF OF VENEZUELA

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Sea turtles use several coastal areas worldwide and are highly migratory species. Along the coast of Venezuela several areas for sea turtle's development are found, such as the Gulf of Venezuela (GV), located at the north-eastern coast of Venezuela; in this area, mostly juvenile turtles are found. Los Roques Archipelago National Park is a reef complex in constant formation, which presents a perfect area for spawning, development and shelter for many marine species living in the Caribbean. In Venezuela, several sea turtle conservation programs, in both, feeding and breeding grounds, as the Gulf of Venezuela and Los Roques archipelago, present different techniques for release, head-starting and general development phases of hatchlings and other stages of sea turtles. In order to understand the efficiency of development and growth of these individuals, this study was conducted to compare the techniques of head-starting, breeding and release of sea turtles, specifically, individuals of the species *Eretmochelys imbricate* (hawksbill turtle), thereby establishing new strategies, parameters and standards in this type of conservation techniques. We evaluated three basic parameters for the release and breeding of sea turtles: morphometry, feeding and captivity conditions. Individuals were measured at Los Roques Archipielago breeding program in a range of 7 to 8 days and a growth rate of 0.5-0.7 mm/day was obtained. Individuals were feed sardines (*Haregula clupeola*) and other

fishes (like *Hipoathenna harringtonesis*), which were delivered daily on alternate shifts (morning and night). The hatchlings were kept in concrete tanks, 1.5 meters height, width and depth respectively, which were washed every other day and then filled with fresh seawater. Hatchling from the Gulf of Venezuela program, achieved a growth rate of 0.5-0.9 mm/day. Individuals were fed various species of invertebrates and vertebrates (shrimp, squid and small fishes) performing on a regular schedule. These hatchlings were kept in plastic tanks of 100 L for a period of 60 days and then transferred to 1500 L tanks, which were filled with fresh water, salted with sea salt, and filtered, which allowed water circulation. Los Roques Archipelago Foundation presents a head-starting program for hawksbills and loggerheads, representing one of the most stable and successful program in the country, due to easy access to hatchlings, which are monitored from their emergence. In the GV, hatchlings were rescued from artisanal fishery interaction, and all normal conditions of these specimens were compromised. This technique (head–starting) is one of many strategies and conservation tools to avoid predation and decease in early stages, which is why is needed the creation of standards parameters and conditions thus further improve the results and strengthening of populations of this species in the Caribbean.

WHAT IS THE GENETIC COMPOSITION OF THE *ERETMOCHELYS IMBRICATA* FISHERY STOCK STUDIED DURING THE LAST LEGAL FISHING SEASON IN THE JARDINES DEL REY ARCHIPELAGO, CUBA?

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Hawksbill turtle, *Eretmochelys imbricate,* was the model species that was studied, and for which fishing statistics were gathered via the legal sea turtle fishery in Cuba. Although this fishery was shut down in 2008, illicit harvest persists at the regional level. This species has been listed as Critically Endangered (CE) by the IUCN and in Appendix I of CITES. However, gaps remain as to how individuals migrate and aggregate in the Caribbean Sea and the Gulf of Mexico. *Eretmochelys imbricata* is a phylopatric and migratory species. Understanding *E. imbricata*'s life cycle migratory routes and its origin is critical to developing effective conservation strategies. We determined hawksbill haplotypes using data from the last studied Jardines del Rey archipelago (Cuba) marine stock through NCR-mtDNA sequencing, and by temporally comparing the haplotype composition with other samples from the same fishing stock. As the hawksbill fishery has been neglected since 2006 with only 48 individuals harvested in that year, and only 14 of those individuals sequenced, we will not include these sequences in these analyses. Straight carapace length (SCL) was classified in four SCL classes taking into account SCL classification from 1990's historical harvest records. Relationships between haplotype frequency and fishing year, sex, maturation stage in females (immature and breeding adult), and SCL class were determined

using a χ^2 test of independence, corrected with a sequential Bonferroni procedure with 1000 simulations using the program CHIRXC. 105 individuals corresponding to 16 haplotypes (821 bp) were sampled from the last two years of the legal Cuban fishery (2004 and 2005). Significant differences in the haplotype composition between these years were observed. Only the females contributed to this statistical signification and to the SCL classes III and II. Haplotypes A1 and A11 were the most frequent, but A1 was significantly more frequent in 2005, while A11 was more frequent in 2004. Haplotypes A23 and A41 were more frequent in 2005. A1 was frequent only in males for both years. The haplotype composition of immature and breeding females was independent between 2004 and 2005. The last females were of low frequency in the fishing stock in both years but primarily in August and September. These females mainly presented SCL class IV followed by class III. Breeding females with haplotype A1 had similar frequency in both years, while those with A11 were only represented in 2004. When the haplotype composition of these 2000's individuals (465 bp) was compared with the 1990's haplotype composition (n=53), we also obtained significant differences. MX2 is the main contributor due to its representation by one individual (1995) in relation to five and seven individuals detected in 2004 and 2005 respectively. The 1990s and 2000s data show stock fluctuations of the most frequent haplotypes (A1 and A11), the trend to increase the frequency of individual in SCL classes II and III and the prevalence of non-adult hawksbills in this zone. We thank to ISTS, Western Pacific Regional Fishery Management Council, US Fish and Wildlife Service, and the US National Marine Fisheries Service for supporting Emir Pérez's travel grant.

PATTERNS OF PATERNITY AND WHAT THEY CAN TELL US: MOLECULAR INSIGHTS FROM THE HAWKSBILL TURTLE*

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In marine turtles, genetic techniques have been instrumental in revealing previously unknown details about life histories, such as movements and migrations and mating behaviour. This information is valuable to conservation biologists interested in population boundaries and effective population sizes. However, although our knowledge of turtle mating systems has advanced considerably, our understanding of the processes behind these mating systems is still limited, and the testing of specific hypotheses is relatively rare. The development of general theories on marine turtle mating systems is further restricted by taxonomic bias. In the present study, we examine the mating system of the critically endangered hawksbill turtle *Eretmochelys imbricata*, perhaps the turtle with the least well-characterised mating system. Our study includes tests of genetic-based mate choice hypotheses not previously reported for marine turtles. Tissue samples were collected from nesting hawksbill females and emerging hatchlings (20 per nest) on Cousine Island, Seychelles, in a single nesting season (1600 hatchlings, 85 nests, from 50 females). All samples were genotyped at 32 microsatellite loci. The program COLONY was used to test for multiple paternity in the clutches of females, and for multiple mating by males. Male genotypes were reconstructed and used to test for heterozygosity- and relatedness-based mate choice by females. The majority of females showed single paternity across all clutches, all multiple-paternity clutches could be explained by two males per clutch, and all females were found to have mated with different males. Overall, our results suggest a large number

of males contribute to the population, that there is little or no reproductive skew and that mating may not be occurring close to nesting beaches. These processes may act to increase effective population size and help hawksbill populations maintain genetic diversity as numbers recover from historic declines. Sperm storage by females appeared to be ubiquitous, and may benefit females through avoidance of costs associated with re-mating rather than through promotion of sperm competition or cryptic choice. The absence of evident mate choice based on heterozygosity or relatedness suggest that turtle mating is predominantly stochastic with respect to these factors, indicating that there may be insufficient benefits for these types of choice to evolve in the hawksbill's ecological context. Research funding acknowledgements: University of East Anglia Faculty of Science, Cousine Island, Natural Environment Research Council Biomolecular Analysis Facility (NBAF). Travel funding acknowledgements: Richard Warn Memorial Fund, International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service, International Sea Turtle Symposium.

DOES TELOMERE LENGTH MATTER FOR LEATHERBACK TURTLES' LIFE HISTORY TRAITS?*

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Telomeres are repetitive non-coding DNA sequences that cap and stabilize the ends of eukaryote chromosomes. Because of the process of DNA replication, telomeres shorten throughout cell divisions, causing chromosome instability, cell death and ultimately senescence. Although first studies have postulated that telomeres shorten with organisms' age, this hypothesis has been now reported to be controversial, telomere length rather reflecting physiological age than chronological age. Recently, there has been a major interest in understanding the links between telomere shortening and life history traits, mainly survival. However, to date, the links between telomere length and reproductive investment have received much less attention. Further, individuals performing better in terms of survival and reproduction are commonly qualified as "good quality" individuals, a concept largely used in evolutionary ecology but rarely explicitly defined and still difficult to measure. In the present study, we propose to (1) test the age-telomere hypothesis in the leatherback turtle *Dermochelys coriacea* and (2) investigate the potential relationship between female leatherbacks' reproductive performances and telomere length. We performed quantitative Polymerase Chain Reaction for measuring telomere length (T/S ratio) in red blood cells' DNA of 42 reproductive females nesting in French Guiana and 22 hatchlings that failed to emerge. In addition, 30 nesting females of known identity and reproductive history (i.e. years of nesting seasons and remigration intervals' duration over their reproductive lifespan) were monitored throughout one nesting season (2005 or 2006) for assessing their biometrics (carapace length and width, body mass) and their reproductive effort (in terms of number of clutches laid). First, we found no differences in telomere length between hatchlings and adult females (T/S ratios: 1.82 ± 0.20 [0.60, 4.32], n=22 and 1.79 ± 0.28 [0.08, 8.26], n=42, for hatchlings and adult females respectively, t=0.08, p=0.94). Second, females' annual reproductive effort was best explained by individual telomere length rather than by their biometrics, better breeders having longer telomeres (final model of multivariate linear analysis: F = 7.95; df=20; p=0.011). Moreover, turtles performing longer migration prior the considered nesting season also had longer telomeres (T/S ratios 2yrs-migration: 1.33 ± 0.26

[0.12, 4.75], n=21 vs T/S ratios 3yrs-migration: 3.85 ± 0.81 [0.52, 8.26], n=9, t=-3.98, p=0.0005). Finally, telomere length was positively related to the mean remigration interval duration females performed over their entire known reproductive lifespan (r^2=0.14, p=0.03). This absence of telomere shortening with age may be related to an early high telomerase activity (i.e. the enzyme that restores telomeres), which generally occurs is fast-growing species. Such a process preventing telomeres from early attrition may occur in leatherback that is the fastest growing sea turtle, and may represent an adaptive strategy enhancing survival. Our study suggests that telomere length in leatherback turtles is not only an index of survival chances but also of reproductive performances, thereby making telomeres a potential new tool to evaluate individual quality in this critically endangered species.

GREEN TURTLE (*CHELONIA MYDAS*) MIXED STOCKS IN THE WESTERN SOUTH ATLANTIC, AS REVEALED BY MTDNA HAPLOTYPES AND DRIFTER TRAJECTORIES

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Genetic structure and natal origins of green turtle mixed stocks in southern Brazil were assessed based on analyses of mitochondrial DNA (mtDNA) control region sequences from the Arvoredo Island (n=115) and Cassino Beach (n=101) feeding areas. These were compared to other mixed aggregations for examining structuring and to Atlantic Ocean nesting colonies for evaluating natal origins through Bayesian Mixed Stock Analysis (MSA). In order to develop novel priors, surface drifter trajectories in the Atlantic were analyzed and combined with rookery data, and we used Kulback-Leibler information measures in order to compare the difference of information among the four proposed priors. Each study area presented twelve haplotypes, ten of which were shared at similar frequencies. Haplotypes CM-A8 and CM-A5 represented around 60% and 20%, respectively, and remaining haplotypes accounted for less than 5% of samples. Genetic structure was not observed between the two study areas or between them and other feeding grounds in the western South Atlantic except Almofala, in northeast Brazil. Structure was observed between study areas and Caribbean and North American mixed stocks. Drifter trajectory analysis revealed that drifters from Ascension and Trindade Islands have a larger chance of reaching Brazil. The prior drifter data and rookery size/drifter data combined contained the most information, but stock estimates were not greatly changed. MSA indicated that Ascension, Aves/Surinam and Trindade were the main stock contributors to the study areas. Since impacts on mixed stocks may affect populations thousands of kilometers away, the results presented here have important implications for the conservation of this endangered species.

GENETIC STOCK ORIGIN OF LEATHERBACKS (*DERMOCHELYS CORIACEA*) FOUND AT FEEDING GROUNDS OFF THE ARGENTINE COAST

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The leatherback turtle, *Dermochelys coriacea*, like other species of marine turtles, is known to undertake long migrations between tropical nesting beaches and distant temperate foraging areas. Since 2003, the Regional Program for Sea Turtle Research in Conservation of Argentina (PRICTMA) has investigated the status and habitat use of these endangered species of reptiles in the coastal waters off Argentina. Satellite telemetry studies have demonstrated that the coastal waters off South America provide important feeding grounds for leatherbacks in the western South Atlantic, and "hotspots" have been identified off Argentina, although there is no nesting documented south of Brazil. In the present work we analyzed mitochondrial DNA (mtDNA) variation of leatherbacks sampled at feeding areas off Argentina in order to determine their nesting stock origin. A 711 bp fragment of the mtDNA control region was sequenced using primers LCM 15382 and H950 and aligned to an unpublished reference dataset (Dutton *et al*. unpublished data). We sequenced a total of 26 samples (16 females, 9 males and 15 indeterminate) collected from adult leatherbacks (mean 146.3; 148.5–141.1 cm curved carapace length) captured (10%) in fisheries or encountered as strandings (90%). We identified 3 haplotypes, the most common (n=21) being DC 1.1, and the other two rarer DC 1.3 (n=4) and DC 13.1 (n=1). The genetic diversity was evaluated through the haplotype (0.3354 +/-0.1060) and nucleotide diversities (0.000456 +/- 0.000515). We conducted Bayesian Mixed Stock Analysis (MSA) using unpublished data from Dutton *et al*. (in prep) for the key potential source rookery stocks in the Atlantic. Results of the MSA estimates show that the Argentina foraging leatherbacks come primarily from the West African rookeries (mean estimate=82%, 40.9-99.7%, 95% confidence interval) as opposed to Caribbean and western Atlantic rookeries. Our results are consistent with those from mark-recapture studies, since four leatherbacks captured in Argentinean waters were adult females that were originally tagged on the nesting beaches in Gabon, West Africa. Taken together these findings reinforce our understanding of the connectivity between these breeding and foraging areas on opposite sides of the ocean in the South Atlantic. These genetic results provide new information to link nesting and foraging areas in the South Atlantic and are part of a broader effort to determine regional stock boundaries and migratory routes in order to develop and implement effective conservation measures to mitigate threats both on the nesting beaches and at developmental and foraging areas.

POPULATION DYNAMICS REFLECTED BY MICROSATELLITES: PAIRWISE RELATEDNESS OF FEMALES COMPRISING THE GREEN TURTLE ROOKERY OF BUCK ISLAND, USVI*

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Green turtle nesting on Buck Island, St. Croix, United States Virgin Islands has been historically sparse, but nest numbers have increased over the previous decade. During the 2001 through 2009 nesting seasons, 48 nesting females were tagged and genetically sampled. Previous mitochondrial DNA analysis of these females suggested historical connections with the Aves Island rookery, but significant differentiation of mitogenomic haplotype frequencies also indicated demographic partitioning between the two rookeries. In order to assess the genetic relationship of the individuals nesting on Buck Island and hypothesize colonization scenarios, we genotyped all nesting females at 28 microsatellite loci. Parentage analysis indicated that no mother-daughter pairs were present among sampled nesting females. However, sibling and half-sibling clustering implemented in the program COLONY2 predicted that the 48 nesting females could have descended from as few as 18 mothers. The largest predicted maternal cluster of 13 females consisted of a set of five full sisters, a separate pair of full sisters, and six half-sisters. The second largest predicted cluster consisted of ten females: a trio of full sisters, a pair of full sisters, and five half-sisters. Microsatellite results were consistent with mitogenomic haplotypes for all but a single assignment: one of the four females carrying haplotype CM-A16 was assigned to a different mother than the rest, but was considered a paternal half-sister to a full-sibling cluster containing the other three. It is more likely these four turtles shared a mother but that the fourth had a separate father from the rest. Therefore, each of forty of the females was assigned as related to at least one other female at the half-sibling level or higher. Only eight females were completely unrelated from all others and may represent strays from nearby St. Croix beaches. One of these carried control region haplotype CM-A5.2 and could represent an Aves Island immigrant. These results suggest that irrespective of how the Buck Island rookery was founded (directly from Aves Island or Aves Island via the East End beaches of St. Croix), local recruitment may now be sufficient to maintain the demographic integrity of the Buck Island nesting population. Given exchange of females between Buck Island and the East End beaches documented through flipper tagging, similar microsatellite fingerprinting of females from the later is warranted to better resolve the relationship of the two rookeries. Future characterization of the male component through paternity analysis and reconstruction will benefit interpretations of relatedness of nesting females. This research represents an important first step towards exploring the scale and precision of natal homing for this species in the region.

FIRST ESTIMATE OF OPERATIONAL SEX RATIOS FOR BREEDING LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) DERIVED FROM GENETIC FINGERPRINTS OF NESTING FEMALES AND THEIR HATCHLINGS*

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There has been much research focused on determining hatchling and juvenile sex ratios in sea turtles. Understanding the proportion of males to females in any population has important consequences for population demographic studies. In general, sex ratios of sea turtle hatchlings and juveniles are strongly female-biased and there has been some concern that under climate change scenarios, populations of turtles may become entirely feminized due to temperature dependent sex determination in combination with warming nesting beach temperatures. To date there have been no studies of the sex ratios of breeding adult turtles, also known as the operational sex ratio (OSR). The OSR has important implications for mating behaviors and mate choice depending on which sex is more abundant. The purpose of our study was to evaluate the number of breeding male and female leatherback turtles in an important nesting population. The proof of concept for this work (deriving paternal genotypes from hatchlings and known mothers) was developed in a previous study of multiple paternity. In 2010, 91 individual females were identified while nesting at St. Croix, in the US Virgin Islands and we identified nests from 58 females where we had sampled at least 10 hatchlings each. As hatchlings emerged from their nests, we sampled them using a 2 mm biopsy punch, taking a single skin snip from the trailing edge of the front flipper. Total genomic DNA was extracted using standard protocols and genotyping was done using 6 polymorphic microsatellite markers. We examined the genotypes of 666 hatchlings belonging to 58 females. Once genotyping was complete, we matched 55 females conclusively to nests we had identified. Of these 55 females, 42 had mated with only one male each, 9 had mated with 2 males each and 4 had mated with at least 3 males each, for a multiple paternity rate of 23.6%. Using GERUD1.0, we reconstructed distinct paternal genotypes for 46 (of 55) known females. Forty-seven different males were identified. Of these, six males had mated with two females each, one male had mated with three separate females, and the other 40 males had mated with just one female each. Thus, the ratio of breeding males to females in this population was slightly more than 1:1. This study shows for the first time that there are at least as many actively breeding males as females in a nesting population and that worries of female-biased adult sex ratios may be premature. In fact, mate choice or competition may play more of a role in sea turtle reproduction than previously thought. This study provides an opportunity to continue monitoring the OSR into the future in order to integrate with other demographic studies linked to hatchling sex ratios and survivorship.

DETECTING ONTOGENETIC SHIFTS AND ELUCIDATING THE "LOST YEARS" OF EAST PACIFIC GREEN TURTLES (*CHELONIA MYDAS*) USING STABLE ISOTOPE ANALYSIS WITH SKELETOCHRONOLOGY

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The East Pacific green turtle (*Chelonia mydas*) a.k.a. 'black turtle' population along the Pacific coast of Mexico is listed separately from global green turtles on the U.S. Endangered Species Act, and this population is currently considered Endangered. Cross-border international efforts to protect this population over the past 30 years have curbed the dramatic population decline that was representative of the black turtles in the last century. Green turtles of Pacific Mexico, like green turtles around the world, are subject to varying threats, presenting managers with unique conservation challenges. Distinct risks, environmental conditions and population trends necessitate specific management strategies for these separate populations. Assessing basic turtle biology during the entire life cycle has been identified as a key research priority for all populations of marine turtles. The age-at-settlement, when juvenile turtles undergo an ontogenetic shift from oceanic to neritic habitats, remains unknown for most marine turtle stocks, and better information on the timing of this shift will facilitate more accurate risk assessment and population estimates for management purposes. Stable isotope analysis has been applied to marine turtle humerus bones and scute keratin to identify foraging habitat of marine turtle populations across the globe. This is made possible due to the fact that tissues such as bone and keratin are comprised of nutrients garnered in foraging areas, and these hard inert tissues record isotope signatures from multiple years' worth of foraging. When an animal moves among spatially discrete food webs that are isotopically distinct, stable isotope values of its tissues can provide unambiguous information about its previous location. Additionally, skeletochronology has been used to estimate age of marine turtles. Using the two together, on adjacent bone or scute samples, allows a determination of the stable isotope values of specific growth layers, which in the case of humerus bones are believed to be annular. Thus, isotopes and skeletochronology has the potential to decipher what habitat types are occupied during sequential years of life. Here we present our initial findings from stable carbon (δ13C) and nitrogen (δ15N) isotope analysis conducted on humeri bones from five green turtles stranded along the Pacific coast of the Baja California Peninsula, Mexico and from within the Gulf of California. The five samples were collected between 1995 and 2001, and the known straight carapace lengths (SCL) (n=2) ranged from 73.3cm to 86.2cm. These initial data, plus additional samples collected more recently, will later be linked with skeletochronology and isotope analysis of bone and scute material to elucidate ontogenetic shifts of individual turtles from green turtles in this region. The goal of our research is to investigate the duration of the pelagic juvenile stage (i.e. the "lost years") of green turtles along the Pacific coast of Mexico by determining the age-at-settlement for this recovering population of green turtles and improving understanding of green turtle ontogeny. Funding support generously provided by the University of California San Diego, the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service.

YOU ARE WHAT YOU EAT AND WHERE YOU EAT IT: INTERPRETING THE ISOTOPIC NICHE OF THE CARIBBEAN GREEN TURTLE*

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We investigate the trophic ecology and spatial distribution of green turtles (*Chelonia mydas*) in the Caribbean through stable isotope analysis. The isotopic niche is a proxy for the ecological niche encompassing the diet and habitat resources used by a consumer, and has become a tool to identify differences among or within populations. We assess the trophic and spatial contributions to carbon and nitrogen isotope values in the aggregate nesting population at Tortuguero, Costa Rica. We compare the isotopic niche of the nesting population to that of five foraging grounds. We evaluate variability in trophic position and differences in isotopic compositions of primary producers using analyses of the primary diet item *Thalassia testudinum* from the Greater Caribbean and using compound-specific stable isotope analysis of amino acids in a subset of the nesting population. The nesting population had greater isotopic variability resulting in a larger isotopic niche compared to each of the foraging grounds. The combined results indicate that the population likely feeds at the same trophic level, while geographic differences in the isotopic compositions at the base of the food web contribute to the isotopic variation in the nesting population. These spatial differences also allow us to estimate the proportion of the nesting population using a specific foraging area. This study can be useful in better understanding the foraging ecology of highly dispersed and migratory populations.

GENETIC ASSESSMENT OF SEA TURTLE FORAGING AGGREGATIONS OF BONAIRE, NETHERLANDS ANTILLES

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As a result of dispersal and migratory behavior, sea turtles establish a complex interconnection between their original natal rookeries and their developmental and foraging grounds. Elucidating this interconnection is of vital importance as it provides a regional perspective of conservation priorities and initiatives to recover and maintain their populations. In addition it provides important clues to gain a better understanding of the migratory behavior of sea turtles and the factors influencing their spatial and temporal distribution. In this study, we assessed the genetic variation of a section of the mtDNA control region to investigate the genetic diversity and origin of the green sea turtle and hawksbill sea turtle foraging aggregations (FAs) of Bonaire, Netherlands Antilles. Furthermore, we estimated the most likely contribution of the FAs to recruitment of the Caribbean and Atlantic nesting rookeries. We analyzed 169 individuals (hawksbills=75,

greens=94) an observed a relatively high genetic diversity characterizing both aggregations, with the green aggregation exhibiting the highest genetic diversity so far observed for a foraging aggregation. We obtained evidence that confirms the cosmopolite character of the FAs with individuals exclusively from Caribbean rookeries recruiting to the hawksbill foraging grounds. Interestingly, a contribution of rookeries from South Atlantic and probable from West Africa was estimated for the green turtle foraging ground suggesting the migratory capabilities of the green turtles and providing the framework to further test hypotheses about the mechanism influencing such long-distance dispersal. Results from this study not only confirm the regional connectivity established between the Island of Bonaire and the rest of the Caribbean nesting rookeries but also reveals the connectivity with rookeries from as far as Africa.

GENETIC CHARACTERIZATION OF MESOAMERICAN PACIFIC HAWKSBILL TURTLE, *ERETMOCHELYS IMBRICATA* (TESTUDINES: CHELONIIDAE)*

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Even when the hawksbill turtle (*Eretmochelys imbricata*) is a species being critically endangered and it has been a species of interest since decades, is until recent years that the attention has been focus on the diminished populations in the Eastern Pacific. We present the first genetic characterization analysis of mitochondrial DNA (mtDNA) control region sequences (n=25) of hawksbill turtles, juveniles and adults, from localities along the Mesoamerican Pacific. Our results showed ten haplotypes non-reported in any nesting population to date, with one of them accounting for 24% of the samples (Ei_EP09). These ten haplotypes were closely related to each other and the AMOVA analysis shows no genetic structure within the Mesoamerican pacific individuals, but they are highly divergent from all known Caribbean and Western Atlantic haplotypes. We found one haplotype (Ei-EP01; 12% of the total samples) closely related to haplotypes previously detected in rookeries from the western Pacific, suggesting a recent divergence between Western and Eastern Pacific hawksbill populations. The genetic data presented here carried significant conservation and research applications. This study highlights the necessity of additional research, particularly expanding the genetic analyses throughout the Eastern Pacific to include unsampled areas.

In-Water Biology and Monitoring

THE ORIGIN OF LOGGERHEAD TURTLES (*CARETTA CARETTA*) CAUGHT BY THE CALIFORNIA DRIFT GILLNET FISHERY IS INFERRED BY STABLE ISOTOPE ANALYSIS*

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Loggerhead turtles, *Caretta caretta*, in the North Pacific are listed as endangered under the U.S. Endangered Species Act and the IUCN Red List. Due to their imperiled status, extensive efforts are underway to reduce incidental capture in marine fisheries throughout the North Pacific. For example, in 2003 the U.S. National Marine Fisheries Service established a time-area closure of the California drift gillnet (CDGN) fishery operating within the Southern California Bight (SCB) that was to be triggered by El Niño Southern Oscillation (ENSO)-derived warm-water conditions, which is the time when loggerheads are believed to enter the SCB. Understanding the origins of loggerheads captured in the SCB will help elucidate the oceanographic mechanisms that influence movement of turtles into this region, and can assist in clarifying the most appropriate environmental triggers for implementation of the SCB fishing closure. To date, however, no information is available on their whereabouts prior to entering the SCB. In this study we used stable carbon (δ13C) and nitrogen (δ15N) isotope analysis and satellite telemetry to determine the migratory origin of loggerhead turtles encountered in the SCB region. Skin samples from loggerheads captured in the CDGN fishery (n=7) were compared with skin from loggerheads bycaught in the Hawaii longline (HLL) fishery (n=20) and sampled during in-water research off the Baja California Peninsula (BCP), Mexico (n=9). The mean δ13C values for the HLL, CDGN, and BCP loggerheads were −18.0 ± 0.1‰, −17.4 ± 0.4‰, and −16.2 ± 0.2‰, respectively, while δ15N values were 11.0 ± 0.3‰, 11.3 ± 0.2‰, and 15.9 ± 0.3‰, respectively. These results suggest that the loggerheads in the SCB most likely originated from the central North Pacific, a finding consistent with three satellite-tracked turtles that showed movements from the central Pacific to the waters near the SCB or the BCP. We elaborate on potential oceanographic mechanisms by which loggerhead turtles access the SCB and propose a framework that can inform future determinations on the timing of the SCB fishing closure.

INSIGHT'S INTO BELIZE'S MARINE TURTLE POPULATIONS: AN INVESTIGATION UTILIZING RECREATIONAL DIVERS AS MARINE OBSERVERS

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With the continued degradation of marine environments, and substantial deterioration of coral reefs, marine monitoring has become essential to conservation and management of marine biodiversity. The use of volunteers to collect data on marine species is a quick and cost effective way of accumulating a large amount of uncomplicated data. This study used recreational divers and snorkelers to assess marine turtle populations in Belize while, at the same time, investigating effects of protection on marine turtle abundance. Data was collected during the initiation of the "Belize Turtle Watch Project," a program that recruits recreational dive organisations and volunteer divers and snorkelers to report marine turtle information. 641 dives and snorkels and 25 boat sightings were reported from around the country, including data from eight marine protected areas. 113 hawksbill (*E. imbricata*), 47 loggerhead (*C. caretta*), 27 green (*C. mydas*), and 7 unidentified turtles were reported. Hawksbill (CCLmin<80cm) and green turtle (CCLmin<99cm) populations were predominately immature (72% and 85% respectively), while loggerhead populations (CCLmin<92cm) were largely adult (87%). Presence of protection (unprotected vs. protected) was found to have a significant influence on number of turtles encountered per dive (GzLMM, $\chi 22=6.5455$, $p<0.05$) and a highly significant influence for hawksbill turtles (*E. imbricata*) encountered per dive (GzLMM, $\chi 22=21.786$, $p<0.001$), with fewer turtles encountered in protected areas. The highest turtle frequencies (mean turtle encounters per dive) occurred in Ambergris Caye, Glover's Atoll and Lighthouse Atoll while the lowest frequencies occurred in Bacalar Chico. These results suggest that Belize provides important developmental habitat and mating areas for marine turtles, particularly hawksbills, and continued monitoring of these populations may be essential to the overall conservation of Caribbean hawksbill populations.

THE GULF OF MANFREDONIA: A NEW NERITIC FORAGING AREA FOR LOGGERHEAD SEA TURTLES IN THE ADRIATIC SEA

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The Adriatic Sea is an important foraging area for the loggerhead sea turtle (*Caretta caretta*) but neritic habitats for this species along the Italian coast were identified in the northern shallow area only. The Gulf of Manfredonia is a relatively wide shallow area in the south-west Adriatic and its features and preliminary information make it a potential foraging ground for turtles. In order to assess sea turtle occurrence in the area, we monitored 11 bottom trawlers based in the port of Manfredonia during the period Oct 2010 – Jul 2011 through a voluntary logbook programme, resulting in a total of 84 turtle captures during 916 fishing days. Since a turtle capture represents a rare event during such sampling, data were analysed by a zero-inflated Poisson (ZIP) model. Results indicate that: (i) the Gulf is a neritic foraging ground for loggerhead turtles which occur there with a relatively high density comparable to other Mediterranean foraging grounds, (ii) it is frequented by a wide range of size classes, including small juveniles as well as adults, (iii) the highest occurrence is during the period Jun-Dec, (iv) over 1700 turtle captures occur in the Gulf annually. Preliminary findings about recaptured individuals suggest that some turtles are resident in the area. The peculiar features of the Gulf of Manfredonia and the collaboration of the fishing fleet, make it a valuable index site for studying current trends of sea turtle populations at sea as well as other aspects of sea turtle biology and conservation.

TURTLEWATCH AND TRANSECT SAMPLING: TWO APPROACHES TO ESTIMATE GREEN AND HAWKSBILL TURTLES DISTRIBUTION AND ABUNDANCE IN THE EGYPTIAN RED SEA - PRELIMINARY RESULTS*

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Five of the seven sea turtle species existing in the world, can be found in the Egyptian Red Sea: the green turtle (*Chelonia mydas*), the hawksbill turtle (*Eretmochelys imbricata*), the leatherback turtle (*Dermochelys coriacea*), the loggerhead turtle (*Caretta caretta*) and the

olive ridley turtle (*Lepidochelys olivacea*). While the green and hawksbill turtles are considered common, the other three species have been observed only sporadically in the region. Both green and hawksbill turtles are known to feed and nest in Egyptian Red Sea coastal waters. While the location of their major nesting sites is already known, only scattered data are available on their feeding grounds. The aim of this project was to identify major feeding grounds for both species, estimate population relative abundance and collect data on population structure. As our aim was to cover the Egyptian Red Sea, we used two different approaches: a turtle-sighting reporting system (a project known as TurtleWatch Egypt) that relies on the collaboration of dive centers and monthly snorkeling transect sampling in the southern Egyptian Red Sea. For both approaches, every time a turtle was spotted the geographical position and, when possible, the species, approx. size, gender (when discernable) and activity at first sight were recorded. Here we will present the preliminary results of the work realized from April 2011 to February 2012 (10 months). We will present preliminary estimates for relative abundance, population structure and some results from the photo-identification work we are using in Marsa Abu Dabbab. Some implications for conservation as well as further developments of this work will also be discussed.

DISTRIBUTION OF LOGGERHEAD TURTLES (*CARETTA CARETTA*) WITHIN THE GULF OF SIRTE, LIBYA*

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Despite extensive studies of nesting loggerhead turtles within the Mediterranean, little is known about the at-sea distribution of this species during all stages of its life-cycle. In particular, our knowledge of the dispersal of individuals within Libyan waters is extremely limited. A 3D seismic survey was carried out in the Gulf of Sirte, Libya, from October 2008 to September 2009. Opportunistic sightings of marine turtles were recorded and provide new information to address the gaps in our knowledge. A total of 1592.15 h of visual survey effort were made in weather conditions considered adequate for detecting turtles, Beaufort force ≤3, and a total of 40 sightings (52 individuals) were recorded. Of these sightings, the majority of turtles were juveniles and 10% of the sightings involved individuals entangled in discarded fishing nets. Satellite tracking has mainly focused on the movements of adults, whilst juveniles are considered more difficult to tag and track. Results reveal that long-term seismic surveys, whilst being limited in their scope, can provide some useful information about the spatial distribution of marine turtles in-water, and potentially important habitats for conservation and management. Furthermore, whilst fishing activities are limited within Libya and the Gulf of Sirte, the high proportion of entanglements raises further concerns about the impact of fisheries on marine turtles within the Mediterranean. Measures to reduce incidental catch should be implemented until further information can be gathered.

CHARACTERIZATION OF SEA TURTLE FORAGING GROUNDS IN THE GULF OF MEXICO USING STABLE ISOTOPE ANALYSIS

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Multiple life stages of green (*Chelonia mydas*), loggerhead (*Caretta caretta*), and Kemp's ridley sea turtles (*Lepidochelys kempii*) forage in shallow, coastal waters of the Gulf of Mexico. Recently, sea turtle foraging studies utilizing analyses of stable nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) isotope signatures have provided valuable insight into trophic variability and identified differences in foraging habitat use among and within species. However, comprehensive studies of isotopic signatures of organic matter, primary producers, consumers and/or potential prey from previously identified sea turtle foraging habitats are needed to yield an accurate interpretation of isotope results. The objective of this study is to isotopically characterize Gulf of Mexico nearshore habitat from Naples, FL to Grand Isle, LA, and provide a basis for interpretation of results from isotope studies of sea turtles inhabiting this region. We present stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) signatures of particulate organic matter (POM), primary producers, and consumers collected within sea turtle foraging habitats of this region during 2011. This study will provide data that contribute to the first isotopic profile, or isoscape, for the region. Acknowledgements: International Sea Turtle Society Student Travel Grant Committee, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service, and Texas A&M University at Galveston.

SEASONAL DISTRIBUTION OF LOGGERHEAD TURTLES IN THE COASTAL AREA INFERRED FROM INCIDENTAL CAPTURE BY POUND NET IN SHIKOKU, JAPAN

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A total of eighteen hundred and sixty seven loggerhead turtles were incidentally captured by three large pound nets set around Cape Muroto, Kochi prefecture, Japan from October 2002 to September 2011. The pound nets set at the coast near Kuroshio Current. Loggerhead turtles appeared all year round, however, 62 % of turtles were concentrated from March to July (frequency of appearance in March: 0.11, April: 0.14, May: 0.11, June: 0.16, July: 0.10). Then, numbers of turtles drastically decreased from August (frequency of appearance in August: 0.05, September: 0.02, October: 0.03). Loggerhead turtles usually lay eggs from May to July and the average size of SCL in May to July (77.5±7.0 cm, n=629) was larger than in others months. In fact, large females had eggs in their bodies when they were dissected or scanned by ultrasonic. For mature males, they appeared infrequently but appeared all year round, while mature females appeared only in the nesting season. Thus, high frequency of appearance from June to August would showed by the nesting migration. On the other hand, most individuals seemed to be immature according to their SCL. Even in the nesting season, more than half of turtles were assumed as immature, while the rate

differs in each year. So, mature females that would nest at the season alone cannot explain the relatively high frequency of appearance from March and the decrease in August. Seasonality in this study area would be occupied by immature appearance. Many immature turtles also appeared from March to July, however, the most concentrated season was a bit differ each year, i.e. most concentrated season was from April to July in 2005 and 2010 and from December of preceding year to May in 2006 and 2007. In addition, the smallest SCL size class turtles, which were less than 60 cm, only appeared in May and April. There were no remarkable temporal changes of sex ratio and SCL distribution in this study period and this suggests that population framing would not change but immature loggerhead turtles also shows seasonal migration and the timing of migration and/or route will change by sea temperature where they use and probably the route of Kuroshio Current.

NEW ZEALAND WATERS, A POTENTIALLY IMPORTANT SUMMER FORAGING AREA FOR WESTERN PACIFIC LEATHERBACK TURTLES, *DERMOCHELYS CORIACEA**

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There have been occasional reports of the critically endangered Pacific leatherback turtle, *Dermochelys coriacea* in New Zealand waters since 1892. Previous records suggest occurrence around both North and South Islands from 35ºS to 47ºS with a concentration in the northern part of North Island during the austral summer (January-March). Despite being listed as Native Migrant under the New Zealand Threat Classification System, there is no systematic collection of data or protocols for dealing with sightings and strandings in New Zealand. Recent published information on satellite tagging from the South Pacific nesting beaches (Solomon Islands and Papua New Guinea) show that some turtles from these beaches migrate to New Zealand waters and exhibited area restricted search behaviour implying feeding. In addition these turtles then moved north during the austral winter into warmer subtropical waters and returned the following summer. This is a similar pattern to that exhibited by leatherbacks in the Atlantic Ocean and North Pacific where it has now been established that the high latitude areas serve as important summer foraging areas where the leatherback turtles feed on jellyfish. Support from the Leatherback Trust has recently facilitated field work that included interviews with commercial and artisanal fishermen, marine tourism operators, researchers, government conservation and fisheries officials, museums, aquaria, and coastal indigenous communities to collected additional information on sightings and strandings. In addition tissue samples were collected for DNA analysis and limited necropsies were performed. This new information is substantiating the satellite tagging information that New Zealand appears to be an important area for leatherback turtles. During this field work community and school awareness programs were carried out that has increased awareness and is now yielding additional information on leatherback turtles in New Zealand. This paper will report on the spatial and season distribution correlated with oceanographic conditions, size, feeding habitats, population affinity (DNA analysis), and threats. Additionally, recommendations will be made for future documentation, research, and efforts to ensure conservation of these foraging leatherback turtles in New Zealand waters.

TWICE-A-DAY FORAGING MIGRATION OF JUVENILE GREEN SEA TURTLES IN YAEYAMA ISLANDS, JAPAN*

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In many studies on feeding ecology of marine animals, the stomach contents and stable isotope analyses have been popular. Using these methods, however, it has been difficult to monitor when, where and how long marine animals feed preys. By using bio-logging techniques, in this study, we investigated when, where and how long the feeding event occurs of the juvenile green sea turtles at Yaeyama Islands, Japan. We conducted the experiments on July 2009 and July and August 2011, and used 15 juveniles in total (two individual in 2009, 13 individuals in 2011). In 2009, the turtles were attached the acceleration data logger (M190-D2GT, Little Leonard Ltd.) on their heads, and the speed, acceleration, magnetism and depth data logger (W1000L-3MPD3GT, Little Leonard Ltd.) with time-scheduled release system (Little Leonard Ltd.) on their carapaces. In 2011, the turtles were attached the Fastloc-GPS and depth data logger (Mk10-FB, Wildlife Computers Ltd.) and video data logger (modified from GoPro Ltd.) with the time-scheduled release system on their carapaces. The turtles were released at the place where they had been captured before. At the scheduled time after the releases, the data loggers were automatically detached from the turtles by the time-scheduled release system, and then popped up to the sea surface. As the result of this study, we succeeded in retrieving the loggers and consequently obtaining 3-5-days of behavioral data from nine turtles (two individuals in 2009, seven individuals in 2011). Our result indicated that the turtles moved to the shallow waters (one to three meters) twice a day around 6:00 and 18:00, and from the video and acceleration data, they fed sea grasses there. The rest of the time, they rested or moved within the small range (<15km^2) in the waters outside of reef edge at the depth of 10-30 m. Video data logger indicated that turtles feed not only sea grasses, but also floating jellyfish. Our results demonstrated that the juvenile green sea turtles in the Yaeyama Islands undertake the foraging migration to the sea grass bed in the shallow waters of the nearshore area twice a day. Acknowledgments: We gratefully acknowledge travel support from Internatioal Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service, International Sea Turtle Symposium provided through the Symposium Travel Committee.

ASSESSING DYNAMICS OF AN IMMATURE HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) AGGREGATION IN PALM BEACH COUNTY, FLORIDA USING CAPTURE-RECAPTURE ANALYSIS*

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Statistical modeling can be used to investigate the dynamics of biological systems, and is especially useful for interpreting baseline data on rare or wide-ranging species where direct observation is limited. Hawksbill turtles (*Eretmochelys imbricata*) are a highly endangered, circumglobally distributed marine turtle species that exhibit geographically distinct life stages. Though no significant nesting occurs in Florida, recent in-water studies have documented robust aggregations of sub-adult hawksbill turtles residing on the nearshore coral reefs of central and northern Palm Beach County. Capture-recapture data collected over a six-year period were examined with Pollock's robust design. Five candidate models were created to estimate parameters including survivorship, detection probability, abundance, immigration, and emigration. Additionally, a geographic information system was used to estimate aggregation density. The model estimated the emigration parameter to be 0.57±0.11 (values are estimated mean ± SE). The immigration and survival parameters were estimated at 0.77±0.16 and 0.79±0.14 respectively, representing an overall increase in abundance. This research represents one of the few comprehensive studies conducted on this species in Florida and it provides important baseline data on the dynamics of a high-latitude aggregation of hawksbill turtles.

FEEDING ECOLOGY OF THE BLACK TURTLE (*CHELONIA MYDAS AGASSIZII*) DURING AN IN-WATER MONITORING PROGRAM AT "BAHIA PARACAS", PERU

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Bahia Paracas is considered one of the most important black turtle (*Chelonia mydas agassizii*) feeding areas in the South East Pacific. Sea turtle fishery is a traditional practice in the area and currently turtles are still captured. Because of the importance of this area, efforts are needed to know turtle's feeding habits. The black turtle diet could reflect food availability present in the environment. Items consumed can indicate feeding preferences in the area. Since March 2010, the project "Sea turtle Occurrence, Biological Parameters and Feeding Ecology in the Pisco area" has been developed by IMARPE. As part of the project we collected and analyzed the last consumed items obtained by means of esophageal lavages performed in 23 from a total of 75 caught turtles. Frecuency of occurrence (%FO) of all items consumed were obtained as follows: Chlorophyta (78%), Rhodophyta (30%),

Cnidaria (43%), Crustaceans (43%), Polichaeta (17%), Mollusca (17%), Sand (26%) and Plastics (17%). The algae were highly represented in the samples (95.65%) highlighting the presence of *Ulva* sp. and Rhodophiceas, followed by animal matter (82.61%) which include mostly cnidarians. Moreover, marine debris (43%) were also reported, and probably ingested accidentally. The aim of this on-going research project is to provide black turtle feeding ecology framework in order to intensify conservation efforts and management plans for this species on feeding areas. In addition in this work, diet was analyzed from live individuals that were compared with the food availability inside the bay. This is the first time that this kind of research is been carried out in detail in a systematic way.

SPATIAL AND TEMPORAL VARIABILITY ON ABUNDANCE AND SOMATIC GROWTH DYNAMICS OF IMMATURE GREEN TURTLES AT CULEBRA, PUERTO RICO

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The understanding of population dynamics and demography is essential for the evaluation of population trends and the subsequent conservation of sea turtle populations. We investigated the somatic growth rate dynamics of immature green turtles *Chelonia mydas* in two foraging grounds from Culebra, Puerto Rico: Tortuga Bay and Puerto Manglar, through the analysis of 14 years (1997 – 2011) of mark-recapture records. The dataset included captures of recruits with sizes starting at 25.05 cm in straight-carapace-length (SCL), up to subadult turtles, with a maximum of 83.6 cm SCL. The effects of foraging site, mean SCL, sampling year, growth interval and the presence of fibropapillomas on growth rates were investigated through non-parametric regression modeling approaches. Population abundance at each foraging ground was estimated using recapture probabilities from a Cormack-Jolly-Seber model in a Horvitz-Thompson type estimation procedure and compared with the sampling year specific growth rate function to test for density-dependent growth rates. Foraging site and mean SCL were the predictors that best explained growth rate variance. Absolute growth rates ranged from 0.39 to 11.09 SCL $cm.yr^{-1}$, with a mean of 4.160 ± 1.60 $cm.yr^{-1}$ at Tortuga Bay and 6.11±1.76 $cm.yr^{-1}$ at Puerto Manglar. Puerto Manglar had significantly higher mean growth rate than Tortuga Bay, and the highest mean somatic growth rate described so far for green turtles. This spatial variability on growth rates is probably attributable to site ecology and habitat quality. The expected size-specific growth rate function was monotonic at both sites, with growth rates declining continually with SCL. At Tortuga Bay there was a significant effect of sampling year on the growth rate function, with two periods of decline on growth rates which immediately preceded two peaks of higher population abundance, in 2001 and 2008, suggesting that this aggregation might be under a density-dependent effect on the growth rate. The population abundance in Puerto Manglar peaked also in the years of 2001 and 2008; however, the mean annual growth rate did not change significantly at this site. The growth dynamics found in this study are similar to that of immature green turtles from the Bahamas, whereas the estimated absolute growth rates are comparable to those of immature green turtles from both the Bahamas and Florida, while much higher than those found in Australia, Hawaii and the Gulf of California, giving further

support for a clear-cut difference on the somatic growth of the green turtle between the Atlantic and the Pacific ocean basins.

IMMATURE HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) FEEDING AROUND ABROLHOS PARK, SÃO PEDRO AND SÃO PAULO ARCHIPELAGO AND ARVOREDO RESERVE, BRAZIL

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We studied immature hawksbill turtles at three feeding areas in Brazil: Abrolhos National Marine Park, São Pedro and São Paulo Archipelago (SPSP) and Arvoredo Biological Marine Reserve, by in-water observation and hand-capture through snorkeling. We captured 65 (CCL 24.5 to 63, mean 37.9 cm), 15 (CCL 30 to 75 cm, mean 53.7 cm) and 6 (CCL 30 to 59.5, mean 41.3 cm) individual hawksbills at Abrolhos, SPSP and Arvoredo, respectively. Through photo-id of facial profiles in dives, we identified 50 animals and registered maximum permanence of approximately 9 months for Abrolhos and 8 for SPSP, and though recapture registered permanence of 10 months at Arvoredo. We observed feeding activity on sessile benthic invertebrates at all areas (mainly zoanthids and sponges), and cleaning associations with reef fish *Elacatinus figaro* at Abrolhos, the endemic *Stegastes sanctipaul* at SPSP, and juvenile *Pomacanthus paru* at Arvoredo. This work is a result of expeditions intended for tissue and carapace sampling for genetic (mtDNA) and stable isotope (^{15}N:^{14}N and ^{13}C:^{12}C) analyses of the areas. Alongside samples provided by Project Tamar-ICMBio (from shores of Bahia and Ceará state, northeast Brazil) and Núcleo de Educação e Monitoramento Ambiental (from Cassino Beach, south Brazil), and combined with data on surface ocean currents (drifter and particle models), we will create a biophysical model of connectivity and migrations between our study areas and other hawksbill feeding/nesting areas in the Atlantic Ocean.

FEEDING ECOLOGY OF THE GREEN TURTLE (*CHELONIA MYDAS*) AT ROCKY REEFS IN WESTERN SOUTH ATLANTIC

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Feeding ecology of green turtles, *Chelonia mydas*, was studied with use of observational sessions (n=1521) and captures (n=177) at the rocky reefs of Arvoredo Island (27°17'S 48°18'W, southern Brazil) in summer (2005 to 2008), winter (2005 to 2008) and autumn (2007 and 2008) seasons. The juvenile turtles use the area for feeding, with some degree of residence and fidelity to resting and feeding sites. Their behaviour was influenced by water temperature, which was positively correlated with feeding and negatively correlated

with resting. Turtles selected particular seaweeds and coelenterates among those available in the studied area. They showed a mixed diet although the red seaweed *Pterocladiella capillacea* predominated in most samples. Turtles were concentrated in the shallow portions of the studied rocky reef (0-5 m), where most feeding occurred. Grazing sites were usually situated in the shaded portions of almost vertical rock walls with high seaweed diversity. The suggestion is made that green turtles maintain "grazing plots" of tender algal blades by periodically cropping the tips.

CHARACTERIZING JUVENILE GREEN TURTLE (*CHELONIA MYDAS*) SEX RATIOS IN EAST CENTRAL FLORIDA: PRELIMINARY RESULTS

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The Intergovernmental Panel on Climate Change (2007) reported that 11 of the 12 years from 1995 to 2006 were classified as having the highest global surface temperatures ever recorded. With a predicted 6°C increase in temperature by 2090, many organisms will have to adapt in order to survive. Organisms exhibiting temperature-dependent sex determination (TSD) have become a research priority, due to the dependence of offspring sex ratios on environmental conditions. Sea turtles have existed for millions of years and may exhibit various strategies to cope with environmental changes, but the accelerated climate change occurring may pose additional challenges. Mixed results have been observed with regards to higher sea surface temperatures and green sea turtle nesting phenology off the Atlantic coast of Florida, but little else is known about additional effects climate change may have. Each life history stage offers research opportunities, with numerous studies focusing on hatchling sex ratios. Studies have found that sex ratios of hatchlings can change seasonally and annually, therefore there is considerable variation in sex ratios at the hatchling-level. Additionally, few hatchlings survive to adulthood, so ratios obtained from hatchlings may not reflect the adult ratios. Alternatively, juvenile populations in developmental habitats have been found to constitute multiple cohorts from an accumulation of years. Since these developmental areas consist of multiple age cohorts, a snapshot of the juvenile sex ratio provides information about sex ratios from several years of nesting. The objective of this study is to characterize the sex ratio of juvenile green turtles in two developmental habitats investigated as far back as the late 1980s. The two habitats are located on central Florida's east coast, in the Indian River Lagoon (IRL) near Sebastian Inlet and in the Trident Submarine Basin at Port Canaveral. Samples for testosterone analysis through radioimmunoassay (RIA) were collected at both sites from 1995-1997, revealing extremely female-biased ratios of 5.27 females to 1 male in the IRL and 5.71 females to 1 male in the Trident Submarine Basin. Ten years prior, in 1987 in the IRL, a sex ratio study on juvenile greens was also done exhibiting a ratio of 0.9 females to 1 male. The highly female-biased ratio after just ten years raises questions, especially in light of climate change. Blood samples from juvenile green turtles at both locations were collected beginning in fall 2011 and will be collected through fall 2012. Testosterone levels will be determined through RIA and analyzed with a replicated G test goodness-of-fit. Preliminary results comparing sex ratios to those from the 1990s will provide information on how sex ratios have changed over the past decade. Having long-term information on the juvenile population is critical to understand how to effectively conserve the green turtle. Acknowledgments: Attendance of CLS to present this work at the 32nd International Sea Turtle Symposium was funded in part

by International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and the International Sea Turtle Symposium.

COMPARATIVE SURVIVAL OF IMMATURE LOGGERHEAD TURTLES (*CARETTA CARETTA*) AND GREEN TURTLES (*CHELONIA MYDAS*) AT THE FLORIDA POWER AND LIGHT ST. LUCIE PLANT, FL, USA

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Concerns over the status of loggerhead sea turtle (*Caretta caretta*) populations in the United States have been raised due to a dramatic decrease in nest production between 1998 and 2004. On the other hand, green turtle (*Chelonia mydas*) nest production has increased exponentially in the southeastern United States during this time. One possible explanation for this disparity is differential survival in the immature neritic size classes. More reliable estimates of annual survival rates of immature turtles is one of the vital rates called for by the 2008 Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle. However, very few reliable estimates currently exist in the literature for immature loggerheads and green turtles and none based on mark-recapture analysis are available for populations located in the state of Florida. Reliable survivorship values for all life stages are necessary for population viability analysis of both species. For this study, immature loggerhead and green turtles captured at the Florida Power and Light St. Lucie Plant, FL by Inwater Research Group Inc. were subjected to a mark-recapture analysis using Program MARK. The objective of the mark-recapture analysis is to provide estimates of annual survival for the two species living in near-shore habitats along south Florida's Atlantic coast. Barker's model was used to elucidate patterns in survival and movement through the use of competing model sets. Turtles for this study were captured between 2002 and 2010. Loggerheads greater than 85 cm and green turtles greater than 83 cm were considered adults for the purpose of this study and were excluded from the analysis as they are not resident in the area and few if any recaptures are available. Input for the models included recaptures, live-resightings and dead recoveries. Captures were broken down into two categories: those that occurred during a designated primary capture period (July-October) and those that were seen during the remaining eight months of the year (November-June). Individuals captured outside the primary sampling period, as well as data from turtles observed alive in the interval between primary periods, are included in the models as incidental captures. All available information on dead recoveries is also included in the models. The results of these analyses provide valuable information that can potentially be used to explain differences in population trends seen at the level of adult females on nesting beaches and for future population viability analysis. Attendance of the 32nd ISTS was funded in part by the University of Central Florida, the University of Central Florida Marine Turtle Research Group, the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service.

TESTS OF STABLE ISOTOPE PREMISES ARE NEEDED FOR MARINE VERTEBRATES: A CASE STUDY WITH LOGGERHEAD TURTLES IN THE GULF OF MEXICO

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Stable isotopes are being increasingly used to infer pre-nesting movements and habitat use of nesting marine turtles. While this may be a promising technique, there is a substantial need to corroborate stable isotope applications by pairing this technique with satellite telemetry, which is a more definitive means to track turtles, albeit the data reflect movements after nesting. We provide definitive tests of assumptions for stable isotopic analysis in an ecological study of 86 loggerheads (spanning 6 years, adult size classes from 80 to 116 cm, latitudes from 17 to 30 degrees, and oceanic to neritic foraging grounds) tracked via satellite telemetry in the Gulf of Mexico. Several animals were tracked repeatedly to derive confirmations of trophic status. Our findings do not fully support the general predictions of marine isotope studies to date and suggest that marine systems may involve more complexity than would allow for the use of isotopes to reliably track turtles at fine spatial scales. Our results may also be cofounded by polymodal foraging or individual specialists in a generalist population. There are considerable challenges to craft a new explanation for isotopic gradients and a lack of adherence to hypothetical patterns. These factors may include complexities shaped by temperate vs. tropical latitudes, neritic vs. pelagic marine environments, areas of nitrogen enrichment and dead zones, and ontogenetic differences in size or diet preference.

URUGUAY, A PERMANENT FEEDING AREA FOR MARINE TURTLES: 12 YEARS OF STRANDINGS DATA

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Here we analyse the presence seasonality of marine turtles in Uruguayan waters, including the Rio de la Plata estuary and the Atlantic zone, based on 12 years of stranding data (1999-2010) and 1107 records. Since 1999, marine turtle strandings in the Uruguayan coast were collected by a stranding network ran by Karumbe (n=886 turtles). Moreover, since 2006, systematic beach surveys were conducted by Karumbe's technicians at the Department of Rocha (n=221 turtles recorded). The species recorded were the green sea turtle (643, 58.08%), the loggerhead turtle (329, 29.72%), the leatherback turtle (131, 11.83%), three hawksbills (0.27%) and one olive ridley (0.09%). Different age classes were registered for each species: For green turtles, all the individuals were juveniles (mean±SD curved carapace length, notch to tip [CCLn-t] = 41.53±7.476 cm; range: 25.7-94.5, n=538), with the

exception of one individual that measured CCLn-t = 94.5 cm. For loggerheads, most were large juveniles and adults (CCL = 72.57±15.362 cm; range: 10.3-114.6; n=203), and the same for leatherbacks (CCL= 139.41±11.1 cm; range 110.5-160; n=53). No significant differences were found in size distribution among years, months, or zones in which the Uruguayan coast was divided for the study: Zone 1 (inner estuarine area), zone 2 (outer estuarine area) and zone 3 (Atlantic Ocean influence area). Strandings density (number of marine turtles by 10 km of coastline) maps were created for the three main species for the study period and per season. Most of the strandings registered by the network occurred in zone 2 (n=261) and zone 3 (n=582). In zone 1 only 32 turtles were recorded. Although occurring year round, stranding records show a clear seasonal pattern. For the three main species we found significant differences in monthly patterns between zone 2 and 3 (Mann-Whitney U=46789.5; p<0.0001), higher frequencies of stranding in the zone 3 were registered during the warmest months (November-April). However, in zone 2, higher frequencies were registered during austral fall (March-June). Particularly green turtles were registered all year round in zones 2 and 3. The loggerhead turtle is present during the entire warm season but quite scarce during the coldest months (Jul-Oct). Leatherback records exhibited high variability among years, with stranding peaks appearing in January in zone 3, and in April and May in zone 2. No leatherback records were registered in August and September. Strandings distribution may be influenced by environmental and/or anthropogenic factors. The main causes associated with strandings in this area were marine debris ingestion (principally for green turtles), fishery interaction (green turtles, loggerheads and leatherbacks) and hypothermia (green turtles) among others. Data collected suggest that, despite a clear seasonality, some marine turtles, most under development, stay all year round in the Uruguayan coastal waters. Although inferences from stranding data are subject to a number of caveats, when integrated over wide spatio-temporal extents, they can provide information about geographic ranges, seasonal distribution, and life history of marine turtles in critical feeding and developmental areas, such as the Uruguayan waters.

DO NUTRITIONAL AND DIETARY SHIFTS EXIST AMONG IMMATURE, NERITIC GREEN TURTLES, *CHELONIA MYDAS*, IN ST. JOSEPH BAY, FLORIDA?

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Recent developments in open water research have refined our understanding of green turtle, *Chelonia mydas*, foraging ecology, but diet characterization among populations remains understudied. Previous hypotheses state that once young green turtles recruit to shallow water habitat they shift rapidly from an omnivorous to herbivorous diet. These hypotheses rest on the assumption that the timing of ontogenetic dietary shifts and diet variation are rigid and unidirectional. Supporting evidence has primarily been derived from traditional gut content analysis that only provides a small window in time to perceive the diet of an animal. In contrast, stable isotope analysis explores how a consumer uses its resources over a

broad temporal scale to determine the contribution of prey items to a consumer's diet. We tested the dietary shift hypothesis using gut content and stable isotope analyses to assess the nutritional ecology of a juvenile green turtle aggregation in the northern Gulf of Mexico. We examined the gut contents of 65 green turtles collected from 2008 and 2011 hypothermic stunning events in St. Joseph Bay, Florida. Gut contents were evaluated using volume, dry mass, percent frequency of occurrence, and index of relative importance (IRI). The immature St. Joseph Bay green turtle aggregation showed an omnivorous feeding behavior, feeding on a variety of animal and vegetal items with a bias towards seagrass and tunicates. In addition, we examined the effect of green turtle body size on diet variation. We measured the stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope values in skin of 43 green turtles, ranging from 22.5 to 72.7 cm in curved carapace length (CCLmin), and eight known prey items (e.g. algae, seagrasses, invertebrates) collected in 2011. Our study provides a foundation for characterizing the foraging ecology of green turtles in St. Joseph Bay, and highlights the value of utilizing isotopic ecology for further foraging studies.

POPULATION STRUCTURE, HABITAT USE, AND GENETIC IDENTITY OF A DEVELOPMENTAL FORAGING AGGREGATION OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) ON THE SOUTHEAST FLORIDA CONTINENTAL REEF TRACT*

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This study was conducted off Palm Beach County, Florida, USA, along approximately 30 linear km of the Southeast Florida Continental Reef Tract. Between 5 April 2004 and 22 October 2010, a total of 435 SCUBA dives were made during all months starting at any one of 44 dive initiation sites. Dive initiation sites were plotted on LADS and benthic habitat maps that are available for the area. Bottom types and depths at sites of capture were recorded by the divers to further elucidate habitat use by hawksbills. Hawksbill turtles were observed 340 times. Straight carapace lengths of 146 turtles ranged at first capture from 35.7 to 83.9 cm SCLn-t. Capture of 146 individuals provided data on population structure, seasonality, growth rates, and movements. Observation records (captures, recaptures and re-sightings) suggest that individual turtles may remain in the area throughout the year. A 740 bp mitochondrial nucleotide sequence was generated for 112 different individual hawksbills, all of which were assignable to Abreu-Grobois standards. Seventeen different "long haplotypes" were represented and suggest that hawksbills residing in the study area are mostly from a single source area. This study provides evidence of a significant foraging aggregation of hawksbills in continental US waters and suggests that hard-bottom habitats along the coast of Florida may provide important habitat for this Critically Endangered species. Proximity of the study site to the Gulf Stream Current may explain the presence of this aggregation at a relatively high-latitude location.

Nesting Biology and Monitoring

MOON AND TIDES: THEIR ROLE IN GREEN TURTLE NESTING IN GUANAHACABIBES PENINSULA, CUBA

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We determined the influence of two abiotic factors: moon phases and tides on the nesting of the green turtle, *Chelonia mydas,* of Guanahacabibes Peninsula, located near at the westernmost point of the Cuban Archipelago. We compared the number of female visits to the beach with the succession of moon phases, considering the moonrise time. The highest frequency of females was produced mainly during the full moon, especially if it was the female's first egg laying episode of the season. Also, the frequency of sightings was higher during the period when the moon was most visible, sometimes three to five hours after the moon rose, except for the new moon which rises during the diurnal period. We also compared the number of visits by females during the different tidal periods. Most of the sightings took place during the period of the rising of the tide, suggesting that females are taking advantage of its transporting effect.

RELATING SEA SURFACE TEMPERATURE TO THE NESTING PHENOLOGY OF HAWKSBILL SEA TURTLES (*ERETMOCHELYS IMBRICATA*) AT BUCK ISLAND REEF NATIONAL MONUMENT, ST. CROIX, U.S. VIRGIN ISLANDS*

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Sea turtles, as ectotherms, are especially sensitive to the temperature of their environment. Previous studies of loggerhead sea turtles (*Caretta caretta*) and green sea turtles (*Chelonia mydas*) have documented the relationship between sea surface temperatures and nesting phenology. Earlier nesting behaviors in both species have been associated with warmer sea surface temperatures. There are gaps in knowledge in the relationship between sea surface temperature (SST) and the nesting phenology of marine turtles, with two of seven marine turtle species studied. In this study, we analyzed a 23-year (1988-2011) dataset of hawksbill sea turtles (*Eretmochelys imbricata*) nesting at Buck Island Reef National Monument, St. Croix, USVI (an important rookery for the endangered hawksbill sea turtle) and sea surface temperatures (SST) from the adjacent Caribbean Sea, in order to predict their response to future sea surface temperatures associated with climate change. Daily nest surveys for the sampling window consistent in all survey years from 1988 to 2011 were used in the analysis. Ordinal dates within the survey time frame were weighted by nest number, and standard statistical descriptors (e.g. mean, median, mode, standard deviation) have been used to characterize hawksbill nesting frequency for the annual sampling window. Nesting season

dispersion was measured by standard deviation instead of season start and end dates, because hawksbill nesting has been recorded during every month of the year. Sea surface temperature data was obtained for the years of 1988 to 2011 using the Reynolds Optimally Interpolated SST dataset which is derived using both in situ data from buoys and AVHRR satellite data from the Physical Oceanography Distributed Active Archive Center (PO.DAAC) available through the NASA Jet Propulsion Laboratory. The temporal and spatial resolutions used were monthly at 1°, respectively. We evaluated changes in phenological metrics over the 23 year period (1988-2011) and a linear regression analysis was used to evaluate whether the phenological metrics relate to monthly SST measures and nest numbers following prior studies to allow for comparison. In analyzing this long term data set, we extend research on the effects of climate change to hawksbill sea turtles as well as the Caribbean. An understanding of the relationship between nesting phenology and SST will allow managers to consider whether phenological responses to SST will ameliorate or exacerbate the female-biased sex ratios of hatchlings associated with warmer nest temperatures as well as how to best respond to nesting season overlap with hurricane seasons, which are predicted to become more intense and frequent with climate change.

CHARACTERIZING THE INTER-NESTING BEHAVIOR OF LOGGERHEAD TURTLES (*CARETTA CARETTA*) AT KYPARISSIA BAY, GREECE*

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The second most important loggerhead turtle (*Caretta caretta*) rookery in the Mediterranean Sea is found along Kyparissia Bay, Greece. Recently, the number of nesting females at this site has begun to increase, however, so has the local human activity, tourism, and beach development. There is currently no governmental protection of this rookery's beaches or bay habitats. Understanding of the habitat usage of loggerhead turtles will help guide potential conservation efforts. Inter-nesting behavior of loggerhead turtles was studied with temperature and depth loggers (TDLs) along with radio transmitters deployed on 10 nesting turtles at Kyparissia Bay. TDLs were recovered when the turtle returned for subsequent nesting attempts. All of the radio transmitters provided locations, and three TDLs were recovered. The turtles maintained a relatively constant thermal habitat, with average temperatures of 24.8 (±1.3 SD), 25.4 (±1.4 SD), and 27.6 (±0.9 SD) °C. Minimum temperatures experienced by the turtles were never lower than 18.5 °C, while maximum temperatures experienced were 28.2, 28.7, and 30.4 °C. The turtles spent 94.5%, 99.7%, and 95.1% of their time in the top 4 m of the water column (Turtle 1 average depth 1.68 m, ±1.44 SD; turtle 2 average depth 0.73 m, ±0.62 SD; turtle 3 average depth 2.15 m, ±1.30 SD). Less than 1% of all dives were deeper than 10 m, with maximum dives likely limited by the bathymetry of the area (turtle 1 and 2 max depth 21 m, turtle 3 max depth 36 m). The radio transmitter data showed 84% of contacts were within 2 km of the primary nesting area. Furthermore, only 2 of 114 recorded contacts came near the mouth of the relatively busy Kyparissia Harbor. In summary, the loggerhead turtles of Kyparissia Bay spend the majority of their inter-nesting period close to the primary nesting area in the upper portion of the water column. This presentation was made possible by the generous support of the International Sea Turtle Symposium, International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries

Service. I would also like to thank Aliki Panagopoulou and Dr. Jim Spotila for continued assistance.

MARINE TURTLE NESTING AT THE ARCHIE CARR NATIONAL WILDLIFE REFUGE, FLORIDA, U.S.A. IN 2011: 30 YEARS AND COUNTING. AN UPDATE, AND AN EXTRAORDINARY YEAR FOR GREEN TURTLES

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The Archie Carr National Wildlife Refuge spans two counties on the east central coast of Florida. The University of Central Florida's Marine Turtle Research group has been conducting surveys and studying sea turtles on the 13-mile stretch of beach in South Brevard County since 1982. In 2011, the nests laid in these 13 miles accounted for about 26% of the Florida loggerhead nests, 49% of the Florida green turtle nests, and approximately 6% of the leatherback nests in the state of Florida. Annual loggerhead nest production averaged 9,300 nests during the decade of the 1980s, prompting the creation of the Carr Refuge in 1990. Nesting continued to increase during the 1990s, reaching an all time high of 17,629 nests in 1998. Nest numbers fell over the next six years, to 7,599 in 2004. The next two years were slightly elevated, before falling to an all time low of 6,405 in 2007. Nest numbers have increased since then, and averaged about 9,488 for the most recent decade, similar to that seen in the 1980s. The 2011 season produced 10,885 loggerhead nests. We feel that the decline has leveled off and are optimistic that there will be increased loggerhead nesting in the future. For the first three years that the UCF group worked in South Brevard County, there were fewer than 50 Florida green turtle nests per year, but nesting has been rising exponentially since that time. Adhering to a biennial pattern, nesting increased dramatically during the "high" years, but "low" years remained at fewer than 200 until 2003, when nesting also began to increase in the "low" years and, with a shift in 2008-2009, the biennial pattern has all but disappeared. For the first time, the record-high green turtle nesting season in 2010 (4,095 nests) was followed by an even higher season in 2011, with 5,505 nests. Chaloupka et al., (2007) reported that the rate of increase for the Carr Refuge green turtle population is 13.9% per annum; more than twice that of five other major green turtle nesting populations. Leatherback nesting at the Carr Refuge also continues to rise exponentially, although the numbers remain low when compared to most other leatherback nesting beaches. During the decade of the 1980s and the first half of the 1990s, nest production was at zero to two nests. In 1996, for the first time, the UCF group counted 10 nests. Nest numbers in the "high" years continued to increase, reaching a high of 52 nests in 2007, while nest numbers in "low" years remained at 11 or 12 until 2008, when a "low" year produced 20 nests. A change in the nesting pattern occurred in 2009-2010, removing the biennial appearance. The 2011 season finished as the second highest for leatherbacks with 51 nests.

FILLING THE GAPS: A NESTING STUDY AND CONSERVATION STRATEGY ON GHANA'S WEST COAST

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From August 2011 to March 2012, preliminary studies were carried out to establish the current status of nesting sea turtle populations around the small township of Beyin (located on the western coast of Ghana, close to the border with Côte d'Ivoire). Previous studies have found that three main species of turtles nest in Ghana: olive ridleys, greens, and leatherbacks. For locals, sea turtles are generally regarded as nothing more than their next meal; however there have been some turtle conservation efforts attempted in the Western Region by foreign-owned hotels and businesses as a combined tourist attraction and conservation effort. While these efforts are well-intended, minimal nesting data has actually been documented. Our initial research was conducted with aim to fill the data gaps and use the surveyed nesting beach as an index for the region while simultaneously connecting local people with conservation. Nesting frequency, species type, emergence tracks, clutch size, and hatching success data were recorded on a 10 km stretch of beach in Beyin. Standard methodologies were used in morning and night surveys, and 100% of nests found on night surveys were relocated to nest boxes in the hatchery in effort to protect the eggs from poaching. In addition to the known three species, hawksbills were positively identified and loggerheads were reported (yet-unconfirmed); these two species have not been recorded here for over 25 years. This initial single-season data set will be used as a base on which to build the intended index for the region. While survey data was collected and recorded it became evident that further conversational efforts are warranted and essential based on the prevalence of poaching as well as the local people's positive reaction to initial conservation efforts. Over the coming years, the intention is to cooperate with established regional businesses to create a more thorough and scientific approach to sea turtle conservation by using standardized methods and a central database, and incorporate locals into specific project related roles and improving project-community relations.

FIRST REPORTS FOR NESTING OF SEA TURTLES AT BOBALITO BEACH, NECOCLI (COLOMBIAN CARIBBEAN) DURING SEASON 2011

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The Bobalito Beach is located at the south of the Colombian Caribbean, along the eastern margin of the Uraba Gulf in the Department of Antioquia. This beach (12.7 km long) is part of a Regional Protected Area and is currently considered an important nesting area for the leatherback sea turtle (*Dermochelys coriacea*) and the hawksbill sea turtle (*Eretmochelys imbricata*), although the local community has reported the loggerhead sea turtle (*Caretta caretta*) and the green sea turtle (*Chelonia mydas*). The conservation activities are an initiative by the community to protect the coastal and marine resources for the next generations, with a special attention for sea turtles as the community poached close to 100% of nests and females in the past. This initiative was initiated in 2006, but it was not until the year 2009 and 2010 that the local community started the protection of the nests. In 2011 the project became supported by Regional Environmental Authority (Corporation for the Sustainable Development of the Uraba – CORPOURABA) and Conservacion Ambiente Colombia Foundation to strengthen the involved personnel. The priority was set on capacity building for sea turtle monitoring, to improve acquirement of information. The project team conducted a sea turtle monitoring program on nesting activity at the Bobalito Beach including a) Track count data, b) Biometry data, c) Tagging data for Chelonidae, d) Protection of nests. Unfortunately due to lack of resources, trained scientific supervisory personnel could not be maintained and could not be based full-time. Our activities focused on three sectors along the Bobalito Beach between March and November of 2011 to determinate the importance of these nesting sites. During our surveys, we encountered 169 nests for leatherbacks, 27 hawksbills and 4 green turtles, while no nests were reported for loggerhead. The average curve carapace length of leatherbacks was 1.62 m, they lay on average 106 eggs per clutch and their average incubation period was 60 days. The most important month to nesting activities for this specie was April, while the nesting period lasted from March until August. The average curve carapace length for hawksbills was 89.5 cm; they lay on average 142 eggs per clutch and their average incubation period was 54 days. The most important month to nesting activities for this specie was July, starting in April until August. The main threats to sea turtles in this area include erosion, flooding, predation by wild animals and some sporadic events of poachers from neighboring communities (observed three times) and bycatch. To support the capacity building exchange program, the team received additional resources. Local participants contributed as assistant researchers in Green Turtle Program 2011 at Tortuguero National Park (Costa Rica) with support of Conservacion Ambiente Colombia Foundation, Sea Turtle Conservancy, Gulf and Caribbean Fisheries Institute and UNEP-CAR –RCU. We are analyzing data and experiences of this current season to

strengthen the management and monitoring program for the next season and complement the activities for environmental education focusing on children, younger and fishermen.

GUYS, GIRLS AND GLOBAL WARMING - PREDICTING HATCHLING SEX RATIOS OF THE FLATBACK TURTLE (*NATATOR DEPRESSUS*) IN WESTERN AUSTRALIA NOW AND IN THE FUTURE

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Population sex ratio is a vital demographic parameter for assessing the viability of threatened species. The sex ratio of species with temperature-dependant sex determination (TSD) depends upon temperatures experienced during incubation, which vary temporally and spatially. We used a mechanistic model to predict sand temperatures and empirical data to predict corresponding hatchling sex ratios in the flatback turtle (*Natator depressus*) along the western Australian coastline. As most physiological data on *N. depressus* has been collected from East Coast populations, we measured sex ratios under laboratory and field incubation to produce a sex determination function for the genetically distinct West Coast *N. depressus* population. Predicted sand temperatures were compared with nest temperatures measured in the field and were a good representation of average beach temperatures, but did not account for fine-scale variation in aspect, shade, sand density, reflectance and thermal conductivity. Sex ratios were predicted at three representative nest depths (400-600 mm), during five potential laying months (October–February), under the current climate. Eggs laid in October produced mainly males or male biased nests, with the exception of Cape Domett in the far north of Western Australia. In later months a higher proportion of mixed sex nests appeared in lower latitudes around the Dampier Archipelago, while a higher proportion of males were predicted along the Kimberley coastline. The effects of climate change on sex ratios in 2030 and 2070 under high and low emission scenarios were also examined, and an increased proportion of female biased nests were predicted. Laying earlier in the nesting season and at latitudes south of Exmouth, would appear to be the most effective behavioral adaptations for neutralising the female-biased sex ratios predicted under global warming.

DIFFERENTIAL NEST SITE SELECTION OF LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*) AT PACUARE NATURE RESERVE, COSTA RICA

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Leatherback sea turtles (*Dermochelys coriacea*) at Pacuare Nature Reserve, Costa Rica have been observed over the past ten years to preferentially nest in certain beach sections. The aim of our study was to test this general observation by comparing nesting activities and false crawls within and among sections of the 6 km beach that have been historically identified as “high” and “low” density nesting regions. Additionally, we related physical beach

variables (i.e., slope, width, sand grain composition, sand color composition, substrate water content, and temperature), near-shore parameters (i.e., bathymetry), and nest characteristics (e.g., nest depth, distance to vegetation, and number of eggs) to the hypothesized difference in nest preference using non parametric statistics and indirect gradient analyses. Between May 6th and June 6th 2011, 61 nesting and 25 false crawl events were intercepted. Our results suggested significant differences in nesting densities, with twice as many turtles observed nesting in high density areas as opposed to the low density areas, supporting 10 years of anecdotal evidence of nest preference at Pacuare. While we report no significant differences in many of the physical parameters measured (e.g., sand color, moisture content, nesting distance from mean high tide water line), high density nests were significantly farther away from vegetation than low density nests (11.49 m vs. 7.60 m, p=0.02). Most metrics typically reported for nesting turtles (e.g., curved carapace length and width, clutch size) were invariant relative to nesting density, though nest depth was significantly deeper in low density regions (78.56 cm vs. 71.00 cm, p=0.0007). Initial bathymetry analysis suggests that gently sloping regions of the surf zone and shallow offshore are correlated to higher nesting regions. Our research suggests that the critically endangered leatherback sea turtles of Pacuare Nature Reserve preferentially and differentially nest in specific beach regions that are related to physical and biological parameters of the beach and near-shore environment. This study provides an initial step into evaluating the potential for survival differences of nests placed in such a differential manner. This project and presentation was made possible by: Coastal Carolina University, National Science Foundation's GK 12 Program, Pacuare Nature Reserve, World Wildlife Fund, International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service.

USING LOCAL KNOWLEDGE TO TEST PATTERNS OF NESTING SEA TURTLES IN ADA FOAH, GHANA

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Environmental cues that trigger beach emergences by female sea turtles are still not fully understood. It is important to understand these because such behavior patterns may increase survival for either the nesting female or for the eggs and hatchlings. Understanding such survival differences could aid in future sea turtle conservation efforts. Historically, researchers have relied on local knowledge to aid their understanding of sea turtle biology. In this paper, we use four years of nesting data in Ghana to assess the accuracy of local knowledge regarding sea turtle nesting patterns and behaviors. Ada Foah, Ghana (and the surrounding area) harbors approximately 9 km of beach used by nesting leatherback and olive ridley sea turtles. Previous conversations with area residents indicate a commonly held belief that nesting females would only emerge if the moon were in the correct phase or position. Specifically, residents independently informed us that sea turtles emerge to lay eggs when the moon is closer to full and is positioned in the western sky. Residents also indicated the turtles required a high tide to emerge onto the beach. To determine the accuracy of their assertions, nesting surveys were conducted from August 2006 through 2010 to determine the tide, moon phase, and the moon's positions during each sea turtle emergence. Of the 1,507 emergences recorded in Ada Foah, 752 occurred while the moon was not visible. For those that nested under moonlight, a chi-squared analysis indicated a

significant preference for emerging near a full moon for both olive ridley (n=461, p<0.0001) and leatherback turtles (n=294, p<0.0001). While the moon location analysis indicates a significant difference from random (p<0.0001), there was not a single dominant cardinal direction. Neither species showed a significant preference for emerging during high or low tide (olive ridley n=929, p=0.4505; leatherback n=578, p=0.2441). While the local predictions did indicate a preference for emergence near a full moon, it is possible that residents are more likely to see and remember nesting sea turtles when there is more light available. Because of this, it is uncertain whether or not the residents of Ada Foah have made an accurate prediction. Further study is necessary to determine if local knowledge can help drive sea turtle research questions in the future.

MARINE TURTLE CONSERVATION IN SENEGAL

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Senegal has established a network of protected areas, most are nesting sites, food and/or migration corridors for six species of sea turtles (*Chelonia mydas*, *Lepidochelys kempii*, *Lepidochelys olivacea*, *Eretmochelys imbricata*, *Caretta caretta*, *Dermochelys coriacea*). The results obtained since 2009 are quite encouraging, including: a report on the inventory of marine turtles; an awareness kit, an identification guide and a database of turtles. Over 200 nests were monitored till hatching by staff of the national parks supported by local communities. However, knowledge of the distribution of these species and their abundance in Senegal is inadequate and does not allow defining appropriate measures for their conservation. Thus, Senegal, in addition to conventions and agreements signed, has set up an institutional and regulatory framework to reduce the threats to marine turtles and to take action for the protection and conservation of these endangered species. To this end, a national plan of action for the conservation of sea turtles was completed in 2011. This plan is based on a participatory approach to reduce the major threats identified and the improvement of knowledge. It will build on the initiatives and international best practice; identify strategic priorities and a framework for action for a good dynamic conservation of sea turtles. It will serve as a platform for dialogue between key stakeholders in the conservation of sea turtles in Senegal and will include a set of concrete measures.

FIRST REPORT OF SEA TURTLE NESTING ACTIVITY IN THE NORTH WESTERN COAST OF THE GULF OF VENEZUELA

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The Gulf of Venezuela (GV) has been considered a very important foraging ground for marine turtles along the Venezuelan coast, and highly important for the Caribbean region. Previous research in the GV has been focused mainly on sub-aquatic habitats (seagrass beds and coral reefs patches) due to the lack of information about possibility of nesting activities on beaches of this area. In 2005, the first record of nesting activity was made in Zapara Island (South GV), reporting a hawksbill turtle (*Eretmochelys imbricata*) nest. Later in 2009 and 2010, 4 hatchlings turtles (3 hawksbills and 1 loggerhead) were reported. Also, several authors have confirmed nesting of *Dermochelys coriacea*, *Caretta caretta* and *Chelonia mydas* in the area (Guajira Peninsula), reaffirming the importance of GV as a habitat of ecological and optimal value for the development of these reptiles and also as a potential area for nesting. Given all these historical and biotic characteristics in the GV, we describe new evidences of nesting activity between March and May 2011. Two beaches located in the northernmost region of the GV, which ends at the borderline with Colombia, were evaluated (North and South) in La Ensenada Malimansipa (11°32', 12°00' N and 71°08', 71°28' W). At each beach, morphological data were taken (length, height, presence of obstacles, coastal lagoons, among others) and every trace or nest found were counted and described (species, approximate time of nest creation, distance from nest to vegetation line, distance from nest to high tide line, and an overview of the tracks).The beaches north and south of Ensenada Malimansipa presented the basic and essential characteristics for the presence of marine turtle species listed above. North beach presented a total length of 1.23 km and South beach a total length of 0.86 km. These beaches have several rock formations along the coastline and represent the borderline and entrance to the Laguna de Cocineta. There were a total of 10 traces of nests (6 for *Eretmochelys imbricata*, 3 for *Dermochelys coriacea*, and 1 for *Caretta caretta*), at 2.09 km of beach, resulting in a nest density of 5 nests per km. Some threats for nesting activities were observed; natural erosion (due to strong waves and winds) and deposition of solid contaminants (plastics and metals) on the shore dragged by ocean currents and winds, represents the most influential threats. We can only speculate that the occurrence of these nest and traces in the northern Gulf of Venezuela are merely coincidental or an indicator of nesting beaches which were used by

sea turtles in the past. It is possible that these beaches were visited once by sea turtles, but due to a null specific monitoring program and non-continuous walks in these beaches, some of these events were not noted.

SEA TURTLE NESTING IN PRINCIPE ISLAND, WEST AFRICA

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The present study is an effort to fill the gap in the knowledge of sea turtle nesting on the Island of Príncipe; information needed for a sustainable management of the coastal areas. The island is mainly used by green sea turtles but there is also a small nesting population of hawksbills, very important in relation to West Africa region and only occasionally some leatherbacks nests. For the first time, annotations of the number of nesting activities, nesting habitat and threats were made in all beaches. The potential nesting area around the island consists of 50 beaches which add up to 10 km of suitable nesting habitat. Some beaches differ by a number of morphological and environmental characteristics. However, they also show similar degrees of accessibility by turtles, are relatively narrow when compared with green turtle nesting sites and are usually backed with a conjugation of lowland rain forest, coconut plantations and scarps. Sea turtles were found nesting in 32 of the beaches and showed a clear preference to beaches where human presence is low. Natural predators are not common but threats like human development and capture still exists. Recently, a legislation to stop sea turtle capture and commercialization came into force as a part of a larger development plan based on preservation of the local culture and nature. The study allowed estimating that 82 hawksbill clutches and 952 green turtles clutches were laid in Príncipe Island during the 2009/10 nesting season (September to February). By the inclusion of data from other nesting seasons the total female population size was estimated to be between 48 to 60 hawksbills and 518 to 554 greens. Annual female mortality in the nesting habitat was estimated from the data to be 19% for hawksbills and 11% for green turtles. It is essential to halt the extirpation of sea turtles on Principe Island, especially the genetically unique hawksbill population. This can be done by the integration of the local communities in their conservation. Aknowledgements: We are indebted to: Príncipe Regional Government; Archie Carr Center for Sea Turtle Research; Professors Carla Sousa and Teresa Borges; Norberto and his fishermen; Praia Seca community; the cook Dona Xica; the spear-fishermen Tachada, Gabriel, Nuno Kuto and Anastácio; Nhô Jó and his family; Portuguese Foundation for Science and Technology; Drs. Natacha Carvalho and Franscisco Leitão; International Sea Turtle Society; Western Pacific Regional Fishery Management Council; U.S. Fish and Wildlife Service; U.S. National Marine Fisheries Service; and the International Sea Turtle Symposium. This study will be submitted to a peer reviewed journal.

INFLUENCE FACTORS IN THE NESTING OF THE MARINE TURTLE IN MEXICO

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The Sanctuary Playon de Mismaloya (69 km), located between the municipalities of Tomatlán and Cabo Corrientes, Jalisco, Mexico in the Eastern Pacific, is one of the most important beach systems for nesting sea turtles. Five turtle camps are found within the sanctuary, which work towards population restoration. Every day the beach is patrolled on ATVs or walking. The length of the beach in each of the Turtle Camps differs, measured in kilometers by GPS or using the odometer of the ATV. Each kilometer is denominated as a station, each consecutive station being further from the Camp. The nests are found and relocated to protected incubation hatcheries; in this process the following field information is recorded: date, time of nest collection, station number, number of eggs, biometric data and particular observations. These activities are achieved from July to December of every year. This work was carried out in the following Turtle Camps: Majahuas-Sur, periods: 1997, 1999 to 2003, 9 kilometers of beach (19°50'16.61"N, 105°22'18.33"W); and Villa del Mar, period: 2006 to 2010, 16 kilometers of beach (20°13'37.08"N, 105°33'15.23"W). With the information recorded on these beaches, we analyze nesting incidence in each station. The data being used is for *Lepidochelys olivacea*. The statistical analysis is done for each camp, with the purpose of contrasting results from the different camps. Majahuas-Sur, has 5882 cases; of 6 years of records; the nesting incidence in each one of the 9 stations is with n=54; the correlation of nesting incidence among every year on the average is r=0.92853; it was found differences in the nesting incidence for each station (ANOVA one via) F8-45=5.949. Villa del Mar, has 761 cases; of 5 years of records; the nesting incidence in each one of the 16 stations is with n=80; the correlation of nesting incidence among every year on the average is r=0.08138; it was not found differences in the nesting incidence for each station (ANOVA one via) F15-64=0.576. Majahuas-Sur, has difference in the nesting incidence for each station, this means that the females nest every year in specific stations; we suppose that the cause is a high variation of characteristic morphophysiological in beach. In Villa del Mar, the nesting incidence is not specific, it occurs aleatorily in any station and we observe characteristic morphophysiological homogeneous in beach. We infer that the longitude of beach of each camp influences in those resulted, but we feel that the morphophysiological variations are the factor that impacts in the nesting. Majahuas-Sur has high morphophysiological variation, in a longitude of 9 kilometers; on the contrary Villa del Mar has characteristic morphophysiological homogeneous. To conclude; the morphophysiological variability in beaches attributes particularities to each beach that affects the nesting incidence. We give thanks to The Travel Committee of the Symposium and the financial assistance of the International Sea Turtles Symposium and especially to Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and International Sea Turtle Society to finance our assistance at the 32nd symposium.

ESTIMATION OF SURVIVAL FOR LOGGERHEAD SEA TURTLES NESTING ON CAPE VERDE USING MULTI-STATE MODELS WITH UNOBSERVABLE STATES

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Survival of adult females is the demographic parameter with deeper influence on population dynamics of sea turtles. Due to the elusive and complex life history of these megavertebrates, the estimation of adult survival is not appropriate using conventional demographic models. The better estimations are based on tagging and recapture of females on nesting beaches. However, females do not reproduce every year, non-breeder individuals are not present sampling breeding grounds and are, therefore, unobservable. It is impossible to catch all nesting turtles and though fidelity to the nesting beach is high, there is a significant large number of transients. For these reasons, some authors recommend the use of multi-state models with unobservable states. Mark-recapture data gathered during 10 years (1998-2007) in the Southeast of the island of Boa Vista (beaches of Caletha, Ervatao and Ponta Cosme) were used to estimate the adult survival and other demographic parameters on the loggerhead population of Cape Verde. This population has been considered by the IUCN in 2011 as one of the 11 world's most threatened sea turtle populations and the most threatened loggerhead population in the Atlantic. The fit of data to a multistate model was tested with modified single estate GOF test using program U-CARE. The results showed a strong heterogeneity, due to the abundance of transients and a trap-dependence effect on recapture, the latter related to the remigration interval. Forty-eight models were formulated, with a breeding cycle ranging from 2 to 5 years. The influence of time and transients on survival, and time and trap dependence on recapture, were studied. Models were fitted in program MSURGE. Due to over-dispersion in the data, detected by GOF test, model selection was based on lowest QAIC values that take into account the variance inflation factor in its estimate. The best model constrained the reproductive cycle to a maximum of 4 years, included the effect of transients on survival, and contained a time effect on recapture rates. The estimate of annual survival for adult females was 0.85 (SE=0.027). This result is similar to that obtained for the same species on South Carolina using multistate models, and higher than those obtained previously for the South-eastern coast of U.S. using life history tables and Cormack-Jolly-Seber open population models. Transition probability estimates were the same for several models permitting an estimation of a mean value of the remigration interval for the Cape Verde population of 2.46 years. The probability of nesting in two consecutive years was 1.2% (SE=0.005), of nesting after spending 1 year as a non-breeder was 59.2% (SE=0.04), and of nesting after spending 2 consecutive years as a non-breeder was 31.9% (SE=0.09). The 7.7 % (SE=0.49) of adult females skipped their reproduction more than 3 years.

PRIORITIZING MARINE TURTLE NESTING BEACHES IN SOUTHERN NICARAGUA'S PACIFIC COAST*

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The beaches in southwestern Nicaragua present appropriate conditions for the nesting of a variety of marine turtle species, including *Chelonia mydas* (green sea turtle), *Eretmochelys imbricata* (hawksbill turtle), *Dermochelys coriacea* (leatherback), all of which are critically endangered in the eastern Pacific; the endangered *Lepidochelys olivacea* (olive ridley) also nests at various beaches in this region. Since 2008, Paso Pacífico has led a program protecting sea turtle nesting beaches along southern Nicaragua's Pacific coast, primarily in the buffer zone of La Flor Wildlife Refuge (a major olive ridley nesting site); the beaches we are protecting have been shown to be particularly important nesting sites for green and hawksbill sea turtles. In May 2011, with the support of The Eastern Pacific Hawksbill Initiative (ICAPO) and the Danish Embassy, we carried out a survey using interviews with local community members to identify important nesting beaches found between La Flor and Río Escalente-Chococente Wildlife Reserve, two protected areas with olive ridley mass nesting sites; these two reserves are considered among the 7 most important olive ridley nesting sites in the world. Over 20 small (100-800 m long) beaches are found between these two globally important olive ridley nesting sites; the purpose of our study was to determine their importance for green and hawksbill turtle nesting. Unfortunately, at these sites over 70% of nests are poached in their entirety. Our study suggests that these beaches are more important for green sea turtles, although informants reported hawksbill, olive ridley, and leatherback nesting at the majority of beaches surveyed. Interviews and our own monitoring data suggest beaches between 5 and 200 nests for green turtles, between 1 and 10 nests for hawksbills, 0 to 2 nest for leatherbacks, and 20 to 300 nests for olive ridleys (excluding nesting from the mass nesting sites of La Flor and Chococente, which account for 50,000 to 100,000 nests). Based on this survey we have developed a map prioritizing among these small beaches for further sea turtle monitoring and conservation along southern Nicaragua's Pacific coast.

AN OVERVIEW OF SEA TURTLE NESTING IN THE EGYPTIAN RED SEA

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Five species of marine turtles have been observed in the Egyptian Red Sea: the green (*Chelonia mydas*), the hawksbill (*Eretmochelys imbricata*), the loggerhead (*Caretta caretta*), the olive-ridley turtle (*Lepidochelys olivacea*) and the leatherback turtles (*Dermochelys coriacea*). However, only the green and hawksbill turtles are considered common and have been observed nesting and feeding along the Egyptian Red Sea coast. We present here preliminary results from surveys efforts carried out yearly from 2001 to 2008. This is the first long-term study of nesting activity along the Egyptian Red Sea coast. With this, we aimed

at identifying highly valuable beaches to be submitted to special management regulations and where regular monitoring should be carried out and give some trends on nesting abundance. During this study, 38 beaches were surveyed and classified according the density of nests and tracks. Out of the 38 surveyed beaches, 22 sites were classified as valuable nesting sites: 8 off-shore beaches for hawksbill turtles and 14 in-shore and off-shore beaches for green turtles. During 2001-2008, nesting monitoring efforts were concentrated on Big Gifton Island for hawksbill turtles and Zabarged Island, Al-Mashayeikh North, Ras Hankorab and Umm El-Abas, for green turtles. The nesting activities were estimated quantitatively based on the density of tracks. Green turtle population in the Red Sea is estimated to be around 450 nesting females per year (excluding Eritrea for which data are not available). However most of the marine turtle population estimates available in the literature are based on scattered surveys and interviews with fishermen. More recently, two major nesting spots have been reported: 1) the Wadi Gemal-Hamata National Park (WGHNP) in the south and 2) Zabargad island, an off-shore island located south-east of Ras Banas. Scattered nesting events have also been reported all along the coast but at very low-density. More recent estimates consider the green turtle nesting population as being around 1,500 females per year. While green turtles are known to nest from August to December in Saudi Arabia; along the Egyptian coast, green turtles nests have been found from June to August with a peak in July. Nesting hawksbill turtle population in the Red Sea is estimated to be around 450-650 females per year (excluding Eritrea, for which no quantitative data are available). The population trend is not known, however it is believed that the actual population is smaller than what it used to be mainly due to direct intake for shell trade, coastal development and habitat destruction and oil pollution. The most recent estimate reported a nesting population of 50-100 females per year along the Egyptian Red Sea coast. This represent a negative trend if compared with previous estimate of 200-500 females per year reported by Frazier and Salas (1984) and 200 females per year reported in 2004. Main nesting sites for hawksbill turtles are located on the off-shore Shadwan Islands group and near-shore Giftoon Islands groups. Nesting season is believed to start in May and finish in July, with a peak in June. Currently nesting sites along the Egyptian Red sea coast are submitted to an increasing pressure coming from unsustainable coastal development. The increasing artificial lightening, habitat degradation due to irrational land use, the growing number of tourists and vessels using the same areas as adults and large juvenile marine turtles, are all well identified threats to nesting turtles; however no information is available at present on their impact on nesting populations.

FOUR LOGGERHEAD TURTLES WITH LIVING TAG NEST IN THE MEXICAN CARIBBEAN

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The technique of living tag was started with hatchling sea turtles on X'cacel beach, Quintana Roo, Mexico in 1990. The first living tagged green turtle female (*Chelonia mydas*) nested in

2004. From 2004 to 2010, 30 living tagged females returned to nest. The present work documents the nesting of loggerhead turtles (*Caretta caretta*) with living tags. From 1991 to 2008, 93,607 loggerhead turtles were marked with living tags, 5 of them were head started. Since 1996, nesting beaches were patrolled nightly from May to October as part of an ongoing tagging study. The beach coverage allows for >90% of nesting turtles to be observed. All encountered turtles are checked for flipper and living tags. In 2011, four nesting loggerhead turtles with living tags were reported. The age at first nesting for these loggerhead females ranged between 16 and 20 years, with a mean 19 years old first nesting age. These are the first records of living tagged loggerhead turtles nesting. Recorded data for all these turtles included clutch size, nesting frequency and nesting site fidelity. The living tag program is discussed in this paper.

TWENTY YEARS OF HAWKSBILL SEA TURTLE (*ERETMOCHELYS IMBRICATA*) NESTING ON THE ISLAND OF MAUI, HAWAI'I (1991-2010)

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Critically endangered hawksbill sea turtles (*Eretmochelys imbricata*) predominantly nest on Hawai‘i Island within the Hawaiian Archipelago. Considerably lower numbers also nest on the islands of Maui, Moloka‘i and O‘ahu. Since Hawai‘i and Maui Islands are the only two that have long-term, active nest monitoring programs, the best statewide estimate is at least 100 reproductive females. Hawksbill nesting was first scientifically documented on Maui in 1991, and a community-based effort to systematically monitor these activities was initiated in 1996, by Hawai‘i Wildlife Fund, and has been ongoing ever since. During these twenty years, hawksbill nesting has been documented during all but five of them, with nesting season occurring from May to December. A total of 62 nests and 51 false crawls were recorded on eight different Maui beaches (nests/seasons): Kealia (24/11), Kalepolepo (1/2), Kawililipoa (17/3), Little Beach (1/1), Oneloa (16/4), Hana Bay (1/2), Koki (1/1), and Hamoa (1/1), with only the first five beaches being actively monitored by USFWS “Dawn Patrol” volunteers. Maui’s number of nests/year for this twenty-year period ranged from 0-8 (mean=3.1 ± 2.7 SD), and the number of females/year ranged from 0-4 (mean=1.4 ± 1.1 SD). Individual hawksbills laid 1-5 nests/season, and seven turtles have been tagged since 1997: four at Kealia, two at Kawililipoa and one at Oneloa, with remigration rates from 3-13 years (n=8). Curved carapace lengths ranged from 83.5-96.0 cm (mean=89.8 ± 3.8 SD) and widths from 76.5-87.0 cm (mean=82.7 ± 3.34 SD). The maximum CCL and CCW growth measurements were 3.1 and 1.6 cm. Five of the seven tagged turtles were fitted with tracking devices and their post-nesting foraging grounds were found to be within the Main Hawaiian Islands: three off Hawai‘i Island and one each off Moloka‘i and O‘ahu. Known individual inter-nesting remigration rates ranged from 16-23 nights, with 19 and 20 nights being the most common interval: 25.7% and 28.6% of the 35 returnee’s first nesting attempts (mean=19.2 ± 1.72 SD). Females emerged to nest between 18:58-03:42 and the whole nesting process typically took ~2 hours. Fifty emergences from the ocean were recorded during night patrols

and the most frequent time blocks (52%) were 22:00-23:00 (n=10), 20:00-21:00 (n=9) and 21:00-22:00 (n=7). Only 34% of the emergences occurred after midnight. Clutch size data were available for 55 out of the 62 nests: range=116-224 eggs, mean=177.7 ± 27.5 SD, for a total of 9,774 eggs laid on Maui. Successful nest incubation periods varied by beach and ranged from 50-69 days (mean=59.2 ± 5.3 SD, n=31). Both night and daytime hatchling emergences were documented. Nest success varied widely by beach, from 0% to nearly 100%. It remains a mystery as to why nearly all of Kealia's nests, from multiple nesters over the majority of seasons, have had 0% success. Despite other beaches' hatching success and the intense protection of all of Maui's nests and nesters against numerous threats, this population has not significantly increased. Multi-agency conservation efforts will continue in an attempt to recover this small population.

A COMPARISON OF BEACH COMPACTION AND BEACH RENOURISHMENT ON NEST SITE SELECTIVITY OF LOGGERHEAD (*CARETTA CARETTA*) SEA TURTLES ON TWO BEACHES IN NORTHERN BROWARD COUNTY, FLORIDA

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The beaches of Broward County, Florida are a prevalent nesting site for loggerhead (*Caretta caretta*) sea turtles; however, extensive beach erosion is threatening critical nesting habitat. Beach renourishment, the process of transporting offshore or upland sediment onshore, is a widely used method of replenishing lost sand. However, renourishment can negatively affect sea turtle nesting habitat by increasing beach compaction; the resistance to applied pressure in pounds per square inch. Increased sand compaction impedes the digging of the female which affects nest success. Beach compaction has never been previously examined over the course of a nesting season on Hillsboro and Deerfield Beach. Therefore, this study examines beach compaction data for Hillsboro, a mostly natural beach, and Deerfield, a completely renourished beach, during the 2010 nesting season. Compaction readings were collected during March-October using a compaction meter at every other property along three beach points, the dune base, mid-beach, and average high tide line; and at three depths, 6in, 12in, and 18in. Values remained consistent throughout the season for each beach. Hillsboro compaction values were rarely over 500 psi, even at 18in depth. Deerfield compaction values exceeded the 600 psi measurement limit of the meter at most of the sample sites at a depth of only 12in. Sand compaction data was analyzed for any trends between beaches as well as within each beach. The data was grouped by Florida Department of Environmental Protection survey zones, which are each approximately 304.8 meters long, and numbered from R1 to R5 in Deerfield Beach and R6 to R23 in Hillsboro Beach. The average for each zone was calculated. Historically, loggerheads have preferred Hillsboro beach as a nesting site to Deerfield Beach. The average beach compaction values were compared to the number of nests per zone, and percent of hatching success using correlation analysis. To look for any smaller scale relationships, nest numbers and nesting success of the two beaches were also analyzed by dividing each zone into 100 m segments using GPS coordinates recorded at the mid-beach point of each sample site or property. The same correlation analysis was performed for false crawls per zone and 100 meter segment within each zone. The 2010 season recorded Hillsboro with 773 loggerhead nests and Deerfield with 30 loggerhead nests. Deerfield recorded 69 loggerhead false crawls with an average of 13.80 per zone and there was 907 loggerhead false crawls recorded in Hillsboro, averaging 50.39 per zone. Although Hillsboro averaged more false crawls per

zone, it also averaged far more nests per zone with 42.94. Deerfield averaged six nests per zone. The average loggerhead nesting success in Deerfield was 31.75 percent with the lowest value being 9.52 percent in zone five. Hillsboro had an average nesting success of 46.03 percent with eight out of seventeen zones at 50 percent or higher. Deerfield consists of five zones; however, three quarters of this beach has a nesting success below 40 percent. These results demonstrate decreased nesting success with increased beach compaction. I would like to thank the following organizations for their generous donations which make travel grants possible: The International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service. Without travel vouchure awards like the one I received and the efforts of the International Sea Turtle Symposium, I would not be able to participate in the Symposium.

TEMPORAL CONTROLS UPON SPATIAL VARIABILITY IN NESTING OF *DERMOCHELYS CORIACEA* AT THE PACUARE RESERVE IN COSTA RICA

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The 6 km beach of the Pacuare Preserve on the Atlantic coast of Costa Rica is an extremely important nesting ground for the population of Atlantic leatherback sea turtles. Examination of nesting data from 2002–2011 was performed to elucidate spatial and temporal variations in nesting attributes. While the spatial pattern of beach sectors supporting high and low nesting densities exhibited remarkable consistency from year to year, other demographic attributes of the nesting season such as onset of nesting, peak nesting date, and nest numbers show considerable inter-annual variation. Further, annual averaged curve carapace length (CCL), clutch size, and nest depths varied significantly by year (Kruskal Wallis; $p=7.79e^{-5}$, $9.63e^{-4}$, $4.04e^{-30}$), but were not significantly correlated to each other. This data suggest that non-allometric factors possibly related to nesting climate, or prior migratory/reproductive regimes may be important. So the nesting attributes aforementioned, were correlated to nesting season meteorology (monthly mean), and regional sea surface temperature (monthly mean). Results of this analysis may help to explain how biotic and abiotic factors operating at differing spatial and temporal scales influence broad nesting demographics (seasonal chronology, reproductive energetics), and fine scale nest construction (microclimate). Interactions of these factors will have strong implications for future populations.

NEST-SITE PREFERENCES OF HAWKSBILLS IN THE EASTERN PACIFIC: IMPLICATIONS FOR REGIONAL MANAGEMENT AND CONSERVATION*

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Knowledge of nesting behavior and reproduction is essential for the proper management and conservation of marine turtle populations. Despite its designation as a priority research area, the eastern Pacific is an area where little is known about nest-site preferences of hawksbill turtles (*Eretmochelys imbricata*). As a result, management and conservation of hawksbills in the eastern Pacific are informed primarily by data collected on hawksbills in other regions, particularly the Caribbean, where they are more abundant. Recent studies have demonstrated that mangrove estuaries are critical nesting and foraging areas for hawksbills in the eastern Pacific. Biophysical conditions of chosen nest-sites could influence the thermal environment experienced by developing embryos, impact hatching success, and affect primary sex ratios. Therefore, there is an urgent need to understand the factors influencing nest-site selection by hawksbills in the eastern Pacific to better inform region-specific management and conservation practices for hawksbills in this region. The objective of our study was to investigate the relationships between beach microhabitats and nest-site choice by hawksbills in the Bahía de Jiquilisco-Xiriualtique Biosphere Reserve in El Salvador, a major nesting area for hawksbills in the eastern Pacific. We assessed the location of 56 hawksbill nest-sites in relation to the high tide mark, low-lying vegetation, forest border, and overstory vegetation cover. We found that hawksbills tended to prefer oviposition sites located <10 m from the high tide mark (mean + SD; 7.32 + 5.13) and a mean distance of -6.34 + 5.89 m from the forest line. Low-lying vegetation was present at 54% (n=30) of nest-sites and had a mean distance of -6.12 + 5.81 m from chosen sites. Hawksbills preferred to nest below a high percentage of shade cover (83.22 + 26.54), with over two-thirds (n=37) of nest-sites located under higher than 90% shade cover. Nearly 93% (n=52) of nest-sites were placed in forest or forest border, whereas 4 were placed in low-lying vegetation and 0 in open sand. Our data demonstrate the importance of forest cover to nest-site choice by hawksbills in El Salvador. Maintaining forested areas that are available to nesting hawksbills from the high tide mark to 30 m landward is critical to the successful management and conservation of hawksbills in the eastern Pacific. We urge the Salvadoran government to ensure the protection of these rapidly developing areas in El Salvador, as

they are state-owned per Salvadoran law. We thank the network of local assistants in the Bahía, Boone & Crockett Club, SeaWorld & Busch Gardens Conservation Fund, Rufford Small Grants for Nature Conservation, USAID, Ministry of the Environment of El Salvador, International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service for invaluable support provided.

2011 SEASON MONITORING RESULTS IN "RESERVA PACUARE"

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Pacuare Reserve is a 6 km long nesting beach for leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), and hawksbill (*Eretmochelys imbricata*) sea turtles on the Caribbean coast of Costa Rica protected by the Endangered Wildlife Trust since 1989. Monitoring has occurred since 1994 in the form of nightly patrols and a daily census of nesting activity of the previous night. Historical data on the number of leatherback nests laid each year suggests a four-year cycle, with years of peak nesting activity occurring every four years. 2011 was typical of a non-peak year, with 716 nests (122.66 nests/km) out of 962 total leatherback activities (160.33 events/km). A total of 367 individual females nested, of which 18% (n=66) were identified as neophytes, fewer neophytes than the 25% recorded in 2009 (n=149) and the 23% recorded in 2010 (n=111). In 2011, a total of 7 hawksbill activities were recorded, of which 3 were nests. More total activities were recorded in 2011 than for 2009 (n=4), but fewer than 2010 (n=19). The number of nests was equal to that of 2009 (n=3), but less than 2010 (n=9). Although there is not sufficient historical data to determine a long-term trend, data from recent years suggests that Pacuare does not (or no longer) attracts large numbers of nesting hawksbills. In contrast, Pacuare is an important nesting beach for the green sea turtle, with annual nesting activity varying between 60 and 200 nests per year, except for 2008, when only 40 nests were recorded. Nesting activity for the green sea turtle reached a historic low in 2011, with the fewest number of green nests recorded since 2000; of 48 total activities for the green turtle recorded in 2011, only 20 were nests. Linear regression indicates a decreasing amount of nesting activity since 2000, but a decrease of 50% from the previous low recorded in 2008 is cause for concern. Low numbers of nesting green turtles may have been observed at other important nesting beaches for the green turtle in the Caribbean in 2011. Further investigation is required to determine the significance and extent of decreased nesting activity of the green sea turtle and establish whether a change in the long-term trend has occurred. Monitoring and research of all species of sea turtle nesting at Pacuare will continue, following methodology established in previous years, improving research and monitoring procedures by addressing problems that have arisen in previous years, and implementing new technologies, such as the application of PIT-TAGS, GIS projects, and SONAR mapping of the littoral zone. Monitoring, beach security, educational activities, and job creation have decreased poaching from 98% to 2% since the start of the project in 1989. Increased communication and collaboration with other regional projects in standardization of data collection, publication and sharing of data will facilitate understanding of the status of the populations, and collaboration in the development of environmental education programs and economic alternatives in communities where sea turtle products are traded and consumed will assist science to ensure the survival of sea turtles.

SATURATION TAGGING OF LOGGERHEADS NESTING AT THE PRAIA DO FORTE, BRAZIL: PRELIMINARY RESULTS

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In sea turtle research, the number of clutches laid on a nesting beach in a particular season is commonly used as a relative index of population density. Though, it is recognized that long-term mark-recapture studies on nesting beaches should be undertaken whenever possible to ensure that valuable abundance and demographic data are being generated to inform conservation management strategies. Praia do Forte beach in Bahia stretches along 14 km and encompasses one of the major loggerhead rookeries in Brazil, monitored since 1982 by Projeto Tamar-ICMBio. The nesting season for loggerheads in Praia do Forte lasts from September to April; however, the period between October and February concentrates 90% of nesting activity. The most significant loggerhead nesting (60% of the total) occurs along a 5 km segment where 88% of the females exhibit intra-seasonal high-site fidelity (less than 2 km variation). In 2008 a saturation tagging program of loggerheads nesting at the Praia do Forte beach was started to obtain site-specific demographic parameters for this population. During the first nesting season we conducted a preliminary study from October 15th to December 15th. Nightly patrols were performed from 8 pm to 5 am. As a result we determined that 75% of the female encounters occurred between 8 pm and 2 am. According to this, during the 2009-2010 and 2010-2011 nesting seasons, the tagging saturation effort was conducted during five months (from October 1st to February 28th) along the 5 km stretch from 8 pm to 2 am. This area was monitored every 45 min to assure that every female was encountered during this period. Early morning surveys also identified any missed nesting activity in order to evaluate the efficiency of the method. We calculated: (1) the observed clutch frequency (OCF), and (2) the estimated clutch frequency (ECF) corrected by taking into account missed nests based on inter-nesting intervals. To increase the chances that the first and last nests laid by a female were counted, females included in the estimates of clutch frequency were those that initiated nesting between October 1st and January 1st, and completed their nesting by the end of February when beach monitoring ceased. Females that were observed nesting only once in the season were eliminated from the estimation of clutch frequency. Mean inter-nesting interval of females loggerheads was 14.7 ± 1.5 days (n=91), both seasons combined. In 2009-2010 the OCF was 3.2 ± 1.1 and the ECF was 3.9 ± 1.3 clutches (n=40 females), while in 2010-2011 the OCF was 3.2 ± 1.1 and the ECF was 4.0 ± 1.5 clutches (n=54 females). Taking into account that the saturation study has 3 years, remigration intervals were not fully documented; however, tagged turtles from previous years indicate that 2 yr remigrations was the most common period, followed by 3 yr remigrations. The saturation study will continue for at least 3 yr more to estimate the average remigration interval and obtain robust demographic data.

CONSERVATION AND NESTING OF *ERETMOCHELYS IMBRICATA* (LINNAEUS, 1766) IN BEACHES SOUTH PERNAMBUCO, BRAZIL

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The species *Eretmochelys imbricata* has a circum-tropical distribution, nesting in Brazil occurs in the states of Piaui, Ceara, Rio Grande do Norte, Paraiba, Pernambuco, Bahia, Espirito Santo and Santa Catarina. Whilst this species is found in many states of Brazil it is critically. In order to investigate the biology of this species, this study aimed to determine the temporal distribution, reproductive success, fecundity and incubation time during the reproductive seasons from 2007 to 2010 on the beaches of the south coast of Pernambuco, Brazil. The study area has the coordinates 08º24'25"S and 35º03'45"W. 12 km of the coastal area were monitored along the beaches of Muro Alto, Cupe, Merepe, Porto de Galinhas e Maracaípe, City of Ipojuca. This area gets anthropic influences; it is a very popular area for tourists. The data was registered under permission and coordination of the NGO "Ecoassociados". The sampling was conducted during the months of October to June of the years 2007/2008, 2008/2009 and 2009/2010. The record of the nests was made by vizualization of the female at the time of spawning and also by viewing the trail left by the turtle. The nests were surrounded and monitored until the day of emergence of neonates, each nest was opened three days after hatching, when the eggshells, stillbirths, and unavailable eggs were counted to estimate the the total number of eggs from nests. During the three breeding seasons the study found a total of 350 nests of the species *E. imbricata*, in parallel, there were six nests of other species, four of *Caretta caretta* and two of the species *Lepidochelys olivacea*. 65.5% of the spawnings occurred during the dry period, September throughout to February. Hawksbill turtles started their spawning on October and ended in May, registering the most nests (83.5%) in the months of January, February and March. Reproductive success was 65.6% for three seasons, with 59%, 68.6% and 45.9% respectively in 2007/2008, 2008/2009 and 2009/2010. The average and standard deviation of fertility in 2007/2008 was 147 ± 28 eggs (n=100, 69-206), in 2008/2009 was 142 ± 36 eggs (n=153, 77-212) and 2009/2010 was 153 ± 53.5 eggs (n=103, 75-227). Incubation of nests for the three breeding seasons averaged 55 days (40-67, n=201). Regarding to reproductive success of each beach, Cupe and Merepe beaches got higher rates of 65% and 62%, these beaches also had the highest number of nests respectively n=62 and n=132, and were characterized by vegetation cover and gently sloping, due to that, those beaches are favorite areas for spawning, it is therefore suggested that conservation efforts are greater in these nesting sites. The data reported here shows the importance of monitoring this area for conservation and handling of sea turtles. This study has helped to further our knowledge of sea turtles reproductive habits which can hopefully help to protect the species.

MARINE TURTLE HATCHERY MANAGEMENT IN SETIU, TERENGGANU, MALAYSIA - CHALLENGES AND ACHIEVEMENT

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Setiu is a district located in the state of Terengganu, on the east coast of Peninsular Malaysia. The 25 kilometers stretch of beaches along the coastal area is the key nesting sites of green turtles (*Chelonia mydas*) in the state, as well as the critically endangered painted terrapin (*Batagur borneoensis*). Local communities living along the coast, mostly comprised of fishermen, have traditionally consumed turtle eggs for a long time. Eggs consumption is one of the major threats to turtle conservation in Terengganu. At present, there is no law to protect turtle eggs except for the sale of leatherback's (*Dermochelys coriacea*) within Terengganu state, while other turtle species' eggs may still be consumed and traded. Leatherback nesting population in Peninsular Malaysia has declined tremendously in the past few years, and nowadays nests are rare. Two hatcheries have been built since 1990's to relocate and protect leatherback turtle and painted terrapin eggs from natural predators and excessive collection by the local community for consumption. However, due to lack of funding in the previous years, turtle conservation efforts in Setiu have been sporadic. Local community engagement in turtle conservation went on full-scale in 2009, entailing education, awareness activities, and their active participation in hatchery management. The implementation of Best Hatchery Practices (BHP) was fully emphasized in Setiu with the increasing involvement and participation by the locals. In addition, the 'Egg Buy-Back' Scheme was introduced to the locals, which aims to get more turtle eggs collected from other than reserve beaches. Incentives were later given to those who provide viable egg clutches with 70 percent and higher success hatch rate. This scheme has not only given the locals an additional income, but also helps in creating awareness on the need for egg protection, encourage BHP, as well as effective handling of turtle eggs for increasing the hatch success rate. Hatchery performance and local response towards the program within the last three years (2009–2011) were monitored, and the progress has been very promising. The number of relocated nests has increased from 99 nests in 2009 to 175 nests in 2011. Moreover, the number of nests with highly viable eggs sold by the locals to the hatcheries increased from only 5 nests in the first year to 50 nests. Average hatching rate in 2009 was 73 percent and the rate has been increasing in the following years. Nests temperature in the hatchery was recorded only in 2011, registering an average nest temperature around 29ºC, which indicates that hatchlings produced would be mostly males.

BLUFF BEACH, ANOTHER IMPORTANT NESTING BEACH FOR CRITICALLY ENDANGERED LEATHERBACK (*DERMOCHELYS CORIACEA*) AND HAWKSBILL (*ERETMOCHELYS IMBRICATA*) SEA TURTLES IN BOCAS DEL TORO PROVINCE, PANAMA

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Bluff Beach (Playa Bluff) is located on Isla Colon, in the Bocas del Toro Province, on the Caribbean coast of Panama. This nesting beach, which hosts leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*) sea turtles, has been subject to a diverse range of anthropogenic threats in recent years, including sand extraction, poaching of nests and degradation of the nesting habitat resulting from the use of the beach for filming of various reality television shows. In 2010, the filming of a 'Survivor' type program during the leatherback nesting season brought international attention to the beach, and criticism from local residents disturbed by the apparent disregard of the production crew for the negative impact of their activities on the turtles or their nests. One positive outcome from this situation, however, was the creation of a conservation organization in the local indigenous community; the Bocas Hawksbill Nature Association (Asociación Natural Bocas Carey - ANABOCA). Sea Turtle Conservancy (STC) provided training to members of this community to monitor the nesting beach; in 2010 there was sporadic monitoring, but in 2011 daily track surveys and night patrols were conducted throughout the nesting season. Results from the monitoring activities have revealed that the beach is another important nesting site in Bocas del Toro Province for both species; 305 leatherback and 148 hawksbill nests were recorded in 2011. STC plans to continue working with the indigenous community to further develop the sea turtle monitoring and conservation program. There is also potential and local interest, in developing eco-tourism activities at the beach; STC will draw upon many years of experience gained at Tortuguero, Costa Rica to provide advice and technical support in the development of sea turtle tours. The goal is to work with key stakeholder groups in the area (local community members, ex-pat residents and business owners, investigators, local government and environmental enforcement agencies) to produce a management plan for the area that would ensure the protection of this important nesting beach and the survival of these critically endangered sea turtle species.

DOES THE NESTING BEHAVIOR OF LOGGERHEAD TURTLE CHANGE BY LEARNING?*

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We studied to declare whether the nesting behavior of loggerhead turtle *Caretta caretta* which is instinctive behavior change by learning. The nesting behaviors of 12 turtles were filmed and recorded with the infrared video camera from June 13th, 2011 to August 2nd in Senri beach of Wakayama Prefecture, Japan. Nesting turtles were new recruits and have been already nested before in this season, while no nesting history was recorded in past

season. We categorized the nesting behavior into 7 phases: landing to the beach (LN); making the body pit (BP); digging the egg chamber (DG); laying eggs (LE); burying the egg chamber (BU); camouflaging the egg chamber (CF); and returning to the sea (RE). The phase time and number of rotating of all limbs were recorded. Then frequencies of a minute of rotating limbs were calculated in each phase. In almost all the cases, LN had already started when the turtles were found, and the time of LN was eliminated from analysis. Nesting turtles took time mostly in CF followed by DG, LE, BU, RE, BP. They had spended the longest time for the camouflaging the egg chamber, in other words, it was confirmed that CF is important for continuation of the species. Then 12 turtles divided into the recruits (n=8) and the remigrants (n=4), we compared with their average time, number of rotating, and frequency of rotating. The average time of the remigrants was shorter than the recruits at LE and CF (recruits: LE 16.4±1.4 min, n=3; CF 18.9±5.4 min, n=8; remigrants: LE 13.1±0.5 min, n=2; CF 13.5±6.7 min, n=4; t-test, $p<0.05$). Nesting turtles can learn how they shorten the time of nesting behavior which is risky time for nesting turtles and laid eggs. The average number of rotating of the remigrants was fewer than the recruits at BU and CF (recruits: BU 123.1±46.5, n=8; CF 187.7±74.7, n=8; remigrants: BU 78.5±12.6, n=4; CF 157.4±40.3, n=4; t-test, $p<0.05$). The average frequency of rotating of the remigrants was lower at BU and higher at CF than the recruits (recruits: BU 12.0±2.6, n=8; CF 11.0±1.7, n=8; remigrants: BU 8.0±2.9, n=4; CF 17.0±5.2, n=4; t-test, $p<0.05$). These results suggested that the nesting turtles get on to bury the egg chamber more carefully which implied by decreasing the frequency of rotating and camouflage the egg chamber more quickly which implied by increasing the frequency of rotating. This study shows that the learning by experience of nesting is contributed to mitigation of the risk accompanying nesting for sea turtles even within the same nesting season.

REPRODUCTIVE BIOLOGY AND CONSERVATION OF THE LOGGERHEAD SEA TURTLE *CARETTA CARETTA* IN THE NORTHERN STATE OF RIO DE JANEIRO, BRAZIL

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Projeto TAMAR-ICMBio began its activities in northern Rio de Janeiro in 1992, when the Bacia de Campos station was first established. The early fieldwork included mostly nesting surveys as well as beach monitoring and nest protection along 8 kilometers of the northern coast of Rio de Janeiro. Gradually, the size of the monitored area has increased, and since 2004-2005 about 100 km of nesting beaches have been monitored in each season. Currently, the Bacia de Campos station is responsible for the protection of approximately 950 loggerhead nests per season (close to average number of nests between 2007-2008 and 2009-2010 nesting seasons). The large majority of sea turtle nests in this area are of loggerheads. From 2002-2003 to 2010-2011 nesting seasons, 7,176 nests (99.8%), of a total of 7,187 nests with known species, belonged to loggerheads. However, leatherbacks,

hawksbills, green turtles and olive ridleys have also been observed nesting occasionally. While nesting regions in northeastern Brazil are largely female-producing, Rio de Janeiro is supposedly to be a male hatchling production area, due to its lower average temperatures, as has been observed for the state of Espírito Santo, just north of the state of Rio de Janeiro. The production of significant proportions of male htachlings would place Rio de Janeiro in a relevant position regards loggerhead's population biology and conservation in Brazil. This paper presents data on nesting loggerheads on the northern state of Rio de Janeiro; and was aimed to characterize, for the first time, the loggerhead nesting population in this area. We evaluated data from the last seven nesting seasons, which followed similar spatial and temporal patterns. The mean annual number of nests laid in the last seven seasons was 1,021 (SD=288; range=756–1,625; n=7 seasons). During this period, the average hatching success for relocated clutches was 65.6% (SD=7.6; range=57.7–81.3) for beach nests (B) and 64.9% (SD=4.3; range=61.2–73.8) for hatchery nests (H). Among the seasons, hatching success for in situ (I), B and H nests varied between 57.7% and 81.3%. Mean incubation period was 60.4 days (SD=4.1; range=54.7–66.7; n=933 nests) for I nests, 57.4 days (SD=3.7; range=51.9– 61.3; n=3,527 nests) for H nests and 61.05 days (SD=4.3; range=56.1–67.3; n=614 nests) for B nests. According to literature, emergence periods for loggerheads range from 42 to 58 days. We found longer incubation periods for B and I nests, and it is probably related to the exposure of the hatcheries nests (H) to higher temperatures which increased metabolic rates of the embryos. TAMAR's conservation activities in Rio de Janeiro are based on limiting human-caused damage to sea turtle populations and their habitats. Besides the environmental protection activities, TAMAR has aimed to incorporate human and social issues into all its initiatives, involving local communities in its conservation efforts.

UNFAITHFUL FEMALES: INTER-NESTING MOVEMENTS SUGGEST ALTERNATIVE NESTING STRATEGIES AND NEST SITE INFIDELITY FOR LOGGERHEADS NESTING IN RETHYMNO, GREECE*

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Loggerhead turtles (*Caretta caretta*) globally have a high degree of nest site fidelity and will lay their successive nests within a few kilometers of each other. However, a small number of individuals may lay one or more clutches in the same season at distances over 50 km from the original tagging site. Rethymno, situated on the island of Crete, Greece is a nesting site of regional importance for Mediterranean loggerheads. Habitat degradation due to development, combined with increased mortality caused by fisheries interactions has led to a decline in nest numbers over the last decade. Our study, conducted in collaboration with ARCHELON, the Sea Turtle Protection Society, investigated the at-sea behavior and inter-nesting movements of Rethymno female loggerheads during the reproductive season gaining insights on their use of the marine habitat. To this purpose, from early June to late July 2011, we attached Mk10 satellite tags (Wildlife Computers) on 19 females after they had completed laying their clutch. Tags were attached after we confirmed the presence of follicles in their ovaries with an ultrasound, indicating that these turtles would return after

approximately two weeks to lay another nest. When we subsequently re-encountered these individuals nesting, we performed another ultrasound and continued to track them for the duration of the egg-laying season. Of the 19 turtles most remained within close proximity during the inter-nesting interval, showing a preference for a specific marine area within a 2-5 km radius from the nesting site. 14 of them laid between 1 and 3 subsequent nests within 2-4 km from the original tagging site. However, 5 individuals were tracked to locations up to 140 km away from Rethymno, remaining there for periods exceeding the 14-18 day inter-nesting interval. One of them, tagged on 5 June, was tracked to a location 100 km east of Rethymno and remained there for the remainder of the nesting season before heading north towards the Cyclades Islands in the Aegean Sea. For all of these individuals, the presence of follicles in their ovaries indicated that they probably used these other locations as alternative nesting sites for at least one of their subsequent clutches. Thus a potentially significant proportion of the female loggerheads nesting in Rethymno (almost 25% of our sample size) displayed low site fidelity. Our data have important conservation implications for the future of the Rethymno nesting population: our findings indicate that Crete should be considered to be a single management unit and as such it is important to assess current levels of nesting throughout the island. Acknowledgements: Funding for this project was provided by the Betz Chair of Environmental Science at Drexel University. The authors wish to thank ARCHELON and the Rethymno project team for their support in implementing this study. Special thanks are due to Avalon Mehta, Emily Bell and Jonah Morreale for their assistance in conducting our 2011 fieldwork. AP would like acknowledge support from the ISTS, the Western Pacific Regional Fishery Management Council, the U.S. Fish and Wildlife Service, and the U.S. National Marine Fisheries Service.

GREEN TURTLES IN KUWAIT: NESTING AND MOVEMENTS*

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The Arabian Gulf is known to host widely distributed nesting of hawksbill and green turtles, with loggerheads, olive ridleys and leatherbacks being less frequent. In Kuwait, until recently, green and hawksbill turtles had nested on Umm Al-Maradim Island (28.6798°N 48.6520°E) with green turtles using a sand spit extending from the main island. However in 2005, construction of a large harbour was begun at the site. This has led to reclamation of the green turtle nesting beach and loss of nesting there. Hawksbills were also known to nest on Qaru Island (28.8174°N 48.7765°E) which is 20 km away. Preliminary investigations on these islands began in 2008 and were continued in earnest between 2009 and 2011. Monthly fieldwork comprising periods of ≥8 days were undertaken over the nesting and hatching seasons. Nocturnal and day-time surveys were undertaken to identify nesting turtles. Surveys confirmed that green turtles no longer nest on Umm Al-Maradim, but revealed they are now nesting on Qaru. The number of nesting females is low (≥5 in 2008, 1 in 2009 & 2010 and 3 in 2011) with none of the turtles observed breeding in more than one season. Average curved carapace length (CCL) was 98.2 cm (SD 4.0 cm, range 93-105 cm, n=10). We deployed four satellite tags on green turtles; two on nesters at Qaru and two on turtles (CCL >97cm) that were rehabilitated at the Scientific Center Aquarium, after

becoming trapped in power-plant water tanks and released at Kubbar Island (29.0719°N 48.4924°E) in September 2010. The tag of the first nesting turtle (2009) failed within a few days of deployment but the second (2010) lasted 121 days. In that time, data indicated that the turtle nested a further two times, which when combined with track observations makes a minimum clutch frequency (CF) of 5. Combining established internesting intervals for this species with direct observation of individuals we estimate a minimum CF of 3 nests is common for green turtles in Kuwait. After completing breeding, the tagged turtle migrated 100 km south to very shallow seas in Saudi Arabia (27.8890°N 48.9928°E). The two rehabilitated greens swam in the opposite direction and established long-term residencies along the northern shore of Failaka Island (29.4587°N 48.3295°E) where they remained until the tags stopped functioning after 238 and 248 days. Qaru Island represents a nationally important green turtle nesting habitat for a population at critically low levels. Therefore, measures should be taken to minimise anthropogenic disturbance at this location and prevent any developments that may impact nesting and hatching success; in doing so hawksbills nesting there will also be protected. 'Khadra' fish traps at Failaka Island are documented to catch green turtles, which may die as a result. With two green turtles tracked there for extended periods, conservation measures should be investigated for this site. Under the auspices of HH Sheikha Amthal Al-Sabah and the Voluntary Work Center of Kuwait, the project was sponsored by Total Foundation/Total Kuwait and was carried out in collaboration with the Scientific Centre of Kuwait and the Kuwait Coast Guard. AFR wishes to thank International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and the International Sea Turtle Symposium for assistance to attend.

CLUTCH PROTECTION AT THE MOST IMPORTANT NESTING SITE FOR THE LEATHERBACK SEA TURTLE IN THE DOMINICAN REPUBLIC: A RACE FOR CONSERVATION

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The beaches of the Jaragua National Park (JNP southwest of DR) have been identified as the most important site for leatherback turtle nesting in the Dominican Republic (North Caribbean). From a total of 11 beaches, two stand out as core nesting areas: Mosquea and Bahía de las Águilas located 50 km apart. Together, these sites comprise more than 100 nest.year^{-1}. There has been widespread illegal egg take for decades at the site (close to 100% in the eastern beaches). In 2006, we initiated a conservation program to increase the number of live hatchlings produced during the leatherback nesting season. Due to egg take, we removed the clutches at risk for artificial incubation. Handling and transportation of eggs may result in embryonic death and artificial incubation may introduce masculinising biases, lower hatching success and higher embryonic mortality rates. In the present study, we assess these interventions. We grouped the clutches studied in (1) clutches incubated "in

situ", (2) clutches artificially incubated at Bahia and (3) clutches artificially incubated at Mosquea. All natural nests were incubated at Bahía and clutches of groups 2 and 3 were incubated inside Park rangers' huts in places with different environmental conditions. Clutches incubated "in situ" showing greater hatching success (mean=75.7 ± 21.2, n=125) than those artificially incubated in Bahía (mean=40.9 ± 23.6, n=39) and clutches artificially incubated in Mosquea (mean=49.7 ± 27.9, n=108). We found incubation treatment to have an effect on early and late stage embryonic mortality. "There was no difference in incubation period (IP) between "in situ" incubated clutches and artificially incubated clutches in Bahía. However, IP was significantly longer in artificially incubated clutches in Mosquea. We discuss the significance of these differing approaches to sea turtle conservation at this site. This study is supported by the EU project RESET-ECO FP7-PEOPLE-2009-RG.

FACTORS INFLUENCING THE TIMING OF THE NESTING SEASON FOR PACIFIC AND ATLANTIC LEATHERBACK TURTLES*

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For sea turtles, the timing of the nesting season (termed nesting phenology) can greatly influence hatching success and sex ratios. To investigate inter-annual patterns in the nesting phenology of the leatherback turtle, *Dermochelys coriacea*, we analysed monitoring datasets spanning multiple years from major nesting sites at St. Croix, U.S. Virgin Islands (10 years) and Playa Grande, Costa Rica (18 years). Over the study period, the median nesting date at St. Croix has remained constant with only minor variation (a range of ±4.5 days). However, the median nesting date at Playa Grande has occurred later at a rate of approximately 1 day yr^{-1} (a total increase of 17 days). The lack of variation associated with this shift in the nesting season at Playa Grande suggests that the nesting phenology of leatherback turtles is not strongly influenced by temperature, as otherwise a less continuous pattern should be apparent. In further support of this hypothesis, the median nesting date at either site is not significantly correlated to the mean annual sea surface temperature (SST) of their foraging grounds (Playa Grande – Eastern Tropical Pacific, adjusted R^2=0.021, p=0.865; St. Croix – North Atlantic, adjusted R^2=0.031, p=0.734). Moreover, only weak correlations were observed between the median nesting dates and the mean monthly SST at the same foraging sites (adjusted R^2 <0.348 in all instances). The lack of a correlation between SST and median nesting dates contrasts with similar studies concerning loggerhead and green turtles. The median nesting date was subsequently compared to population parameters. A strong negative correlation was observed between the median nesting date and the number of nesting females (Playa Grande, adjusted R^2=0.727, p<0.001; St. Croix, adjusted R^2=0.448, p=0.005). In addition, the median nesting date for first-time nesters was significantly later than remigrant turtles (two-tailed paired t-test - Playa Grande, 18.19 days later, p<0.001; St. Croix, 6.85 days later, p<0.003). As directional trends in population size are often connected to shifts in the mean age of the population, it is

therefore possible that inter-annual differences in the mean age of nesting females could explain the observed variation in nesting phenology. Specifically, with high levels of adult mortality evident in the Pacific Ocean, the mean age of the population could be decreasing. In turn, this would delay the median nesting date. On the other hand, a more stable population trend at St. Croix could explain the consistency of the median nesting date at this site. As the leatherback turtle nesting season at Playa Grande in now occurring later in the year, turtles are nesting under warmer conditions. As a result, the sex ratios of developing embryos are likely to become increasingly skewed and this effect will only be amplified by climate change. Thanks are extended to the International Sea Turtle Symposium for providing a venue to present this research. Travel to this symposium was supported by grants made availible through generous donations by the following organizations: International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service.

SEA TURTLE ECOLOGY IN MATA OSCURA BEACH, VERAGUAS PROVINCE, IN THE PANAMANIAN PACIFIC

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In the Azuero Peninsula, on the Pacific Coast of Panamá, the nesting has been reported of four (4) of the five (5) existing species of sea turtles in the Eastern South Pacific Ocean. Following up on actions initiated in 2009 by ARAP, UMIP, STRI and CI, in 2011, a follow up project is being carried out at Mata Oscura Beach, with the objective of promoting the conservation of sea turtles. This research work was implemented at Mata Oscura Beach, in the Province of Veraguas, Pacific Coast of Panama, between June and November 2011 with the objective of determining the optimal conditions for sea turtle conservation in Mata Oscura Beach through: marking, collection and evaluation of biological, biometric and environmental data related to the nesting and birth of the turtles. The information was collected during nocturnal monitoring, which was carried out in the 4 km corresponding to the nesting area of the sea turtles. For data collection we divided the beach every 100 m, carried out during 2011, taking into account parameters such as length and width of the shell of the turtles, conditions and data related to the hatching nests. To determine the hatching success of relocated nests, relocated nests in an experimental nursery will be measured. During surveys, nesting turtles of the following species were observed: olive ridley (*Lepidochelys olivacea*), green sea turtle (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*), determining that Mata Oscura, so far has a curvature measurement of 66 cm in length and 70.8 cm wide. Nests were reported mainly in the middle zone of the beach, in sand, mainly between segments 3 to 11, with an egg laying average of 90 eggs. It was possible to determine important aspects of the 2011 nesting in Playa Mata Oscura, which will help establish a baseline to compare the results in subsequent years.

HATCHLING SEX RATIOS OF THREE MARINE TURTLE SPECIES (*CARETTA CARETTA*, *CHELONIA MYDAS*, AND *DERMOCHELYS CORIACEA*) NESTING ON SOUTH FLORIDA BEACHES*

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All species of marine turtles nesting on continental U.S. beaches are listed as endangered or threatened under state and federal statutes, as well as the IUCN Red List. Establishing current population baselines is vital to detect trends and aid in marine turtle recovery planning and conservation efforts. Trends in sex ratios can indicate the current and future reproductive potential of a population; they are important components of population demographics and demographic models. Hatchling sex ratios are the source from which future stage- or age-class sex ratios originate. During embryonic development, sea turtles undergo environmental sex determination in which gonadal differentiation is largely directed by incubation temperatures during the thermosensitive period. Consequently, hatchling sex ratios may vary depending upon weather, species-specific responses to nest temperatures, and any natural or anthropogenically-induced modifiers of those responses. Previous estimates of Florida hatchling sex ratios from the literature indicate a female bias. These studies are few in number, are restricted to just one species, the Loggerhead, and most involve only one beach. We conducted a multi-year, multi-beach, multi-species study to estimate South Florida's hatchling sex ratios. We report sex ratios from laparoscopically sexed neonate Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*), and Leatherback (*Dermochelys coriacea*) turtles sampled from up to seven nesting beaches across the years 2002-2011. Female-biased sex ratios describe all species, however year-to-year differences can be large and the nature of those differences is often species-specific. We thank the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and the 2012 International Sea Turtle Symposium for their generous donations and support that make the presentation of this work at the 2012 International Sea Turtle Symposium in Huatulco, Oaxaca, Mexico possible.

EFFECTS OF RAINFALL ON IN-SITU SEA TURTLE NESTS: A COMPARISON OF GREEN (*CHELONIA MYDAS*) AND LEATHERBACK (*DERMOCHELYS CORIACEA*) NESTS ON PLAYA NORTE, COSTA RICA*

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Successful embryogenesis for sea turtles depends on the moisture content of the nesting substrate, and this in turn depends on local precipitation patterns. It is therefore surprising that few published studies consider the effects of variable rainfall on in-situ sea turtle clutches. In this paper, we document rainfall effects on the incubation duration, in-nest temperatures, hatching and emergence success rates, and resulting sex likelihoods of two species of marine turtles, *Dermochelys coriacea* (leatherback) and *Chelonia mydas* (Green) on Playa Norte, Tortuguero Lowlands, Costa Rica. Temperature data loggers were placed in nests of 18 leatherback and 20 green turtles during ovipositioning and were used to collect

hourly in-nest temperatures during the entire incubation period. Incubation duration of leatherback turtles was negatively correlated with both mean ambient air temperature (Spearman's rank correlation, rs=-0.858, p<0.05) and mean in-nest temperature (rs = -0.765, p<0.05); it was also negatively correlated with sex likelihoods (rs = -0.643, p<0.05). By contrast, there were no significant correlations between incubation duration and in-nest or ambient air temperatures for green turtles. Large rainfall events cooled in-nest temperatures by up to 3° over a 24-h period; thereby, greatly reducing the buffer against daily temperature fluctuation that eggs at depth typically experience. These results have significant implications for the current practice of predicting hatchling sex ratio on the basis of incubation duration, and indicates that the cooling mechanism of rainfall on in-nest temperature must be taken into consideration in future studies.

BEACH CHARACTERISTICS AFFECT THE GAS EXCHANGE ENVIRONMENT FOR SEA TURTLE NESTS*

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Sea turtles bury their eggs deeply on a variety of beaches worldwide. During incubation, the developing embryos exchange gases (oxygen and carbon dioxide) with the surrounding sand and atmosphere at a rate dependent on the properties of the sand. Movement of individual gases via diffusion through the sand is described by Fick's Law and relies on partial pressure differences, whereas movement of bulk air via convection is described by Darcy's Law and is determined by total pressure differences. We tested the diffusivity and convective permeability of sands from sea turtle nesting beaches in Greece, Equatorial Guinea, and both coasts of Costa Rica. Median sand grain size on these beaches ranged from very fine (0.125 mm) to coarse (1 mm). For these experiments, the sand was uniformly wetted to the desired moisture content and repacked in a chamber simulating the repacked sand from egg chamber covering. At all moisture contents (0-10%), diffusivity was greater in fine sands than coarse sands and permeability to bulk flow in coarser sands was an order of magnitude greater than that in finer sands. In all sand types, dry sands had lower diffusivity and permeability than sands that were lightly wetted to 2-5% moisture by volume, similar to field moisture at nest depth. Specific volumes of wet, repacked sands from 2-15% moisture were 1x10-4 m^3/kg greater than dry sand. Porosity increased when water was initially added due to the film adhesion of the wet sand particles creating incompressible aggregates, but decreased with continued additions as water filled in the pore space. These results indicated that sand moisture and sand grain size on sea turtle nesting beaches can affect respiratory gas exchange of developing eggs. Our results also indicated that in all beaches, bulk air flow may account for considerably more of the gas exchange than previously thought due to tidal fluxes and wind-generated pressure gradients. Selective forces on sea turtle nests include protection from predators and development under optimal hydric, thermal, and respiratory conditions. Climate change models predict hotter, drier climates for many sea turtle nesting beaches that would increase the depth of the dry sand layer. It is imperative for conservation and hatchery practices to consider optimal gas exchange in the sand to improve future beach conservation efforts. We would like to acknowledge the sponsors of the ISTS Student Travel Award.

DECLINE IN LEATHERBACK TURTLES, *DERMOCHELYS CORIACEA*, NESTING ON THE NORTHWEST COAST OF PAPUA, INDONESIA*

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The leatherbacks nesting at Bird's Head peninsula, Papua, Indonesia, comprise the only large nesting aggregation remaining in the western Pacific and have been the focus of recent conservation concern. A declining trend was apparent from nest counts from sporadic monitoring at the principal beaches, Jamursba-Medi (JM), since the 1980's through 2004; although a significant new nesting area was recently discovered at Wermon. The current study adds the most recent 6 years of nesting data from expanded annual nesting surveys and adjusts the nest counts to account for variable survey effort over the past three decades in order to integrate estimates of annual nest counts and evaluate trends at the two primary beaches in the Bird's Head peninsula (i.e. JM and Wermon). The estimated annual number of nests at JM showed a significant declining trend over the past 26 years ranging from 14,491 in 1984 to 1,741 in 2010. Nesting at Wermon has only been monitored since 2004, but appears to show a similar rate of decline as Jamursba-Medi from 2,708 nests in 2004 to 1,065 in 2010. Jamursba Medi has relatively higher number of nests than Wermon with a unimodal nesting distribution that peaks during June to July, whereas Wermon has a bimodal nesting distribution with peaks during December to February and also June to July. Based on PIT tag data, the predicted number of nests per female per season ranged from 3 – 10 with a mean of 5.5 ± 1.6, suggesting that there may be fewer than 1,000 females nesting each year in the Bird's Head region. Considering that Bird's Head represents the last stronghold for leatherback nesting in the western Pacific, the significant decrease in nesting highlights the need for continued and enhanced conservation in an effort to prevent the collapse of the leatherback in the western Pacific. We sincerely thank Harold C. Martin Endowed Fund and Graduate Student Association (GSA) of UAB for providing Travel grant in Biology Dept of UAB. We also thank the International Sea Turtle Symposium, International Sea Turtle Society, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service, and Western Pacific Regional Fishery Management Council for supporting our participation in the Symposium. Funding and logistical support for this study were provided by US Fish and Wildlife Service, U.S. National Oceanic and Atmospheric Administration – National Marine Fisheries Service, the Bird's Head Leatherback (BHL) program of the State University of Papua (UNIPA), WWF Indonesia Program and Conservation Bureau of Ministry of Forestry in Papua Barat Province.

EVALUATING PHENOLOGICAL SHIFTS OF THE HAWKSBILL ROOKERY ON LONG ISLAND, ANTIGUA, W. I.

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Shifts in the timing of seasonal events, such as migrations, have been increasingly documented for fauna and flora worldwide, including marine turtles. Such phenological shifts are often linked to climatic changes. Given projections and associated uncertainties about the future global climate, obtaining a better understanding of the impacts on sea turtle phenologies is essential to effective conservation and management. Since its inception in 1987, the Jumby Bay Hawksbill Project (JBHP) has used saturation tagging techniques to monitor hawksbill turtles (*Eretmochelys imbricata*) nesting on Long Island, Antigua. With data collected during the JBHP's 25-year lifetime, we assessed the long-term nesting phenology of the Long Island rookery. We used both population-wide and individual-based metrics to test the hypothesis that the peak of the nesting season has become significantly earlier during the past decade. We additionally evaluated our data in the context of regional sea surface temperatures (SST) and broader climatic phenomena such as ENSO and NAO. We discuss our findings in relation to predicted patterns of global climate change, including regional weather patterns and a projected increase in the number of tropical storms. Finally, we examined the implications for hatchling sex ratios and recommended management strategies to mitigate the potential impacts of an earlier hawksbill nesting season. The presentation of these findings at the 32nd International Sea Turtle Symposium has been made possible by support from the International Sea Turtle Society, the Western Pacific Regional Fishery Management Council, the U.S. Fish and Wildlife Service, and the U.S. National Marine Fisheries Service.

MASS NESTING ECOLOGY AND EGG HARVEST OF THE OLIVE RIDLEY SEA TURTLE AT OSTIONAL BEACH, COSTA RICA*

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The olive ridley sea turtle (*Lepidochelys olivacea*) is a red-listed species characterized by its mass nesting behavior, also known as arribada. This mass nesting phenomenon has facilitated the utilization of this species by coastal communities, much of it illegally. In Ostional beach, Costa Rica a community-based egg harvest program operates legally as a way to generate an alternate source of income for the community while at the same time promoting the protection of the ridley nesting assemblage by decreasing destruction rate of nests and poaching. In spite of this foundation to date no contemporary analysis exists based on data collected since the 1980s indicating the viability of the egg harvest program as a sound management tool. To this effect we generated baseline abundance data of the major arribada events occurred during the period 2006 – 2010. In addition, we report harvest data along with preliminary hatching success as a way of evaluating the effectiveness of the program. Since July 2006 through December 2010 we empirically sampled 42 of the 49 arribadas occurred to estimate the number of egg laying females. Arribadas ranged from 6,471 to 47,340 egg laying females in the dry months of January to May whereas in the wet months of June to December arribadas ranged from 3,564 to 476,550 egg laying females indicating large variability in the nesting population. Estimated egg harvest ranged from 1,527 total nests in April 2009 to 8,138 total nests in August 2006. In relation to the estimated number of nests laid the harvest fluctuated from 1.49% in October of 2008 to 103.59% in June the same year. Hatching rates estimated between July 2007 and January 2008 ranged from 0% in January to 32.57% in September. It is not clear whether arribadas underwent a significant change in abundance during the study period, although the number of years covered is too short to establish a long-term trend. However, when compared with historical data the population appears to have declined. Overall, we see the need to continue monitoring the nesting population as well hatchling production to establish long term trends. However, we do not feel that the egg harvest is large enough to harm the adult population.

NESTING DENSITY EVALUATION OF OLIVE RIDLEY TURTLE IN LA MARINERA BEACH, IN THE PACIFIC OF PANAMA*

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In the Republic of Panama, the existing information on arribada beaches of olive ridley is scarce. The Azuero Peninsula is considered one of the most important nesting sites in the Panamanian Pacific, as the olive ridley (*Lepidochelys olivacea*) arribada beaches of Isla Cañas and La Marinera are located there. This study was developed in Playa La Marinera, located at Tonosi County, Los Santos Province, Panama. La Marinera offers approximately 700 m of optimal space for nesting sea turtles. The objective of this study was to assess the density of olive ridleys arribada nests using the quadrats method on La Marinera beach in the 2010 nesting season (July-December). During the study, 7 quadrats of 2 x 2 m were arranged in two rows and used to sample the nesting area of approximately 6000 m^2. Quadrats were arranged horizontally parallel to the length of the beach with a distance of 30 m between each quadrat. A distance of 7 m was left between the two rows of quadrats, this distance allowed data collection of nest density in both the upper and lower middle area without interference of rising tides. Once the quadrats in the sampling site were ready, we proceeded to dig 20 to 30 cm, to expose turtle nests. This method allowed us to determine the number of nests left on the beach to incubate after each arribada. We observed an increase in the number of the nests as the arribada season progressed, with the November arribada having the largest number of nests, estimated at 3000 nests. However, we observed a low nest density of no more than 2 nests/m^2 in this arribada, concentrating the largest number of nests within sectors 4 through 7, in the middle of the nesting area. This preference was similar for olive ridley nesting in the upper areas of the beach. These data suggest that low densities of olive ridley nests found on La Marinera beach can foster a high hatching success, which benefits the recruitment of neonates favoring the life cycle of this species. Additionally, this research identifies preferred areas for nesting olive ridley sea turtles at La Marinera beach. Finally, we recommend a special management plan, which prohibits the use of the resource extraction, but allows the sustainable use of it through eco-tourism.

COROZALITO, A FUTURE ARRIBADA BEACH FOR OLIVE RIDLEY TURTLES?

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Corozalito is a small beach of just 800 meters situated on the Nicoya peninsula of Costa Rica. It is a well known beach due to the abundant numbers of olive ridley and the occasional green turtle that frequent the beach to nest, and the majority of these nests were being poached. Monitoring of the nesting activity on Corozalito was initiated during August 2008 and has continued during the prime nesting season from July through to December every following year. During the 2008 season 1,366 nesting events were recorded, 1,519 during 2009, 1,551 in 2010 and to date 4,000 events during this current 2011 season, for this reason Corozalito is considered to be one of the most important solitary nesting beaches for

olive ridley turtles in Costa Rica. Due to the high levels of egg poaching occurring at Corozalito, a volunteer program was initiated in 2009 in conjunction with support from the local development committee and other members of the general public which helped promote conservation, investigation and protection of marine turtles. This also helped to reduce poaching from 25% in 2008 to 6% in 2010. On the night of the 23rd September 2011 a synchronised mass nesting event of 2000 olive ridley turtles occurred this event could only be described as a "mini arribada". This was the first documentation of a mini arribada occurring at Corozalito although there have been other reported sightings of this nesting phenomenon occurring in the past, one of which during January 2007. Could this beach be converting from a solitary nesting beach into an arribada beach?

OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) ENVIRONMENTAL MICROZONES FOR HATCHING SUCCESS AT AN ARRIBADA BEACH AT OSTIONAL NATIONAL WILDLIFE REFUGE, GUANACASTE, COSTA RICA*

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Ostional National Wildlife Refuge (ONWR) in Costa Rica holds one of the largest olive ridley sea turtle (*Lepidochelys olivacea*) nesting beaches in the world. Ridley turtles are distinct from other sea turtles because they nest in arribada – mass aggregate nesting and solitary fashion. We conducted a field-based research project at Ostional from September 2010 to January 2011 to test the null hypothesis that all areas of the beach produce equal number of hatchlings. Biological characteristics within different environmental microzones (estuary, high-tide line and vegetation) and their relationship to fecundity rates were identified. After each mass nesting event and egg incubation period, ridley nests were exhumed and the development of embryos was examined. Generally, the average hatching rate (AHR) remained constant throughout September, October and November. The AHR of exhumed nests was found to decrease in areas closer to the vegetation. Near the high-tide line the AHR increased and fluctuated each arribada, this may be due to the density and spatial dispersion of the arribada event. Our main research findings were: a) the production of hatchlings at ONWR exhibits stratification; b) the AHR at ONWR is positively correlated with the proximity of nests to the high-tide line and estuary edge; c) the AHR decreased towards the vegetation and was lowest at the vegetation border; and d) hatchling production decreased significantly after the rainy season. The production of hatchlings at ONWR in 2010 was estimated at 67566, 49767, and 4542 for September, October, and November, respectively. We expect that improving our understanding of the overall hatchling production of the beach and its potential for sustaining the adult population will advance management and harvesting practices at ONWR and advise international policy and conservation programs.

MAPPING BEACH TEMPERATURES AND HATCHLING SEX IN LEATHERBACK SEA TURTLE NESTS ON SANDY POINT, ST. CROIX, U.S. VIRGIN ISLANDS: TAKING SEX RATIO ESTIMATES TO THE NEXT LEVEL*

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During incubation, sea turtle clutches experience a variety of environmental conditions that can influence developmental trajectories. One of those trajectories is the sex of the embryo, which is determined primarily by the temperature of the nest during the middle third of incubation. Generally, warmer temperatures produce more females, while cooler temperatures produce more males. Nest temperatures can be influenced by climatic variation as well as by embryo-generated heat produced as a metabolic by-product of development. Thus, both abiotic- and biotically-derived processes influence nest temperatures and may yield a skewed sex ratio. During the 2010 and 2011 nesting seasons, a study was implemented to estimate the hatchling sex ratio in a population of leatherback sea turtles on Sandy Point National Wildlife Refuge (SPNWR), St. Croix, U.S. Virgin Islands. Nest temperature was measured using data-loggers placed in a sample of nests (n2010=62; n2011=28) throughout the nesting seasons. Sand temperatures of the entire beach were also measured using data-loggers (n2010=38; n2011=52) buried at nest depth along transects in the major nesting areas of Sandy Point. These data were used to create a thermal profile of the beach in order to estimate the temperature of all nests incubating on Sandy Point. Sex was verified in naturally dead emerged hatchlings and dead full-term embryos collected from the sample nests upon excavation (n2010=106; n2011=66). Specimens were preserved in 10% neutral buffered formalin and sexed based on four measures of gonadal and duct morphology (paramesonephric duct size and mobility, lumen completeness and gonad mobility). Sex was verified using histological analysis of gonadal tissue. From nest temperatures, verified embryo sexes and the thermal profile, the sex ratio of SPNWR leatherbacks was estimated in both the 2010 and 2011 seasons. This study provides baseline information on the sex ratio of Sandy Point leatherbacks, which is important for assessing population vital rates and conducting population modeling. Furthermore, the results of beach temperature studies will allow for more informed management decisions that can aid the recovery of the Sandy Point leatherbacks.

Social Sciences, Education and Outreach

AN ASSESSMENT OF LOCAL KNOWLEDGE AND ATTITUDES TOWARD SEA TURTLE CONSERVATION IN GHANA*

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Traditional protection plays an important role in wildlife conservation. This type of protection is based on oral histories that are typically passed from one generation to the next and speak of benefits gained for not harming an animal. In many cases, cultural protection for an animal provides the organism with stronger protection than administrative laws. Unfortunately, modernization and globalization are deteriorating such oral histories and may be compromising the protection of species that were otherwise protected through cultural histories. In this study we assess the attitudes and strategies of sea turtle protection in four fishing villages across the coastline of Ghana. Specifically, we determine if oral history and administrative laws influence fishers' interactions with sea turtles. We surveyed fishers in four coastal villages extending from the western region to the eastern region of Ghana. We also questioned key informants in one village to get further details regarding traditions and taboos against killing sea turtles. Our analyses indicate the existence of traditions and taboos do not afford additional protection to sea turtles, but does make residents more receptive to sea turtle conservation efforts. Across all sites, 73% of those interviewed are aware of the law which prohibits killing sea turtles. Eighty-five percent of the fishermen have captured sea turtles, although most were quick to add that it was not intentional. Respondents were able to distinguish the leatherback ("big turtle") from other sea turtles ("small turtles"), but were unable to differentiate between photographs of green, loggerhead, olive ridley, and hawksbill sea turtles. Fishermen from each village indicated their fish catch is consumed by residents in the village and sold at weekly markets. Fish are captured using gill nets with no specific target species. Each village also indicated that there has been a significant reduction in size and amount of fish being captured. Many fishermen blamed near-shore international commercial fisheries as the reason for reduction of their catches. Both traditional and national laws appear to be working together to inform conservation of sea turtles. It is possible that traditional taboos are no longer providing significant protection due to the influx of residents from inland towns where there are no traditional stories regarding sea turtles. Additionally, it is unclear if the oral histories that afford sea turtles with traditional protection are being passed to the younger generations. Successful conservation efforts in Ghana will include community discussions and workshops that promote the ecological benefits of sea turtles while celebrating the cultural protection turtles have experienced in the past.

COMMUNITIES: THE ACHILLES HEEL OR THE OPPORTUNITY TO EXPAND YOUR FAMILY AND KNOWLEDGE OF SEA TURTLES? OUR STORY IN EL VALLE, CHOCO, COLOMBIA

Karla G. Barrientos-Muñoz and Cristian Ramirez-Gallego

Colombian Sea Turtle, Colombia & University of Puerto Rico

For years, turtle protectors have tried to ensure the conservation of sea turtles worldwide. But, when we reach an area and we have a community, it becomes a priority to achieve the objectives of conserving and divulging the importance of sea turtles, and it becomes more expensive than the collection of biological data. Then, the communities become the heel of Achilles. Largely, the success or failure of the research and conservation projects depends on the communities that make direct use of the resource, and are the only ones who can guarantee the conservation of sea turtles. How many times have we heard from turtle protectors, who have had to leave an area, because the community inhabitants asked them to? The community El Valle, located in Pacific Chocoan, it is the main nesting area for *Lepidochelys olivacea* in South America. The consumption of turtles and nests can reach 100%. The region has historically had a culture of eggs and turtle meat consumption, which not only responds to protein requirements. These customs are of great value for this community and any attempt to minimize these pressures is not easy, especially when it is not possible to offer alternative food or livelihood. During 2008, in the framework of the nesting ecology project of *L. olivacea* in El Valle, Choco, Colombia, in addition to biological data on the species (which in principle was our unique interest), we collected information about culture, economy and perception of community on sea turtles. However, only after four months of daily interaction with the community and at the end of the season, they alone (after "measure us in oil") little by little, they decided to make part of the family and share with us their real perception of sea turtles: *"After what we did (kill nesting females and poaching eggs) have entered the consciousness and don't see that there is the same amount as we thought." We are willing to conserve and that all children and future generations who come to see many like us. Those tourists, you will see something never seen before. Turtles are very beautiful, is not seen in all places of the country or the world." Julio Rivas (Local researcher).* We will show a compilation of cultural and trade data with *L. olivacea* for over two decades. Comparing data reporting up to 300 turtles captured by season and the poaching of 100% of their nests, compared to 2008, which they consumed 5 turtles and egg poaching did not reach 2% of the broods for this season. Moreover, since 2008, they continue monitoring the beaches, when their work permits, tag and collect biometric data from turtles, without any legal or monetary commitment from us to them. But, with great commitment for us to raise funds (because we know their needs) and therefore increase the family that conserves the sea turtles in El Valle, Choco.

INTEGRATION OF INDIGENOUS-COASTAL COMMUNITIES IN THE CONSERVATION OF SEA TURTLE IN THE GULF OF VENEZUELA: COMMUNITY SERVICE LAW, AN IMPORTANT TOOL FOR THE ENVIRONMENTAL EDUCATION

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Sea turtles have always been part of the Wayúu culture, the main inhabitants of the Gulf of Venezuela coast, who consider these animals as a divine gift (from God Maleiwa). Currently, the process of transculturation has changed the needs of these communities, making the commercial aspect an important component in the local economy. These commercial activities include not only the use of sea turtle meat, but also the carapace, and the scutes (in the case of the hawksbill turtle), jeopardizing the survival of these species. This project of indigenous fishing communities' integration started in 2007 aiming to inform, educate and sensitize the local community on environmental issues, such as the identification of sea turtles as keystone species in marine ecosystems and endangered animals, as well as looking for a significant decrease of the illegal trade of sea turtles without modifying the ancestral roots of communities. Active volunteers were trained and committed to the mission of protecting sea turtles and coastal marine ecosystems in the Gulf of Venezuela; they also developed informative materials and tools to encourage the participation of communities, developing various strategies for staff training through intercultural-bilingual (Wayunaikii and Spanish) environmental education. In virtue of this project, communities have joined and committed to protect the environment, with particular emphasis on sea turtles. This is the result of multiple lectures, workshops, sports, murals, semi-structured interviews, and meetings; all of them promoting the participation of community leaders such as teachers, fishermen, community councils, housewives, fishing fleet owners, indigenous groups, among others. The results show the effectiveness of the inclusion of local communities, by introducing them to the resource of interest (sea turtle) and how this relates to their "modus vivendis", and proposing a leading role methodology in the conservation program. The rescue of sea turtles is evidence of the community support, in the last 5 years the number of sea turtles rescued year by year has increased, representing a new record for the Gulf of Venezuela from 2010 to 2011 (259 sea turtles rescued). Around 2,500 people have received the information about the actual critical situation of the sea turtles in the zone. And finally, more communities communicate with this inter-institutional team: LUZ/GTTM-GV/Community Service-Sea Turtle in order to give these endangered species a second chance to live. Keywords: community service law, sea turtle, conservation, Gulf of Venezuela.

OUTDOOR EDUCATION PROGRAMS FOR CHILDREN: "SUMMER NATURE DISCOVERY CAMPS" IN THE REPUBLIC OF CONGO

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Renatura is a French-Congolese Non Profit Organization acting for sea turtle conservation in the Republic of Congo since 2001. First actions were monitoring patrols on nesting beaches. Soon, Renatura staff realized that any field work wouldn't lead to any result without a community awareness and outreach counterpart. That's why, since 2005, Renatura has developed an educational program in rural and urban schools, as well as an awareness campaign for the general public. Year after year, the NGO has thus built its own education tools, based on local context, culture and experience. Posters, comics, tales, movies in local languages, and radio broadcasting are now available to reach a larger public. Nevertheless, summer vacations were a long period (3 months in Congo) during which Renatura educational team couldn't work with the young public. For summer vacation, children and youngsters often go back to their parents' village to help for housekeeping and field work. In 2009, Renatura launched the "Summer Nature Discovery Camps" in Congo. The idea is to offer to the young public in villages an entire week of entertainment mixed with pedagogical session focused on environmental issues. The Renatura educational staff visits week after week every village along the Congolese coast. Two activity leaders are alternating games, environmental information, and manual works. Entertainment times are rare for the children from remote village. These summer camps are thus special and outstanding moments in their childhood. They have fun while discovering their environment in an original context. The summer camps are striking their imagination on the long term, providing them with a different view on their living environment. Pictures are made all along the summer camp week and every night there are shown to the entire villages on a wide screen previous to a documentary movie on environment. Summer camps are really successful in villages that rarely benefit from entertainment activities. This year was the third edition of the summer camps and it is now possible to make a first return. Easy to implement and not too expensive, summer camps allow Renatura for building new relationships based on entertainment with communities. Renatura thus interact with villages all along the year. Summer camps give a new dimension to exchanges with local people, since environmental messages are brought as form of relaxation. Diversifying the way to raise awareness makes it more efficient. Activity leaders share with the villagers' day-to-day life during one week and increase their legitimacy and the value of their speech. One of the difficulties is to renew every year the educational tools: games, information support, and documentary movies. This program needs an important preparation work to ensure the quality of education and entertainment. Summer camps are reproducible in other contexts, easy to implement and with a high value added in term of environment awareness and education for wildlife conservation project.

"SA`WAINRÜ, LEGADO DEL MAR" (LEGACY OF THE SEA): DESIGN OF AUDIOVISUAL PRODUCT FOR SEA TURTLE CONSERVATION IN THE GULF OF VENEZUELA

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The purpose of this Special Work Degree is to promote the conservation of sea turtles in the Gulf of Venezuela through the design of an audiovisual documentary, and to publicize the interplay of these species and the different cultural events that directly involve the Wayuu. These Indigenous people are living in the Alta Guajira area, and since ancient times they use sea turtles everyday as a food source and in many cultural and religious ceremonies, so the conservation of these species in the region involves different variable scenarios, and communication codes such as economics, religion, language, cultural and ideological diversity, among others that are key to identify and establish effective strategies and messages for the conservation of these species in the region. Individuals clearly capture more directly and precise the visual and audio messages. For this reason the elaboration of a audiovisual documentary is an effective tool to promote the conservation of sea turtles, as this allows us to investigate, analyze, examine, promote and address an environmental, social and cultural event, using real footage and interviews, revealing the reality as close as possible to how it manifests. We developed a design methodology based on the development of an audiovisual production, which involves three basic stages: pre-production, production and post-production, executed in a systematic and organized way to get a good outcome. We conducted a comprehensive research in the area and analyzed different case studies related to the topic, to know and handle all aspects of production. Once the methodological process were carried out, the final result was obtained the audiovisual documentary "Sa` wainrü, a legacy of the sea" developed under real image processing and graphics intervention, highlighting the image and graphic design functionality in the genre as a tool of audiovisual communication expression. "Sa` wainrü" is aimed for the general public, especially local communities in the city of Maracaibo and indigenous-fishing communities, the Gulf of Venezuela, making the projection of the documentary in the city of Maracaibo in schools, bazaars, fairs, audiovisual presentations, movie theaters, the short film festival "Manuel Trujillo Duran" and through various local television stations, and also in the towns of Paraguaipoa, Cuzia, Kazuzi, Porshoure, Parashio, Cojoro, Wincua, Irramacira, Castilletes, through massive projection for the entire community in the schools and local sports facilities, providing useful information about sea turtles to more than 10,000 people, increasing by 40% the level of consciousness of the population on the different factors involved and the conservation of sea turtles in town, encouraging people to be partners and advocates of conservation of sea turtles in their localities.

BRIDGE THE BORDER: A VIRTUAL SEA TURTLE RESEARCH JOURNEY FOR K-12 STUDENTS*

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Bridge the Border is a virtual sea turtle research journey for K-12 students in San Diego, CA. It is a collaboration between The Science Exchange Sea Turtle Research Internship program and Ocean Connectors Educational Program. University interns enrolled in The Science Exchange work remotely with Ocean Connectors' K-12 students through distance learning tools like video Skype and blogs. The college interns collect empirical data from wild sea turtles in their natural habitats, while the K-12 students collect experimental data from "fake" nests by burying ping pong balls in a bucket of moistened sand. In 2011, two interns working at a PRETOMA Station in Costa Rica, and two at the Centro Ecologico de Akumal Station in Mexico, communicated weekly to Montgomery Middle School students about their field research. The research questions common to both age groups were: how does the ambient temperature affect sand temperature? How does sand moisture and grain size affect sand temperature? What will happen to the sea turtle nests if global warming occurs? Both age groups had use of the same sieves, scales, hobos and/or thermometers. There are educational and scientific results to report. Pre and post program tests showed an overall 48% increase in knowledge about sea turtle ecology for the 200 students at Montgomery Middle School in San Diego. Qualitative observations from the blog page revealed a marked increase in understanding of the potential effects of global warming on sea turtle ecology, the trials of field work and living in a different country, and the advantages of higher education and working abroad. Both age groups' temperature data were significantly correlated with local weather station data ($p<0.05$), indicating high quality data collection. Intern data collected from hobos inside five turtle nests in Akumal had a minimum temperature of 24.06°C and a maximum of 36.19°C during the third trimester of the incubation periods. The maximum temperatures were above the published lethal limits for sea turtle survival (~34°C) and the pivotal temperatures for producing females (~30°C). Indeed, nests where the temperature never reached 34°C had hatchling success rates up to 32% higher than the nests that hovered below 34°C. The hobo in the classroom nest was artificially heated and cooled with heat lamps and airconditioning during six trials, and the average nest temperature was 20.6°C with a max of 27.13°C. Interestingly, the sand took between 13 and 19 hours to cool to pre-experimental conditions, even with classroom temperatures dipping to 17°C at night. Akumal nests showed less extreme diurnal ranges, possibly from the metabolic warming of the embryos, but also the influence of the higher nighttime tropical temperatures. Air temperature and sand temperatures were significantly correlated in Akumal as well, further indicating that several hours of low nighttime temperatures are valuable regulators or "airconditioning" for extreme high temperatures of the day. Climate change is expected to raise the air temperatures (both day and night), causing concern for the survivability of sea turtle nests and for sex ratios.

CONSERVATION EDUCATION AND COMMUNITY ENGAGEMENT BY THE LEATHERBACK TRUST IN PLAYA GRANDE, COSTA RICA

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The Leatherback Trust (TLT) was officially created to study, conserve and protect the leatherback sea turtles that nest at Playa Grande, Costa Rica. TLT first demonstrated its commitment to outreach by developing a training program to convert egg poachers to eco-tour guides. This initiative served to create a connection between the local stakeholders and the newly created National park as well as illuminate the true value of their natural environment, the surrounding Mangrove Estuary and National Park beaches. This initiative led to a conservation education program as well as a new industry that would yield sustainable, rather than temporary, income for local Costa Ricans. After this initial success, TLT's outreach program became focused on local students and teachers. However, before integration of conservation into the local curriculum, TLT committed to helping these schools meet their classrooms' basic needs. This included providing teachers with appropriate teaching supplies and improved teaching facilities (repairs to the school's kitchen and creation of a computer lab with security features). Completion of these initial goals has allowed TLT to shift its focus to working with teachers to augment existing curriculum with conservation-themed knowledge. In addition, TLT designed a program to broaden the experience of local children in Playa Grande by providing them with a rare opportunity to travel outside their local villages as well as become acquainted with the natural features within their own community. TLT's education program has been sending the graduating class of elementary students on an exploration of San Jose, Costa Rica and near-by biological reserves as well as their own backyards. During trips to San Jose students experienced educational facilities and cultural heritage that would be inaccessible in Playa Grande. By visiting biological reserves students came to understand how the environment of Playa Grande is unique to the rest of Costa Rica. The students also traveled to the local mangrove estuary where they cataloged the immense species diversity; later, the students were given the responsibility of presenting their findings to the rest of the school and to their families. It is hoped that through these experiences students will not only connect to the nature and biodiversity that make their home special but also begin to take ownership for these resources. In the future, TLT proposes a continuation of the concept of 'ownership through experience' by expanding this concept to the community as a whole. To this extent, TLT seeks to engage in a visible, grassroots community conservation movement in Playa Grande that will get community members more involved with the Las Baulas national park, leatherback turtle research activities and neighborhood building programs such as a community garden, enhanced recycling and a "green" community center. These programs will provide greater access to conservation for the community of Playa Grande as well as continue to foster positive relations between the community and TLT. I would like to thank the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service, and the International Sea Turtle Symposium for generously supporting my travel to this year's symposium. I would also like to acknowledge the tremendous support of Judy Zabriskie, Jim Spotila, Frank Paladino, and Bibi Santidrián Tomillo that allowed for the completion of this project.

CULTURAL KNOWLEDGE AND ATTITUDES TOWARD SEA TURTLE CONSERVATION ISSUES IN PEARL LAGOON, NICARAGUA*

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The grounded theory results I presented in 2011 uncovered several key issues, themes, and relationships among concepts that comprise the cultural context in the community of Pearl Lagoon, Nicaragua. The analyses implicitly assumed that, underlying those themes lay a more or less consistent agreement among the people interviewed regarding their understanding of the status of sea turtles as a resource, and about their perspectives on conservation programs. In this research, I set out to empirically address this assumption. I used a cultural consensus analysis (CCA) to confirm the existence of a "cultural agreement", a single cultural model of shared beliefs, among a set of informants to estimate each informant's knowledge of the domain, and also to reveal features of that social reality that suggest additional lines of inquiry. Cultural knowledge or shared cultural beliefs, whether positive or negative, can affect cooperation and environmental stewardship. If consensus exists among residents of Pearl Lagoon regarding the degree to which members of the community agree among themselves about the status of green turtles with respect to conservation efforts, the emergent themes I presented last year, focusing on a lack of trust and perceptions of corruption, presented critical challenges for conservation in the region. The informal cultural consensus model (CCM) was used in this study to determine if there is one common culture of attitudes toward local sea turtle conservation efforts and knowledge of green turtle status in Caribbean Nicaragua. I used CCM to measure cultural knowledge in this research because it is a reputable statistical model for measuring the degree of shared knowledge. The amount of agreement between participant responses is not overestimated, and the CCM analysis provides an accurate estimate of the culturally correct responses to the set of items (from the domain of knowledge about sea turtles and sea turtle conservation in Caribbean Nicaragua) I presented to study participants. The CCAs cognitive testing revealed that residents maintain a high degree of shared knowledge on the domain of sea turtle conservation and population status. These data strengthen the results from my taste preference study (presented in 2010) and the grounded theory analysis (presented in 2011). From a conservation perspective, the results present common challenges to conservation efforts by external NGOs in rural areas of less developed countries. I am hopeful that the findings of my study will be used to inform the direction of future research and sea turtle conservation initiatives in Pearl Lagoon.

DRIVERS OF THE CONSUMPTION AND TRADE OF SEA TURTLE PRODUCTS IN CAPE VERDE, WEST AFRICA – ARE WE TAKING THE RIGHT APPROACH?

Joana Hancock

Turtle Foundation, USA

Shifts from subsistence use to the commercial exploitation of wildlife stocks have led to the local and/or global extinction of many species, or severe declines of others. At the Cape Verde Islands in the Atlantic Ocean, historical records and recent studies indicate heavy human predation pressure on nesting and foraging turtles across most of the 10 islands that comprise the archipelago. This study focused on two of the islands, Boavista and Santiago, which are thought to be the major source and sink of sea turtle meat, respectively. First, the current level of illegal harvesting and consumption was assessed, followed by an analysis of the drivers of these activities. Finally, three broad categories of interventions that have been commonly employed in Cape Verde to reduce illegal and/or unsustainable sea turtle harvesting, trade and consumption were evaluated by interviewing target social groups, such as fishermen, fish sellers, and the general population. This study first assesses the current level of illegal harvesting and consumption on the two islands of Boavista and Santiago, followed by an analysis of the drivers of these activities. Finally, three broad categories of interventions that have been commonly employed in Cape Verde are evaluated, individually or in combination, to reduce illegal and/or unsustainable sea turtle harvesting, trade and consumption. To obtain this information, a series of semi-structured questionnaires were carried out in May and June 2011 on the islands of Boavista (n=147) and Santiago (n=290), employing snowball (harvesters and sellers) and random sampling (consumers). The results indicate that there has been a shift in the type of harvesting, from subsistence level to now being primarily conducted for trade purposes. Sea turtle harvest and consumption are still taking place at high rates, even though a decline has been observed over the last seven years; the drivers for this change were public awareness campaigns on Boavista versus a lack of availability on Santiago. Future interventions should target consumers throughout the whole Cape Verde archipelago, especially as the major drivers of sea turtle trade are shifting towards large and affluent urban populations, while rapid economic growth and infrastructure expansion is facilitating increased access to sea turtle nesting beaches and sea turtle products. The results show the importance of understanding the reasons for harvest and consumption to target interventions to meet the issue requiring resolution, and demand for a regular re-assessment of the effect of interventions in the form of science based management.

STUDENT IMPACT ON SEA TURTLE CONSERVATION PACUARE NATURE RESERVE, COSTA RICA*

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Ecology Project International (EPI) is a non-profit organization whose goal is to progress and inspire scientific education through field-based student-scientist partnerships. Programs involve experiential education, conservation, and cultural exchange in order to motivate

students to take an active role in conservation. EPI's sea turtle program positively impacts sea turtle populations in three key ways: (1) increased student presence on the nesting beach deters poaching and assists data collection, (2) education of international students regarding their impact on sea turtle populations, and (3) education of local students to increase investment in their own environment and resources. Since 2000, more than 5,000 students from Costa Rica, USA and Canada have been involved in EPI's sea turtle ecology program in the Pacuare Nature Reserve (PNR) on the Caribbean coast of Costa Rica. This four mile stretch of beach is among the most important nesting sites for the leatherback sea turtle (*Dermochelys coriacea*) in Costa Rica. Throughout the last eleven years the number of students has increased from 48 students in 2000 to 641 in 2011, with more than 300 student patrols annually. In 2011, students recorded 277 leatherback sea turtle activities and identified 143 individual nesting females. Since 1989, poaching rate within PNR has fallen from 97% to less than 1% in 2010, suggesting a relationship between increased presence on the beach and a decline in opportunistic sea turtle egg removal. While student involvement positively impacts conservation efforts on the beach, the experience and knowledge gained from participating in EPI's program may have a substantial impact on the future of sea turtle conservation both locally and internationally. 2,256 international students have participated in the program, during which they learn aspects of sea turtle biology, behaviour, threats to sea turtle populations, and ways in which they can contribute to sea turtle conservation. The major factor impacting successful sea turtle conservation in this area is related to the participation of students from the region surrounding PNR; 2,775 students in 11 years. Throughout Costa Rica, consumption of sea turtles and their eggs is a socio-cultural norm, embedded in local tradition, and students frequently consume these products in daily life. Through experiential education, these students achieve a sense of ownership related to their natural environment, becoming potential ambassadors for sea turtle conservation and environmental awareness within their families and communities, consequently discouraging illegal consumption of these animals and associated products. Student experiences in the PNR are supplemented with cultural exchanges between local and international high schools, and an annual symposium in which students share their research carried out in PNR and with other students, and present environmental projects resulting from participation in EPI. This further validates the experiences obtained within PNR, encouraging progression of ideas and conservation practices. EPI's sea turtle program demonstrates the potential positive impacts of student involvement in conservation projects. Along with providing a larger, trained workforce, such experiential education programs have the capacity to facilitate environmental awareness in young people, empowering them to take an active role in conservation.

18 YEARS IN TURTLE CONSERVATION AND COMMUNITY DEVELOPMENT: AN UPDATE OF TCP'S ACTIVITIES IN SRI LANKA*

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Five species of sea turtles nest in Sri Lanka. They are the green turtle (*Chelonia mydas*), leatherback turtle (*Dermochelys coriacea*), olive ridley turtle (*Lepidochelys olivacea*), loggerhead turtle (*Caretta caretta*) and the hawksbill turtle (*Eretmochelys imbricata*). All 5 species are listed by the World Conservation Union (IUCN) as either critically endangered

or endangered. Destruction of the coastal ecosystems by coastal communities is a substantial problem in Sri Lanka. Coastal communities have to depend on their surrounding natural resources for survival. As a result, very important coastal habitats such as the coral reefs, sea grass beds, mangroves, marine turtles and other coastal vegetation are under serious threat of extinction. The Turtle Conservation Project (TCP) realized the chain connection between the coastal communities and coastal resources, which heavily depend on each other. Community members of Rekawa exploited marine and coastal resources due to poverty and lack of awareness. TCP has therefore implemented an innovative initiative - the 'Community Based Ecosystem Conservation Approach' (CBECA) - in order to preserve marine and coastal resources. CBECA is a multi-pronged approach with several main components such as: 1) community livelihood development, 2) community infrastructure development, 3) environmental restoration and management, 4) community awareness/capacity development, 5) partnership building/networking, 6) knowledge management and sharing, 7) utilization of local culture. Since then, TCP has improved the socioeconomic conditions and well-being of the community by implementing various community based projects at the same time. TCP has formed different Community Based Organisations (CBO) like as the community batik group, fish breeding group, sewing group, coir mat making group, or bee keeping group, and provides alternative livelihood development skills training for these CBO members. TCP also provides the equipment and initial stocks of raw material. Initial capital needs are met through the revolving fund scheme. TCP has implemented infrastructure development programs such as renovation of rural roads in order to facilitate local ecotourism and other businesses. In addition, TCP has established a public library, public bus stops and drinking water facilities. Furthermore, TCP has also created community skills development programs such as computer and free English language classes, primary school programs, swimming training and disaster preparedness training. Youth clubs were established in order to involve children in the coastal eco-system conservation and management process, providing them with necessary awareness through various educational programs. TCP has also implemented community health programs such as, medical clinics, free herbal drink programs for school children, community welfare services and first aid training. Additionally, TCP developed multiple partnerships with national and international organisations to make this project a success. The Wildlife Conservation Department has been invited and involved in the project to enforce the law and also to declare the Rakawa beach as Sri Lanka's first Marine Turtle Sanctuary.

OCEAN CONNECTORS: SEA TURTLES AS A TOOL FOR INTERNATIONAL CONSERVATION EDUCATION

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Ocean Connectors is a marine science education program that engages underserved students in interactive environmental activities by focusing on the migratory nature of sea turtles. As a project of The Ocean Foundation, Ocean Connectors demonstrates that conservation education can, and in fact must, traverse international borders in order to spread environmental awareness. Ocean Connectors shows that community involvement and communication are fundamental tools to fostering an environmental ethic in today's youth, and thus to achieving long-term conservation success in Mexico and other regions

throughout the world. The Ocean Connectors project began years ago by using sea turtles as a means to teach conservation lessons to youth on a binational scale. By partnering with local scientists we were able to bring some of the region's most underserved students into direct contact with the real sea turtle research taking place in their own "backyard". Ocean Connectors uses education as a tool for raising awareness in coastal communities, focusing on the importance of international cooperation for the long-term protection of sea turtles. Education is a useful sea turtle conservation technique. Students can be inspired to make sustainable lifestyle choices; last year over 45% of program participants committed to picking up litter as a way to benefit sea turtles and the environment. By focusing our lessons on marine issues that are relevant across the entire Eastern Pacific region, this program effectively connects youth and instills community members with a sense of stewardship. This strengthens the public's desire to take individual action to protect sea turtles and ocean health. Ocean Connectors hosted student and teacher workshops as part of the 2011 International Sea Turtle Symposium in San Diego, bringing our yearly audience to over 2,000 youth. Our preliminary results from the 2011-2012 school year strongly indicate that Ocean Connectors had a positive impact, on communities from Alaska to California to Baja California Sur. We studied the behavioral changes that students chose to make after participating (such as litter abatement, pollution prevention, and recycling). Our data shows that student knowledge increased significantly as a result of participating in the Ocean Connectors program, and final results will be available in March 2012.

A STEP IN THE RIGHT DIRECTION: REDEFINING COMMUNITY-BASED SEA TURTLE CONSERVATION IN GUATEMALA

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Akazul, a grass-roots initiative, was founded to focus on the preservation of the natural resources of Guatemala's marine and coastal environments and is currently working to redefine the meaning of community-based sea turtle conservation in the Pacific community of La Barrona. At present, Guatemala's sea turtle conservation strategy employs an egg-donation system in which local egg collectors may harvest unlimited quantities of olive ridley (*Lepidochelys olivacea*) eggs, as long as they donate 20% of the eggs from each nest to a local hatchery. However, due to minimal control of this procedure, donations rarely succeed 12 eggs per nest. The lack of baseline data, nesting activity monitoring, and standardized management techniques make difficult to assess this system's effectiveness. Having recognized the need for increased and measurable community involvement, in 2011, Akazul began developing monitoring and research activities, education programs, capacity building workshops and alternative income generation schemes. The main objective of these activities is to include and empower community members in conservation practices and as key actors in the protection of local sea turtle nesting populations. Akazul is currently one of the only projects in Guatemala which fully engages community members with its conservation and monitoring activities, such as through the "Sea Turtle Stewardship Program". The program includes the development of a community self-monitoring system, where a local team of the most conscientious collaborators patrol the beach to actively promote wider participation and encourage change within the community. The provision of capacity building activities, development of low impact eco-tourism, educational and recreational programs is helping to address wider economic and social needs, and

demonstrate the commitment of the project in supporting the local community in addition to striving to protect local nesting populations. One of the key elements of this program is the idea of long-term sustainability in conservation activities. By developing a sense of pride in conservation participation and nurturing the desire to protect the environment, the aim is to shift the overall responsibility of local conservation issues away from the individual hatchery managers to the community as a whole. The effectiveness of this program has been demonstrated through the quantity of consistent collaborators, the number of donated eggs, participation in conservation activities and a significant increase in positive attitudes towards sea turtle conservation. Guatemala's current egg donation system remains controversial as a strategy for successful sea turtle conservation but it is clear that the effective protection of the country's nesting population will necessarily rely heavily on community participation. We believe that the initiatives provided by Akazul are a step in the right direction for both the olive ridley sea turtles and for the coastal communities of Guatemala.

"SAVING THE SEA TURTLES" FESTIVAL: A LOW COST METHOD TO ENVIRONMENTAL EDUCATION IN COASTAL SCHOOLS OF URUGUAY

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In 1999, some people interested in increasing the knowledge on sea turtles in Uruguay formed the non-profit Karumbé. Today, in Karumbé we think that to conserve sea turtles, we need to know their reality and threats; and we need research on sea turtles to understand their status; but the research will only help the conservation when the results are shared with the scientific community as well as the local communities. Thus, it is very important to work together which each other. Therefore, Karumbé has been developing the "Saving the Sea Turtles" Festival in the schools of the coastal zone surrounding Cerro Verde, the main feeding area of green turtles in Uruguay. The goal of the festival is to share knowledge about sea turtles and to make students aware of our responsability in preserving the environment. Each year, the festival is focused on one specific theme by using artistic, recreational, sportive and research activities, distributed in 5 days (40 hours, one week), involving 500 students (2 schools, 20% of local people). In 2008, we focused the festival around "The Turtles Race", presenting the sea turtles species, their life cycle and threats. In 2009, the theme was "Where do turtles come from?", focused on the differences and similarities of the environmental, geographical, cultural and social aspects between nesting areas in Uruguay. In 2010, the theme was "Our beach, a special home", highlighting the importance of Cerro Verde area to many marine animals, and our contribution to the degradation of these ecosystems associated with the production and irrational use of garbage, presenting the importance of the three Rs (Reduce, Reuse and Recycle). In 2011, the theme was "The drums bring the news, the invaders aren't immortal (Eduardo Galeano)", highlighting the local culture, working with native animals, migration process and invasive species problems. Again, here marine debris was treated as an invader who, with our initiative, won't be immortal in the ocean. Each year, the students were divided in teams (by turtles species, countries, marine animals, terrestrial animals), then they did a study on different fields such as biology, geography and history, painted flags, wrote songs and participated in sportive activities, always with low cost and reusing materials (total cost of US$75 per school). After counting the points, all kids were awarded medals to strength the competitive spirit, with the

idea that the important thing is not to win but to participate, share and learn having fun. Moreover, the students were involved in a conservation task: collecting plastic bottles and caps. The bottles (2,300/year) were reused in the construction of greenhouses at the schools of La Coronilla (2008) and Punta del Diablo (2009), and the bottle caps (10,000/year) were donated to public hospitals that exchanged them for blankets. We think that the festivals have helped to build an identity associated with the care of the environment, forming reality transformer citizens. On the other hand, it had helped to consolidate the ideas in the team, to clarify of our own responsibility as citizens in preserving the environment and to form of a more just society, to strengthen our own goals analyzing the results and learning from the process. Every day, every activity, every emotion felt by the team, is what gives us the strength to keep this proposed work, fighting for the conservation and protection of our culture, economy and nature and know ourselves to be part of it.

THE BARROW ISLAND FLATBACK TURTLE TAGGING PROGRAM: A MUTUALLY BENEFICIAL RELATIONSHIP BETWEEN CONSTRUCTION, CONSERVATION AND THE COMMUNITY*

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The endemic Australian flatback turtle (*Natator depressus*) coexists in northern Western Australia with a large, expanding resource sector (oil, natural gas and mining). Chevron Australia, operator of the Gorgon Gas Project, have approval to develop the Greater Gorgon gas fields located off the edge of the North West Shelf. The processing and shipping facilities for the project are currently under construction on Barrow Island, 75 km south-east and 50 km from the mainland. Pendoley Environmental, with financial and logistical support from Chevron, manages the Flatback Turtle Tagging Program each year at Barrow Island and on the mainland at Mundabullangana, as part of the regulatory marine turtle monitoring commitments of the Gorgon Gas Project. The program is unique as it integrates community participation in marine turtle conservation into one of the biggest construction operations ever carried out in Australia. The tagging program is one of the largest of its kind in the world, and is the largest for this species. It is estimated that 87% and 77% of the flatback nesting populations at Barrow Island and Mundabullangana respectively have now been uniquely tagged (>6,000 individuals) using flipper and PIT tags since systematic tagging studies began in 2004. The tagging program engages a significant number of community volunteers. Over the course of seven nesting seasons more than 350 volunteers have gathered empirical data on turtles. Approximately 35% of the volunteers each season have been involved in the program in the past, demonstrating both their commitment to the program and the positive nature of their experience. The 72 tagging positions are highly sought after; in 2011, there were 274 applications. The volunteers range in age from 18-70 years, and come from diverse backgrounds, including universities, government departments, environmental consultancies, zoos, schools, professionals (eg. engineers, doctors and lawyers), and Barrow Island workers and family members. Local, state, interstate and international members of the public have been involved in the program, with volunteers flying in from China and USA to participate in the program in the 2011-2012 season. Volunteers must adhere to the same rules as other construction workers present on the Island; this includes a comprehensive medical and three days of safety and quarantine training prior to leaving for the Island. Whilst tagging turtles, daily safety meetings and training are held, and all volunteers must wear full-length high visibility safety clothing and boots. Similar

requirements apply to volunteers working at Mundabullangana. The use of volunteers is not a legislative requirement placed upon Chevron; however, it was decided that community participation would be mutually beneficial to both the wider public, by enabling numerous volunteers to directly interact with marine turtles at no financial cost other than their time, and to Chevron in meeting the environmental conditions imposed by the Australian government, without the prohibitive costs associated with paying construction site rates to a large number of people. However, the ultimate goal of the program is to increase our understanding of the flatback, subsequently contributing to appropriate management strategies and conservation of this under-researched species.

POLICY PLAYERS: USING SEA TURTLE BIOLOGY TO TEACH ECOSYSTEM HEALTH AND PUBLIC PROCESS TO MIDDLE SCHOOL STUDENTS

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This project will bring the real world application of land development to eighth grade students focusing on how land development can impact an endangered species. Students will be presented with a scenario where the class is a coastal community who has been approached by a company who wants the rights to develop a resort on publicly held beachfront property that is known to be a sea turtle nesting beach. Using guided inquiry-based lessons, students will learn key scientific principles while becoming engaged in the process by fulfilling the roles of scientist, public constituent and community board. The goals of this module are for students: 1) To gain knowledge of the scientific process to solve real-world environmental problems, using the impact of development on a coastal ecosystems; 2) To understand how light is transmitted; 3) To understand the difference in how human and sea turtle eyes detect light and color; 4) To learn how to communicate scientific information to their peers; and 5) To learn the state and/or local government decision-making process, including the role of public commenting.

IF 'A TURTLE IS WORTH MORE ALIVE THAN DEAD', WHY DOES POACHING PERSIST? A DISCUSSION OF LITERATURES ON POACHING, AND THE PERSISTENCE OF SEA TURTLE POACHING IN TORTUGUERO, COSTA RICA*

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As a social scientist researching ecotourism and 'conservation and development' in Tortuguero, Costa Rica, I have not asked specific research questions about poaching of sea turtle meat, shells, or eggs. In fact, I have projected a lack of interest in turtle conservation-related efforts while 'in the field' so as not to appear overtly 'turtle conservation biased'. I have tried to avoid discussions about sea turtle poaching, since it is an illegal and often controversial undertaking in Costa Rica. I have however, 'accidentally' or 'incidentally' collected data about past and current turtle meat and egg taking, vending, and consumption. In this paper, I present interview and participant observation data on turtle poaching, vending and consumption (2002; 2003; 2004; 2008; 2011). I also include poaching data collected by

The Sea Turtle Conservancy (Caribbean Conservation Corporation), to compare this case with others at conservation sites. I recognize that persistent poaching in Tortuguero exists despite economic alternatives (e.g. turtle tourism), education/outreach activities (e.g. by The Sea Turtle Conservancy), and anti-poaching legislation and penalties. I suggest likely poaching motivations and contextualize these with dominant theories of poaching cultures and underlying motivations in conservation contexts (e.g. parks and protected areas). I include recent poaching cases of sea turtles and other endangered or protected species (e.g. Allister *et al* 2009; Kuhl *et al* 2009; Bell *et al* 2007; Koch *et al* 2006; Yom-Tov 2003; Heltberg 2001;Melner-Gulland and Leader-Williams 1992), and refer to historical cases (e.g. Hutchings' 2002 explanation of England's Black Act-related poaching in the 18th century). In presenting this combination of empirical data and literature review, I problematize how we conceive of and discuss poaching. I draw attention to common treatments of poaching in the sea turtle conservation literature, and respond to these. I invite us to consider our assumptions, denials and portrayals of poaching, and I interrogate the nature of our (limited) attempts to understand poaching and poachers. Do we really know who poachers are or do we emphasize certain stereotypes, while downplaying diversity? Do we take the time to empathize with poachers, or do we begin our understanding of them at the 'official illegality' and undesirability of their acts? Do we take the time to recognize the myriad motivations behind poaching or do we assume that poaching stems from a handful of simple reasons? If poaching activities arise from myriad motivations, do we possess the correct mix of tools, incentives, and processes to address these? Are our portrayals of poachers accurate enough to inform turtle conservation and environmental management? The central question guiding this paper is often hinted at but seldom answered: Why does poaching persist, despite the best efforts of conservationists and anti-poaching enforcers, in places with populations who do indeed understand and appreciate that a 'turtle is worth more alive than dead'?

SEA TURTLE USE AND CONSUMPTION IN URUGUAY, TWELVE YEARS OF CONSERVATION AND CHANGE OF PERCEPTION

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Uruguay is an important feeding ground for five of the seven species of sea turtle in the world, *Chelonia mydas* (green turtle), *Caretta caretta* (loggerhead), *Lepidochelys olivacea* (Olive Ridley), *Dermochelys coriacea* (Leatherback) and *Eretmochelys imbricata* (Hawksbill). To determinate the use of the different species of sea turtle, six years (from 1999 to 2004) of direct observation data from the Uruguayan NGO Karumbe were used. In addition to this information interviews were leaded on March and April of 2011 to establish the perception of the fishermen towards the sea turtles after more than a decade of conservation efforts. From the data basis of direct observation of the use of sea turtle products (especially carapace), *Chelonia mydas* was the most frequent (n=119), followed by *Caretta caretta* (n=95), *Dermochelys coriacea* (n=12), *Lepidochelys olivacea* (n=3), and *Eretmochelys imbricata* (n=3). Rocha Department is the place where most records of *Chelonia mydas* were detected (n=89), while Montevideo Department was the second with high records (n=72), with *C. caretta* being the most abundant species (n=34). The interviews showed that 17 of 18 fishermen had caught sea turtles accidentally during 2011, being the majority green turtles, followed by loggerheads. The fishermen said that in case of the

capture of live turtles these were released, 16 fishermen admitted that they used the shells as ornament, and two consumed the meat. Four fishermen admitted that they used to sell the shells about 15 years ago. The shell was most commonly used as ornaments and the skull was the second remain most used as a piece of collection. The final destination as goods for sale was the one which got fewer records. Nowadays, Rocha's fishermen expressed great interest in the care for the environment, because they suffer from over-exploitation of marine resources and the large increment of waste and pollutants in the sea. The fact that the majority of sea turtle remain records belonged to the green turtle was because this turtle is the most abundant in the coastal zone of Rocha Department. Meanwhile, Montevideo presented more records of loggerhead remains, which can be attributed to the crew of industrial fishery ships that occasionally landed sea turtle shells to be sold or used as ornament. The decrease in sea turtle products sales is attributed to the implementation of the Presidential Decree "144/98" in 1998 which prohibits the capture, possession, transportation and selling of sea turtles goods, and the fostering of conservation programs and environmental education provided by Karumbé since 1999.

HISTORICAL REVIEW OF MARINE TURTLES IN THE EASTERN MEDITERRANEAN OF TURKEY

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Three marine turtle species regularly occur in the Mediterranean basin: *Caretta caretta* (loggerhead turtle); *Chelonia mydas* (green turtle); and *Dermochelys coriacea* (leatherback turtle). Only the first two reproduce in the Mediterranean and they are globally listed as Endangered species in the IUCN Red List of Threatened Species. Marine turtle populations in the eastern Mediterranean were severely exploited in first half of the 20th century by human activities. In modern times, marine turtles have been known as an economic resource in the Eastern Mediterranean since before the beginning of the 20th century. A fishing company from Iskenderun began to buy marine turtles from local fishermen on the coast at Mersin, Adana and Antakya. Hunting of turtles in Turkey started in the early 1950's and continued until the end of the 1960's. FAO fishery statistics mention about 1,000 tons of turtles caught in Turkey in this period. Between 1952 and 1965, up to 15,000 specimens were taken from the shores of Mersin. In May 1965, 100 specimens or more were caught around Adana, all *Chelonia mydas*. In this single area by May 1965, more than 10,000 turtles had been captured for their meat to export to Europe. Hunting for their meat and body fat is a major cause of the drastic decline in marine turtle populations. The hunting of and trade in marine turtles was prohibited in Turkey in 1984. In September 2011, a face to face interview was held in Iskenderun with the last surviving partner of the company involved in the commercial marine turtle trade. After the interview took place, FAO records were reviewed and a separate interview was done with experts from the Ministry of Food, Agriculture and Livestock. The data obtained were used to assess the historical process of decline that occurred in marine turtle populations in the 1960s. As part of the study, the information gained from the Iskenderun interview, the FAO records and interviews with Ministry of Food, Agriculture and Livestock specialists was evaluated. The study will result in a projection for past marine turtle populations in the Eastern Mediterranean. Acknowledgements: We would like to thank all the individuals and organizations that technical supported this study: FAO Turkey Office and Turkish Ministry of Food, Agriculture and Livestock specialists in Ankara; Captain Vecih Ozcan; Fehit Buran; volunteer photographer Volkan Bal and WWF Global

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LOCAL PERCEPTION OF SEA TURTLES IN THE FISHING COMMUNITIES OF "COSTA ORIENTAL DEL LAGO", VENEZUELA

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Sea turtles are closely related to the fishing communities around the world. Assessing the impact of fishing gear on sea turtle populations has been essential in establishing conservation measures that need to be developed in coastal communities. The Gulf of Venezuela (GV) is an important feeding ground for five species of sea turtles (*Chelonia mydas*, *Eretmochelys imbricata*, *Caretta caretta*, *Dermochelys coriacea* and *Lepidochelys olivacea*), and it also constitutes the main economic and food resource for many coastal communities. The NGO “Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela" (GTTM-GV), has implemented Community Based Conservation along several fishing communities, especially on the west coast of the GV. However, the status of artisanal fishing and its relationship with the sea turtles on the east coast remained unknown. Therefore, this investigation seeks to evaluate the interaction of the fishing communities of the eastern coast of the GV (also known as “Costa Oriental del Lago”, COL), and their relationship with the sea turtles. To collect information on those communities, semi-structured interviews were conducted with fishermen in 21 fishing ports of adjacent coastal communities (Ancón de Iturre, Bella Vista de La Candelaria, Los Jobitos, Sabaneta de Palma, and Punta de Palma), in order to describe the fishing gears used and to collect information about sea turtles, such as sightings, species and size. Each location presents different characteristics, which are directly related to the interaction with sea turtles. In the fishing ports of “Los Jobitos” the main fishing gear is longlines with “J” hooks, and this constitutes the area with the most encounters with sea turtles (75% of fishermen reported sighting and incidental capture). Fishermen in “Bella Vista de La Candelaria” release entangled sea turtles when they survive, and despite being the community with lower economic resources, sea turtles are not used as an economical income. In “Sabaneta de Palma” and “Punta de Palma” the encounters with these species are low, because they tend to tear the fishing nets, thus the fishermen try to avoid them. On the other hand, in the “Ancon de Iturre”, the GTTM-GV, in conjunction with another environmental NGO, had initial contact with some fishermen of the community, which resulted in the collection of records of incidentally caught and stranded

sea turtles that were succesfully tagged and released. It is estimated that 1-2 turtles are caught annually in each of the locations assessed in the COL, being the most common species the loggerhead (*Caretta caretta*) and hawksbill (*Eretmochelys imbricata*) turtles. This work increases the general information about sea turtles in the area, considering local knowledge and experience of these communities as a key source for the beginning of conservation processes. Likewise, it is a starting point for the development of strategies that link sea turtles conservation with these fishing communities.

WAYUU CULTURE: FROM CONSUMERS TO SEA TURTLES CONSERVATORS*

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Community-Based Conservation is considered a very effective and consolidated strategy of environment conservation it requires an investment of significant time and effort, but brings long-term positive results for both the communities and the endangered species protection efforts. The Sea Turtle Working Group at the Gulf of Venezuela (GTTM-GV, its acronym in Spanish) has a 14 year trajectory of research and labor with fishing-indigenous communities within the Venezuelan Guajira. Through the years a greater reception and integration of communities, has been observed, resulting in an increase of the numbers of rescued and released sea turtles along with the fishermen in the Gulf of Venezuela. This research describes the efforts of sea turtle conservation in the Venezuelan Guajira, from 2010 to 2011; 100% of these results were obtained from the Wayúu indigenous people. Eighty percent (80%, N=170) of the records represented live sea turtles, 93 (39 %) of these were rescued at the locality of Kasusain, both percentages represent an important indicator of the conservation program's success. The highest proportion of individuals was registered between September and October 2010, with a second highest increase from July 2011. Seventy nine percent (24) corresponds to juveniles individuals, showing that this region is an important recruitment area for these organisms, and affects the impact of conservation activities in other regions, may have a medium to long-term results. We believe that better

results can be achieved if the authorities were to support this activities by working together hand in hand with the indigenous people not only in cooperation but by including them on the staff that works in the project, taking advantage of the local knowledge and the local activities carried out in the area of the Venezuelan Guajira.

ASSESSMENT OF THE LOCAL INTERACTIONS ABOUT SEA TURTLES IN FISHING PORTS AT TOAS ISLAND, VENEZUELA

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Worldwide, it is known that sea turtles are classified as endangered as a result of the anthropogenic impact on their principal feeding and nesting areas. By-catch is considered as one of the factors affecting sea turtle populations, contributing significantly to their mortality. This reality includes the Venezuelan industrial and artisanal fisheries. Considering the richness of the Gulf of Venezuela in terms of marine resources, there has been an increasing development and multiplication of artisanal fisheries throught the past ten years. Taking into account that five species of sea turtles (*Chelonia mydas*, *Eretmochelys imbricata*, *Caretta caretta*, *Dermochelys coriacea* and *Lepidochelys olivacea*) inhabit Venezuelan waters, it is necessary to study and assess their regional status in depth. In order to collect information about sea turtles, such as sightings (aquatic and terrestrial), species, stages and their interaction with fishing gears, we conducted semi-structured interviews with fishermen of the fishing ports in the community of Toas Island (10°57′0″N and 71°40′0.12″W) located in the south of the Gulf of Venezuela. The results indicate that artisanal fishing is the primary income source in these communities. 64% (n=16) of the fishermen described gillnets as their main fishing gear, and worked in areas near to the System of Maracaibo (depths from 15 to 18 m); 24% (n=6) of them use both gillnets and longlines, and only a 12% (n=3) is limited to hook-and-line. The 96% (n=24) of fishermen reported the presence of green turtle (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles, and 20% (n=5) also reported loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) turtles in sourrounding areas. Acording to the information recorded, we estimated 2 to 4 turtle sightings (mainly turtles with basking habits) by fisherman per year, mostly located at the outlet of the estuary waters, where the salinity and depths are higher. By-catch mortality is estimated around 4%, which is considered low when compared with other communities in this zone; this could be due to the use of the gillnets which, as reported in previous researches in the Gulf of Venezuela, decrease the probability of entanglement of sea turtles in this area. Additionally, most of the fishermen claimed to have released the turtles immediately after capture. This work confirms the interaction of sea turtles with the fishing community of Toas Island. Based on the ecological importance that sea turtles represent for the natural balance of marine ecosystems, national and regional

cooperation for the conservation of sea turtles should be a priority. As one of the principal axes of community based conservation, the inclusion of new communities is essential, in order to increase the information about the local knowledge regarding sea turtles, and to promote the application of environmental education as a tool to ensure the sustainable use of natural resources in the area. Key words: sea turtles; artisanal fisheries; Toas Island, fishermen; conservation.

SAVING SEA TURTLES THROUGH FOOTBALL

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La Barrona is a typical village on the Pacific coast of Guatemala near the border with El Salvador, where the majority of families are dependent on small-scale farming, subsistence fishing and the harvest of sea turtle eggs from threatened olive ridleys (*Lepidochelys olivacea*) and critically endangered leatherbacks (*Dermochelys coriacea*). The collection of sea turtle eggs from olive ridleys is permitted as long as the egg collector makes a donation of 20% of each nest found to a local hatchery, but the collection of leatherback eggs is illegal under any circumstance. “Saving Sea Turtles through Football” is a project initiated by Akazul to combine the town’s passion for football with sea turtle conservation by creating a youth football team, coupled with a structured environmental awareness program for the participants. Twenty-two children between the ages of ten and fourteen attend three activities a week. Adults from the local men’s team help coach the children to develop their football skills and teamwork in bi-weekly training sessions. In addition to football-based activities, participants also attend weekly sea turtle education classes and participate in other Akazul conservation activities. The curriculum for the sea turtle education classes is derived from Turtle Talks: the Activity Book, by Zander Srodes. The material covers information of all the species of sea turtles, life cycle, anatomy, threats to sea turtles, and ways children can help protect sea turtles. Akazul involves these children in sea turtle conservation activities such as hatchling releases, nest excavations, and accompanied night patrols. Hatchling releases are an especially important activity because they allow the children to witness the products of community collaboration, such as the donations of eggs that many of their parents have made to the hatchery. Additional conservation activities include beach cleanups, mangrove reforestation, and waste management programs. These three dimensions of the program allow children to become actively involved in the work of Akazul and enhance their awareness for sea turtle conservation and environmental stewardship. ”Saving Sea Turtles through Football” will create the next generation of conservation minded inhabitants, who will be more likely to develop alternative, non-consumptive uses of sea turtles to replace income from traditional, consumptive uses. An additional long term effect of this program will be that the youth will promote environmental consciousness among the adult population of egg-harvesters towards sea turtles and the environment in general.

FORBIDDEN SEA TURTLES: TRADITIONAL LAWS PERTAINING TO SEA TURTLE CONSUMPTION IN POLYNESIA*

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Throughout the Pacific regions of Micronesia, Melanesia and Polynesia, sea turtles are recognized as culturally significant species. The specifics of human-sea turtle interactions in these regions; however, are not well known, in part because ethnographic and historic reports documenting these interactions are scattered requiring extensive archival research. Ethnographic and environmental data collected over a ten-year period is analyzed to assess patterns of human–sea turtle interactions prior to (and sometimes beyond) Western contact. From the ethnographic data for Polynesia, a region-wide pattern emerges where sea turtle consumption was restricted to special ceremonies where the elites, such as chiefs and priests but no one else, ate turtle. Only in two island groups did this pattern differ. Environmental data does little to elucidate explanations for this region-wide treatment of sea turtles as restricted food sources, as there is no correlation between environmental variability and the presence or absence of these restrictions. Instead, the results of this research suggest such practices may have been part of an ancestral Polynesian society, developing well before human settlement into this region of the Pacific.

SEA TURTLES IN AQUARIUMS: 2010-11 CENSUS SURVEY*

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In 2010-2011, the Sea Turtle Working Group (STWG), which meets in conjunction with the Association of Zoos & Aquariums (AZA), developed a survey to produce a census of sea turtles in aquariums, zoological parks and science centers that have public display. Previous surveys focused on North American facilities and were conducted in 1996 and 2002 by the Virginia Marine Science Museum Foundation (now the Virginia Aquarium Foundation) in conjunction with the STWG. The 2010-2011 survey has been made available on Survey Monkey and announced to the STWG and others through AZA supported listservs, e-mails and phone calls. To date, 46 North American aquariums, zoological parks and science centers have reported holding sea turtles at their facilities. All but two facilities reported having sea turtles on public display or for public education programs. The survey was divided into two sections: permanent animal collections and animals held for rehabilitation or research. A total of 203 sea turtles were reported in permanent collections: 88 loggerhead (*Caretta caretta*), 81 green (*Chelonia mydas*), 7 E. Pacific green (*Chelonia agassizii*), 14 hawksbill (*Eretmochelys* imbricate), 11 Kemp's ridley (*Lepidochelys kempii*) and 2 olive ridley (*Lepidochelys olivacea*). The number of sea turtles less than 1 year of age in permanent collections at a facility ranged from 1 to 31 with a mean of 6.9. The number of juvenile and adult sea turtles in permanent collections ranged from 1 to 15 with a mean of 3.4. There were a total of 469 sea turtles being held for rehabilitation or research: 99 *Caretta caretta*, 305 *Chelonia mydas*, 6 *Eretmochelys imbricata* and 59 *Lepidochelys kempii*. The number of sea turtles less than 1 year of age being held for rehabilitation or research ranged

from 1 to 31 with a mean of 8.8. The number of juvenile and adult sea turtles being held for rehabilitation or research ranged from 1 to 264 with a mean of 22.2. Other survey questions included: age class and gender of sea turtles; whether turtles were on public display; time period that the facility had been caring for sea turtles; how sea turtles were acquired by the facility; if the turtles were part of any research activities; if the facility participated in any sea turtle conservation programs; and if the facility would be willing to participate in a more detailed survey for the purpose of developing an animal care manual for sea turtles. Final results of the survey will be used to facilitate increased communication and cooperation among facilities caring for sea turtles and the research community, with the goal of improving husbandry and conservation efforts.

TRASH TALKING CHELONIIDS: SEA TURTLES WITH AN IMPORTANT MESSAGE!*

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The negative effects of marine debris on sea turtles have been well documented throughout the world. A major solution to the marine debris problem is public education. Beach cleanups have become a worldwide program to increase public awareness of the effects of debris on marine life. Working with local children, the Virginia Aquarium & Marine Science Center Stranding Response Program (VAQS) has inspired a statewide campaign to increase public awareness by incorporating trash items collected during cleanups, specifically balloons, into sea turtle sculptures created by children. These "trash turtle" sculptures have been displayed in coastal areas throughout the state along with educational information on the hazards posed by balloons. The expected outcome and success of this program is twofold: it provides a way to increase awareness of the hazards posed by balloons and other marine debris to marine life while involving children in a creative way to learn about the problem and feel ownership for solving it. In Virginia, a trash turtle sculpture is used by the VAQS outreach team in their public display. It is an eye-catcher to those who pass by the display and creates a topic for discussion among visitors and VAQS Team Volunteers. Four additional sculptures were made by the children for display at coastal National Wildlife Refuges and a state park in Virginia. Pledge cards stating that “I promise to never release balloons” were distributed and displayed with the turtle sculptures. In the two years that these four trash turtle sculptures have been on display, hundreds of signatures have been collected. The trash turtle has not only educated hundreds of people about the dangers of balloons, but has also influenced further action by other individuals and groups. A local recycling company has asked for a trash turtle for their education room and a local elementary school will be constructing their own trash turtle sculpture for the children to fill with trash that they find in the environment. Most impressively, a 15-year old volunteer at a local National Wildlife Refuge not only stopped a balloon release using the information that she learned from the trash turtle, but created a “balloon dress” from 87 balloons found on one of Virginia’s barrier islands. This presentation will discuss the following: (1) how we worked with school children in the process of creating several trash turtle sculptures from balloons found during beach cleanups; (2) how to create a public awareness campaign using a trash turtle sculpture; (3) how to modify the sculpture to meet local needs; (4) how these sculptures have been used in Virginia to change the mindset of many adults and children about balloon releases; and (5) future plans for the Virginia balloon campaign. We will also

create a “How-To Guide for Trash Turtle Sculptures” for distribution at the International Sea Turtle Symposium as well as other similar venues.

BUILDING CAPACITY FOR SEA TURTLE MONITORING IN MNAZI BAY-RUVUMA ESTUARY MARINE PARK, TANZANIA

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Mnazi Bay–Ruvuma Estuary Marine Park (MBREMP) is located in southern Tanzania, forming the border with Mozambique. MBREMP supports a rich and diverse variety of marine, coastal and terrestrial habitats including highly productive coral reef and sea grass ecosystems that provide important foraging grounds for all five species of sea turtle found in the Western Indian Ocean: green, hawksbill, olive ridley, loggerhead and leatherback. There is also a small but critical population of nesting green turtles within MBREMP which utilise beaches in the southern part of the Park. Furthermore, a hawksbill nest was recorded in 2005, which represents the only recorded hawksbill nest in mainland Tanzania. A community based sea turtle monitoring programme was established in 2004. Four Turtle Conservation Officers (TCO’s) were elected by their community and received training in all aspects of sea turtle biology and conservation. TCO’s patrolled six nesting beaches throughout the year and conducted track counts to identify the peak nesting season. Verified nests were monitored during the incubation period and post hatching excavations undertaken to calculate hatching success. The monitoring programme recorded 188 nests between 2004 and 2011 with a mean annual nest count of 24 (SD±8). The peak nesting season was in June and July. Over 13,000 hatchlings successfully emerged. However, many nests were lost due to tidal inundation. In October 2011, an evaluation of the nest monitoring programme was undertaken by Sea Sense, a Tanzanian NGO specialising in sea turtle conservation and protection. Interviews were conducted with MBREMP Wardens and TCO’s to identify logistical constraints to the monitoring programme and assess training needs. Two nesting sites were visited and village meetings held to determine the level of awareness and support for the sea turtle monitoring programme in the wider community. Following the evaluation process it was concluded that there was limited capacity to conduct effective monitoring of the six sites, and TCO’s were in urgent need of refresher training in relation to practical sea turtle conservation techniques. There was limited support for sea turtle conservation in the wider community with sea turtle slaughter and consumption being commonplace. It was agreed that five additional TCO’s should be recruited and trained and efforts be made to increase awareness amongst the local community on the importance of sea turtle conservation. A sea turtle training workshop was held and attended by three MBREMP staff, four existing TCO’s, five newly recruited TCO’s and three village leaders. The workshop consisted of theory sessions related to sea turtle biology and life history and several practical sessions including species identification, nest verification, translocation protocols and post hatching excavations. Following the training, MBREMP staff developed a work plan for the implementation of a more rigorous sea turtle monitoring programme that also integrated significant outreach work with local communities to elicit support for sea turtle conservation within MBREMP.

Threats

HABITAT OVERLAP BETWEEN LOGGERHEAD TURTLES (*CARETTA CARETTA*) AND BOTTOM TRAWLERS RESULTS IN HIGH BYCATCH RATES OFF EBRO DELTA (SPAIN)

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Incidental bycath has been identified as a major threat for the conservation of sea turtles worldwide. To date, most of the efforts to reduce sea turtle bycath have focused on gear modification and the identification of areas that should be closed to fishing because sea turtle are highly vulnerable there. Large numbers of juvenile loggerhead turtles (*Caretta caretta*) from the North-Atlantic, Mediterranean and Cape Verde regional management units visit the foraging grounds at the western Mediterranean, where they are exposed to high levels of bycatch by longliners, bottom trawlers and artisanal boats. Ebro delta is a particular hotstop for turtle bycatch in the region and bottom trawling is the fishing gear most often involved. Areas shallower than 50 m are closed to bottom trawlers in Spain, except off Ebro Delta, which migth explain why the bycatch levels there are higher than anywhere else in Mediterranean Spain. We have used aerial surveys and satellite telemetry to understand habitat use patterns by loggerhead turtles in the area and assess the effectivity of closing the shelf shallower than 50 m to the bottom trawlers to reduce sea turtle bycatch. Satellite tracking of eigth turtles ranging 39.5-55.5 cm SCL suggested the existence of two different groups of turtles in the area. Some of the turtles spent several months in the area, primarily into the bays found along the northern and southern shores of the Ebro Delta. However, a second group of turtles spent only a few weeks in the area, used randomly all the bathimetric domains and seldom entered the bays. After leaving the Ebro Delta, these turtles moved to other regions in the western Mediterranean. Aerial surveys covered a 42 x 84 nautical miles area and revealed that loggerhead turtles distributed randomly over the continental shelf off Ebro Delta, with 80% of the animals observed in areas deeper than 50 m. As the aerial surveys did not covered the bays, the turtles spoted during the aerial surveys clearly corresponded to the transient turtles identified by satellite telemetry and represent the bulk of the population in the area. According to these results, most of the turtles will still be vulnerable to bottom trawlers if they were excluded from the shelf shallower than 50 m. It should be noted that the annual mortalilty rate of the satellite tracked animals was 0.626 (IC 95%: 0.566-0.716), much higher than that reported for othear areas of the Mediterranean. The overal evidence is that the continental shelf off Ebro Delta is a sink for loggerhead turtles and simple measures, as closing the shelf shallower than 50 m to the bottom trawlers, will not significantly reduce bycatch. Only a dramatic reduction of the fishing fleet would have any significant effect. This research has been funded by the Zoo de Barcelona. Authors are grateful to the International Sea Turtle Symposium and the organizations that made possible the Travel Grant to attend the 2012 Sea Turtle Symposium: International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service.

USING STRANDED LOGGERHEAD SEA TURTLES TO COMPARE LETHAL AND NON-LETHAL VESSEL TRAUMA IN VIRGINIA, USA

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Since 2005, the Virginia Aquarium & Marine Science Center Stranding Response Program has responded to at least 180 stranded loggerhead sea turtles that sustained injuries consistent with vessel interaction (VI). Frequently, decomposition didn't allow determination of ante mortem injury, but when live or fresh turtles (code 0-1) stranded, we collected these data. We identified 21 code 0-1 cases for this analysis. Based on images and reports, we categorized the cases as: 1) ACUTE=immediately lethal injury in an otherwise healthy turtle (n=10); 2) CHRONIC=healing wounds in a debilitated turtle (n=4); 3) HEALED= apparently healed VI scars (n=7). We then created a lesion atlas for each category by overlaying and resizing images and digitally tracing the wounds onto a line drawing. The atlases showed different patterns of injury for each category which are discussed below. HEALED: We assumed here these turtles died from other causes. The scar pattern in five of the seven cases suggested serial propeller strikes, with two or more parallel scars. Two cases had single linear scars suggestive of sharp trauma. Scars were only present on the carapace, caudal to the third lateral and second vertebral scutes. We didn't observe any plastron or head scars. Finally, the mean carapace length (SCL N-T) on the five cases where we collected SCL was nearly 10.0 cm longer (81.4cm) than the mean for the turtles in the acute and chronic categories (71.7cm). This may suggest that larger turtles are more likely to survive some vessel injuries. It doesn't, however, suggest that large turtles don't succumb to VI as the mean SCL N-T for VI in all condition codes was similar to the healed category (82.0cm). ACUTE: Lesions associated with these 10 cases included a combination of lacerations from propeller strikes (sharp trauma) and crushing injuries probably associated with hulls, keels, chines and/or engine outdrives (blunt trauma). Three of six cases included "through cuts" where a lesion penetrated carapace, body cavity and plastron. One turtle sustained a severe skull fracture. Four injuries that were caudal to the third vertebral scute (similar to healed cases) appeared to be blunt trauma or a combination of blunt and sharp trauma and were associated with significant soft tissue damage. Sharp trauma, to the first three lateral scutes occurred in two cases and damaged lung tissue. All animals were robust with no significant lesions other than observed trauma. CHRONIC: These four cases were all alive upon stranding and were debilitated. We added two cases previous to 2005 to increase the data set. The six cases exhibited lesions intermediate between the acute and healed categories. Three cases included serial cuts and three cases involved head trauma. Although this simple method of VI wound characterization did not allow for interpretation of lesion depth, hemorrhage or soft tissue damage, we feel that it represents an important first step in understanding the mechanism of lethal VI. It may help in the interpretation of decomposed cases where the luxury of a live animal or histopathology isn't available.

USING MICROSATELLITES FOR INDIVIDUAL ASSIGNMENT TO NATAL REGIONS: A CASE STUDY WITH LOGGERHEAD TURTLES (*CARETTA CARETTA*) BYCAUGHT IN THE MEDITERRANEAN SEA*

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Incidental cath has been identified as a major threat for the conservation of marine turtles worldwide. Mixed stock analysis has been the traditional approach to determine the origin of the marine turtles incidentaly caught in feeding grounds shared by different populations, but this method does not allow individual assignment to the natal region, limiting further analysis. Microsatellites offer an alternative approach to assign each individual to its natal population if the microsatellite frequencies at their nesting beaches are known. Juvenile loggerhead turtles (*Caretta caretta*) interact with several fisheries in the western Mediterranean and recent published data indicated that the interaction with longliners and trawlers in northwestern Spain can be of local importance for this species. As each of these fleets operates in different fishing grounds, they may capture loggerhead turtles of different origins. Furthermore, as turtles of Atlantic and Mediterranean origin that share feeding grounds in the Mediterranean differ in growth rate and behaviour, trawlers and longliners might impact different groups within each population. In order to determine the origin of the populations that are affected by the Spanish fishing fleets, we developed a method to make Individual Assignments (IA) based on microsatellite markers. To establish the baseline, we genotyped seven microsatellites from 56 Atlantic individuals sampled from feeding grounds in the western Mediterranean. The Atlantic origin of those individuals was assessed through exclusive mitochondrial haplotypes. In a second step, we compared the observed allele frequencies with published frequencies of 112 hatchlings from Mediterranean nesting beaches. Mediterranean populations were found to be genetically differentiated from the Atlantic stock reaching the western Mediterranean (F_{st}=0.029, $p<0.001$), demonstrating that the two sample sets were different enough for IA. In addition, control individuals bearing mtDNA of known origin matched the expected origin when using microsatellite IA, thus corroborating the efficiency of this new assignation procedure. We then applied this methodology to a sample set of 82 bycaught individuals captured by Spanish trawlers and surface longliners working in the western Mediterranean. Results showed that the majority (88.64%) of loggerhead turtles captured by surface longliners were from Atlantic origin whilst more than the half of individuals (55.26%) captured by trawlers came from Mediterranean nesting grounds. The same conclusion would be derived from MSA, but IA allows further analysis. For instance, when the average length of turtles of Atlantic and Mediterranean origin bycaught by trawlers were compared, statistical differences were not found ($t=1.926$, $p=0.066$), although turtles of Mediterranean origin become vulnerable to trawlers at a much smaller size (29 cm CCL) than those of Atlantic origin (39 cm CCL). Furthermore, IA indicated that 10% of the turtles of Mediterranean origin were adult, whereas all the turtles of Atlantic origin were immature. Overall, these results show the high potential of

microsatellites to provide a further insight into the impacts of incidental bycatch by allowing individual assignment of the captured turtles. This study was co-funded by projects CGL2009-10017 and CTM2010-22218 of the Spanish Government (CICYT) and attendance to the 32nd International Sea Turtle Symposium was supported by the International Sea Turtle Society, the Western Pacific Regional Fishery Management Council, the U.S. Fish and Wildlife Service, and the U.S. National Marine Fisheries Service.

THE IMPACT OF SEA LEVEL RISE ON GREEN SEA TURTLE NESTING HABITAT IN CON DAO ISLANDS, VIETNAM

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Vietnam is one of the countries that will be most affected by the predicted 0.5-1.4 m sea level rise by 2100. One of the most exposed coastal habitat is the sandy beaches and sea turtles depend on these beaches for their nesting and reproductive success. 80% of the nesting of green sea turtles now occurs on protected beaches in the offshore islands of Con Dao national park. Unfortunately low-lying islands, such as Con Dao, will most likely be more affected by a sea level rise than other part of Vietnam, and the sea level rise is therefore a growing threat to the green sea turtle population. In this study we are estimating the loss of nesting beach area and reduction of green sea turtle clutches on Con Dao Islands due to predicted sea level rise. By using geographical information system (GIS) we built a digital elevation model (DEM), and using overlay analysis to predict the future sea level rise for every decade between 2020 and 2100 and for three different climate scenarios (B1, B2 and A1FI). Nesting data from 2010 with geographical positions for clutches could then be used together with the predicted sea level rise to analysis loss of nesting area and decrease of amount of clutches. In Con Dao Islands green sea turtle nesting occurs on six different beaches from Mars to November. It intensifies in the period between June and September with 83% of total nesting and with a peak in July with 28% of the nesting's. Therefore, we estimated the impact from sea level rise for each month separately to easily determine the impact on future nesting and variations over the year. The total nest lost for all of the six beaches in July is between 20-41% in 2100 for the different scenarios. The beach with most nests (52%) will also have the highest loss of 47-83% in July 2100, which is exceptionally high. The inundation of nesting area in March, October and November is much higher, fortunately these months only have 3.6% of the total nesting. For future conservation of sea turtle nesting in Con Dao islands we suggest that other beaches, with higher elevation, are protected from urbanization and other human activities to be used as nesting beaches in the future.

POACHING AND OTHER MAJOR THREATS TO TURTLE POPULATIONS IN GHANA'S WESTERN REGION

Neil R. Davis

Hen Mpoana (Our Coast), Ghana & Coastal Resources Center (University of Rhode Island), USA

From August 2011–March 2012 comprehensive studies of sea turtle nesting populations were carried in Western Ghana together with and funded by NGO, Hen Mpoano and Costal Resources Center (University of Rhode Island). The aim being, to further research and collect data on nesting activity in the region that began and has continued sporadically and inconclusively in 2004. It quickly became obvious that together with a general lack of data and conservation efforts sea turtles are facing severe and numerous threats in Ghana. Poaching and consumption of both turtle meat and their eggs is a huge problem. Traditionally turtles have always been on the Ghanaian menu and the laws put in place here have not helped, either they are unknown or very badly policed/enforced. Turtle meat is freely available at local markets and at fishing ports you can find them openly being butchered and sold along with many other endangered species such as manta rays and hammerhead sharks. Also while conducting nightly nesting surveys evidence of turtles being taken while nesting was observed and recorded. Many times during an average week, researchers would encounter turtle hunters who were more than willing to talk and very open about what they were doing. By documenting and reporting on the problems in Ghana we hope to spread awareness and fuel interest in sea turtles and conservation, both locally and internationally. Destruction of nesting habitats, erosion and sand used as raw materials for construction, litter/plastic, pollution, algal blooms, illegal long lining and trawling by foreign vessels again with a severe lack of policing are all culminating in a potentially catastrophic scenario for sea turtles in Ghana. To try and combat this over this nesting season and the next few years local partners and NGO's are developing a strategy to involve more and educate local people and stakeholders. Together with more volunteers from Ghana and overseas, people employed specifically as turtle researchers/field leaders and aid from local police and the Ghana Wildlife Division the aim over coming years make poaching a thing of the past.

HUMAN INTERACTION STRANDING DATA; A PRELIMINARY SPATIAL AND TEMPORAL ANALYSIS OF LOGGERHEAD SEA TURTLE STRANDINGS IN THE CHESAPEAKE BAY REGION

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The Virginia Aquarium & Marine Science Center Stranding Response Program (VAQS) has responded to more than 2,500 sea turtle strandings in Virginia since 1987. As part of a 2009 NOAA Species Recovery Grant, VAQS analyzed loggerhead stranding data from 2006 to 2010. Here we present a preliminary analysis of minimum estimates of human interactions (HI) within the dataset for lower Chesapeake Bay and Virginia ocean shorelines. To identify temporal stranding trends, we divided the year into seasons: spring (April-June), summer

(July-September) and fall (October-December). A total of 735 loggerheads stranded between 2006 and 2010, with 296 in spring, 316 in summer and 123 in fall. A total of 182 (24.8%) exhibited signs of vessel interaction (VI) with 50 (27.5%) in spring and 96 (52.7%) in summer, when vessel traffic is elevated. Sixty (8.2%) of the total strandings exhibited signs of fisheries interactions (FI) divided almost equally among the seasons with 20, 21 and 19 in spring, summer and fall respectively. Thus, the relative rate of HI (19/123=15%) is highest in fall when fewer strandings occur. The 60 FI included: 35 (4.8%) that ingested or became entangled in hook and line gear, 13 (1.8%) that interacted with unidentified fisheries, 9 (1.2%) in net gear, 3 (0.4%) in pot gear, and 3 (0.4%) that ingested debris. Preliminary analysis of gastro-intestinal contents showed 92 (12.5%) turtles had ingested fish, with 65 (71%) of these strandings in spring with 12 and 15 in summer and fall respectively. It has been suggested the higher than expected fish forage in spring may be a result of lower invertebrate prey availability in spring thus leading turtles to depredate from nets and/or ingest discards. Turtles ingested fish in all seasons, indicating that fish eating is not just a spring phenomenon. Of the turtles which ingested fish, 25% exhibited HI including: 13 hook ingestions, 7 vessel interactions and 4 entanglements. In most cases, these turtles appeared to be in good health aside from the HI, suggesting that when turtles ingested fish they had an elevated risk of FI. We calculated the relative densities of occurrence of HI for areas where VAQS responded with equal effort from 2006-2010. We calculated relative density using the Arcview 10.X point density function. Using the geometric interval scheme, we divided shoreline into three classes (low, medium, and high). High relative density of HI compared with all strandings occurred in 29% of the area. The largest high density HI area was located along the SE ocean coast of Virginia. Although location of interaction cannot be determined from stranding location, a high density of HI suggests an increased risk of mortality in the surrounding area. In order to determine the actual area of risk, we will conduct further analyses. Our preliminary analysis shows that HI is a significant, persistent cause of mortality in Virginia. We identified temporal and spatial trends in HI which will be considered in when prioritizing future stranding resources and developing conservation and management plans.

IMPLICATIONS FOR DISENTANGLEMENT AND IMMEDIATE RELEASE OF SEA TURTLES

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We examined three cases of entangled, rehabilitated and released cheloniid turtles from Virginia and two cases of disentangled and released leatherback turtles from Massachusetts for: 1) severity of entanglement, 2) injuries associated with entanglement and 3) time to healing, if known. The cases in Virginia involved wraps of pot gear buoy line around a front flipper and ranged in severity from: 1) juvenile loggerhead with light abrasions and visible, but minor swelling, to 2) an adult female green turtle that developed a debilitating, bone-

deep flipper lesion with severe swelling resulting in temporary lameness, to 3) an adult male loggerhead with substantial flipper necrosis resulting in amputation. The lesions on turtles 2 and 3 were healing, but not completely healed, upon release. The entanglements involving turtles 2 and 3 included multiple line wraps with tightly twisted trailing line, likely resulting in constriction or complete occlusion of blood flow. In contrast, responders could insert a finger under the entangling line on turtle 1 and the resulting wounds were minor. Turtle 2's entanglement lesion did not initially appear severe, presenting with superficial laceration and minimal swelling. The turtle was brought into rehabilitation due to an eye injury, but the flipper injury worsened over the course of 15 days and eventually necrosed to the bone in two places. The apparent lack of serious injury at the time of disentanglement raises concerns for immediate release of other turtles with tight flipper entanglements. The two cases in Massachusetts involved serially entangled leatherbacks that were disentangled from pot gear buoy lines and released by the Provincetown Center for Coastal Studies in Cape Cod Bay. The first case involved a leatherback with line wrapped around its neck and left front flipper; it was disentangled and released. The turtle exhibited discolored, wrapping marks around both flippers and neck with some areas of skin loss. Based on telemetry the turtle survived for 19 days until it drowned in a second entanglement event. Inspection of the carcass indicated that wounds which had been subtle at the first entanglement event were more apparent at the second. The second case involved a leatherback disentangled from a single line wrap. This turtle was found re-entangled 11 days later and wounds from the first event were more apparent at the next event and the overall condition of the turtle had declined. This latter case indicates that even relatively simple entanglements can result in tissue damage. These five cases raise concerns about the impacts of flipper entanglements on sea turtles that are disentangled and immediately released. While disentanglement may enhance immediate survival for many individuals, the extent of injuries associated with entanglements may be difficult to assess visually. Without adequate mark-recapture efforts the fate of disentangled turtles cannot be quantified. We recommend that disentangled sea turtles be evaluated for ligature wounds. Smaller species, if possible, should be collected and further evaluated in rehab facilities. Concurrently, we should work towards on-water mitigation strategies that may include medications and/or rehabilitation for leatherback sea turtles.

STRATEGY FOR SEA TURTLE CONSERVATION AND RECOVERY-U.S. ATLANTIC AND GULF OF MEXICO

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To reduce the harmful effects of incidental sea turtle bycatch, NOAA's National Marine Fisheries Service is implementing the Strategy for Sea Turtle Conservation and Recovery in relation to Atlantic and Gulf of Mexico fisheries (Strategy). The purpose of the Strategy is to comprehensively evaluate and address bycatch by gear type in commercial and recreational fisheries in state and federal waters of the United States. The U.S. commercial bottom trawl fisheries were identified as the highest priority for investigation and possible sea turtle conservation measures. Together with the Strategy team we evaluated the spatiotemporal distribution of sea turtles and bottom trawl fisheries and identified the

overlap. Fishing effort was estimated using self-reported fishing information (via vessel trip reports and log books). The bottom trawl fisheries operate primarily in shelf waters, though there is some commercial fishing effort reported in waters past the shelf break. Areas of previous interactions between sea turtles and bottom trawl fisheries were evaluated using data from independent fisheries observers. Turtle distributions based on aerial surveys, opportunistic sightings, and stranding data indicated that turtles were present throughout the U.S. EEZ, although the densities varied seasonally, especially in the northeast. The majority of observed sea turtle interactions with commercial fisheries occurred in the Mid-Atlantic region and southward, although the most intense trawling effort occurred in New England waters. Our presentation focused on the spatiotemporal distribution of the turtles in relation to suggested boundaries of a seasonally dynamic sea turtle conservation area along the Atlantic coast of North America.

ASSESSING THE VULNERABILITY OF AUSTRALIAN MARINE TURTLE NESTING SITES TO COASTAL LIGHT POLLUTION

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Australia supports globally significant nesting populations of marine turtles; however, the human population of Australia is also heavily dependent upon coastal areas. Increasing coastal development brings with it increases in artificial light. Since turtles are vulnerable to disorientation from artificial light adjacent to nesting areas, the mitigation of disruption caused by light pollution has become an important component of marine turtle conservation strategies within Australia. However, in addition to disruption from lights, marine turtles are also faced with a multitude of other anthropogenic threats. Managers need to prioritise impacts to ensure limited resources result in adequate protection of turtles. Knowledge of the extent to which nesting areas are vulnerable to light pollution is essential to guide management strategies. In this study, we use GIS analysis to over-lay turtle nesting data onto night-time lights data produced by the NOAA National Geophysical Data Centre, in order to assess the proportion of marine turtles in Australia at risk from light pollution. We also identify the particular nesting sites which face the greatest threat from artificial light. Our assessment indicates that although the majority of nesting turtles are currently at low risk, populations in Western Australia and south Queensland are vulnerable to light pollution. The risk to turtles from light generated by industrial developments in Western Australia is significantly higher than at any other location in Australia. Given the proposed and current industrial development occurring in Queensland, these findings indicate that managers of turtle populations in eastern Australia should expect large potential increases in impacts from light pollution in the areas surrounding these developments. Close monitoring of the resultant impacts on turtle populations is strongly recommended.

SEA TURTLE BYCATCH REVIEW FOR THE EASTERN PACIFIC: DETERMINING REGIONAL PRIORITIES*

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Sea turtles are long lived marine species that are currently endangered because their life history and population dynamics hinder them from withstanding modern anthropogenic threats. Worldwide, fisheries bycatch in on the major threats to the survival of sea turtles and that is also the case in the Eastern Pacific. To establish regional conservation priorities for the mitigation of bycatch, it is essential to first obtain a comprehensive picture of the regional sea turtle bycatch situation. This comprehensive analysis was lacking for the Eastern Pacific; therefore we focused on delivering a regional bycatch analysis for this region. A literature review was conducted to obtain numbers of turtles captured, frequencies, bycatch and mortality rates per species and country in trawl, longline, and gillnet fisheries, and to compile results of mitigation measures. This regional bycatch review used all the information compiled and synthesized to give conservation priorities at the regional level. The review underlines the high bycatch rates in trawls for Costa Rica, Guatemala, and El Salvador and the detrimental impact that these captures could have specially for hawksbill, *Eretmochelys imbricate,* due to its reduced population numbers and for green turtle, *Chelonia mydas,* due to its highest mortality rate. It also emphasizes the continuous lack of use of TEDs as a bycatch mitigation measure. In longline fisheries, the review identifies the high bycatch rates in pelagic longline fisheries of Costa Rica, Ecuador, and Nicaragua in a global context but given that olive ridley, *Lepidochelys olivacea,* is the most common species captured in these countries, it highlights the capture of loggerhead, *Caretta caretta,* and leatherback, *Dermochelys coriacea,* off Peru and Chile due to their small population numbers. Bottom longlines have high mortality rates compared with pelagic longlines in the region and the review identifies a need for further research in this area due to the scarce information but high mortality rates. For gillnet fisheries, the most important highlight is how little information exists for the region given the high rates of bycatch for sea turtles in this gear. However, the difficulties of studying bycatch in highly dynamic and artisanal fisheries are recognized as the major impediment for this situation. Nevertheless, the high bycatch rates in areas where sea turtles congregate in high numbers like in foraging grounds for loggerhead in Baja California, Mexico and for greens in Paracas and Sechura, Peru, calls for either gear modifications, change of gear, or areas closed for gillnets. We hope that the regional bycatch priorities list will be used to guide conservation actions in the Eastern Pacific.

ARTIFICIAL LIGHTING OF BEACHES SIGNIFICANTLY INCREASE PREDATION RISK BY GHOST CRABS OVER LOGGERHEAD NESTS AND HATCHLINGS*

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Most of sea turtles are nocturnal during their terrestrial life and could be sensitive to the artificial illumination of their nesting beaches. Artificial lights can influence female nesting behavior and hatchling orientation. In many nesting areas, the ghost crabs are relevant egg and hatchling predators under natural conditions, but there is a lack of information about the influence of artificial lighting on these predator-prey interactions. The present study was conducted in the loggerhead nesting population of Cape Verde in high density nesting beaches of BoaVista where ghost crabs can prey on more than half of loggerhead eggs and thousands of hatchlings on the beach. Nesting females, hatchlings and ghost crabs were studied under five types of light from white to red and a control with no lights. The impact of 2 lights on female nesting behaviour was evaluated during 50 entire nights on 540 m of beach with variable levels of beach illumination. The influence of lights on crab abundance was studied on the same nesting beach in 254 tests of 10 minutes conducted on two plots of 16 square meter fully illuminated by the experimental lights. Finally, the orientation and behaviour of 1,194 loggerhead hatchlings from 34 different nests were individually studied on the beach into a circle of a diameter of 4 m that was separated 20 m from the high tide line and 15 m of the light source at the opposite side of the circle. No people or other animals were visible during any of the experiments. 250 turtles came out to the beach in the study area and 83 of them laid their nest on the beach. The distribution of false crawls and nests along the study area and also on the most illuminated zones was by random. There were no significant differences on nesting activity between the control nights with no lights and nights at any of the light treatments, both in the large central section of 180 m and the reduced central section of 60 m where the two lights were installed. Nesting success had a mean value of 33% and varied from 25% to 33% in the days with experimental light treatments. Mean nesting success in control days was of 43%, slightly higher than in experimental treatments, but the differences were not significant. Thus, turtles regularly nested on the illuminated beaches. Around 80% of hatchlings exposed to the experimental lights moved toward the lights, and all control hatchlings moves toward the sea. The abundance of crabs and their feeding activity were 10 times higher when they were exposed to white lights than in control, orange and red light treatments. Mean crab abundance and their feeding activity were slightly higher when they were exposed to orange and red lights than in controls but the differences were not significant. Artificial illumination of beaches with conventional lights can have a profound impact on predation of ghost crabs over sea turtle eggs and hatchlings. Ghost crabs can easily find to females nesting in illuminated beaches, then preying on their eggs. The disorientation of hatchlings that feel attracted by lights can substantially increase their predation rate by more active and numerous crabs.

ARTISANAL FISHERIES-SEA TURTLE INTERACTIONS ALONG THE KENYAN COAST*

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The conservation status of sea turtles is aggravated by the impact of fisheries, either as a target species or, more often, as an incidental bycatch. There is a great need to better understand the relationship between fisheries and turtle distribution in order to minimize conflicts. In order to develop a spatially focused management strategy that will minimize the interaction between sea turtles and fisheries, it is thus essential to have an understanding of the spatial distribution of important turtle areas and different fishing zones. This study aimed at identifying, characterizing and mapping important in water areas for sea turtles on the Kenyan coast and overlay these maps with those depicting fisheries areas and gear use. Participatory approach was used to delineate the different fishing grounds and in water turtle areas on the northern and southern sites on the Kenyan coast. A total of 143 fishermen were interviewed at five different sites. More than 250 turtles were reported as bycatch by the interviewees during the year 2010.Species of turtles reported as by catch included green, hawks bill and loggerhead turtles. The highest turtle bycatch was reported by the net fishermen. The results are discussed in relation to resource use-sea turtle conflicts.

INGESTION OF MARINE DEBRIS AND FORAGING STRATEGIES BY LOGGERHEAD SEA TURTLES *CARETTA CARETTA* IN THE NERITIC AND OCEANIC ENVIRONMENT OF SOUTH ATLANTIC OCEAN

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The loggerhead turtle *Caretta caretta* can develop in oceanic and neritic environments, but the rigidity or flexibility between the pelagic foraging and neritic foraging strategies is discussed. For oceanic loggerhead turtles, the observation of benthic food items would be feasible since they have rigid body structures but the depth of oceanic regions prevents benthic foraging. However, neritic loggerhead turtles can forage in pelagic and benthic environments, but ingestion of gelatinous organisms can have a high degree of bias, as these preys often don't have rigid body structures. Nevertheless, there is an item found in the water column that is indigestible and can be observed throughout the digestive tract: marine debris. The occurrence of plastics in the digestive tract could be used to assess the flexibility of foraging strategies of loggerhead turtles in oceanic environments. The objectives of this work were to compare the occurrence and abundance of marine debris in the gut contents of neritic and oceanic loggerhead turtles of Uruguay, South Atlantic Ocean, and assess the flexibility of foraging strategies in both environments. Gut contents from oceanic loggerheads were collected from animals incidentally captured by the Uruguayan pelagic longline fisheries fleet. Marine debris found in stomach contents were classified and counted. The marine debris probability of occurrence in neritic loggerhead turtles was obtained from specimens stranded on the Atlantic coast of Rocha, Uruguay. To compare

the marine debris frequencies of occurrence between oceanic and neritic loggerhead turtles, a Yates's chi-squared test was used. For oceanic loggerhead turtles, thirty (50.85%) of 59 specimens showed debris in the stomach. The number of marine debris found in the stomach contents ranged from 1 to 9 (mean=2.53, SD=2.06). Marine debris were divided in five groups: soft plastics, rigid plastics, styrofoam, wood and bird feathers. The soft plastics, such as labels, seals and plastic bags are the most frequent (O=33.9%), and numerous (N=43.15%). For neritic loggerhead turtles, four (6.78%) of 59 specimens had marine debris in the entire digestive tract. The passage of food in the entire digestive tract (24 days) is higher than the passage of food in the stomach (2 days), resulting in different sampling times between the two samples compared. Even so, the probability of finding marine debris in the sample of oceanic loggerhead turtle is greater than in the sample of neritic loggerhead turtles (p=0.0003). Replacing the occurrence of marine debris for foraging in the water column, the probability of this strategy in the ocean environment is much higher than in the coastal environment. Therefore, we assume that the loggerhead turtle has different foraging strategies, according to the development environment. Normally, loggerhead presents a low mortality by ingestion of anthropogenic debris, when loggerhead turtles strandings are observed. However, given that the oceanic loggerhead turtles, more threatened by marine debris ingestion, don't strand in the beach, the ingestion of marine debris can be a real threat to loggerhead sea turtle populations, biased by sample of the stranded animals.

RELATING BAYESIAN PREDICTIONS OF LEATHERBACK BYCATCH TO A POTENTIAL BIOLOGICAL REMOVAL (PBR) LIMIT*

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Bycatch of rare or endangered megafauna species such as the leatherback turtle (*Dermochelys coriacea*) and the humpback whale (*Megaptera novaeangliae*) threatens populations of these species worldwide. While aggregate population impacts of fisheries bycatch may be significant, at the individual fishery level, such bycatch may occur as rare events, creating a statistical challenge for inference or prediction of bycatch rates. The statistical challenge is heightened in cases where observer coverage of the fishery is below 100%, warranting the use of probability-based inference for the unobserved portion of effort. Quantifying bycatch and relating its occurrence to management objectives is vital to ensuring the future survival of these species. The objectives of this paper are to: 1) demonstrate a Bayesian statistical method for predicting the number of protected species mortalities in a fishing season, 2) use available data on effort, takes, and mortalities to predict a long-term mortality rate per season, contingent upon a known level of fishing effort, 3) use the predicted mortality rate to classify the fishery according to the National Marine Fisheries Service's List of Fisheries classification scheme, and 4) demonstrate how a modeling approach could be applied to a take-cap for turtles, using the example of humpback whales, for which such a "Potential Biological Removal (PBR)" limit already exists. Using observer data from the California Drift Gillnet Fishery, we compared several Poisson-based bycatch models using Markov-Chain Monte Carlo methods, estimated using WinBUGS software, with variations in time of year, location, and fishing effort as variables. We selected the best model based on the Deviance Information Criterion (DIC). Our final results predict annual incidental mortality for leatherback turtles and humpback whales in this fishery. In the case of humpback whales, we further provide the probability of the fishery

exceeding the PBR limit for the affected stock. In conclusion, this study provides a model for administering a PBR-type limit for endangered sea turtles. Acknowledgments: We thank the following organizations for their generous support, which made travel to the Symposium possible: the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service, International Sea Turtle Symposium, and Center for Marine Biodiversity & Conservation at Scripps Institution of Oceanography.

IMPACT OF CLIMATE CHANGE IN *CARETTA CARETTA* INCUBATION: CURRENT ESTIMATIONS AND FUTURE PREDICTIONS*

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In species with temperature-dependent sex determination, such as loggerhead turtles, *Caretta caretta*, small changes in incubation conditions are sufficient to provoke important changes in the sex ratio of hatchlings. Nowadays, as temperature rises, the number of loggerhead females produced in natural nests is expected to increase, leading to a female skewed population of adults, or even a total feminization of the species in the future. Although Cape Verde embraces the third most important loggerhead population worldwide, the last IUCN report indicates that this population is currently one of the world's most endangered sea turtle populations. Alteration and loss of habitat, direct consumption, non-selective fishing and marine contamination are, among others, the principal threats to this population. However, climate change represents nowadays a new concern for this species. In the past 30 years, air temperature in Cape Verde has increased more than 1ºC, and the IPCC estimates an average world augmentation of 3ºC before the end of the century. The sand temperatures measured in different conditions on four beaches of Boavista, point to an 81.1%♀ sex ratio of hatchlings born in 2010 on this island, a value that already exceeds the projection for the end of the 21st century considering the IPCC scenario 2000 constant (77.8%). According to more severe climate change scenarios, the loggerhead hatchling sex-ratio can rise in Cape Verde up to 86.7%♀ (scenario B1) and 97.7%♀ (scenario A1F1) by the end of the century. When we consider the percentage of nests laid each month and their hatching success, these values increase (84.1%♀ in 2010 and around 93.5%♀ until 2099), due to more hatchlings being produced during the hottest months of the nesting season. Even though the hatchling sex ratios calculated for Cape Verde are lower than in other loggerhead nesting areas (such as Florida, North of Brazil and Mediterranean), this skewed tendency is worrying. In loggerhead turtles, males are expected to breed every year, while females mate just every 2.4 years. This difference allows an adult sex ratio of 70.6%♀ to be enough to form an operative ratio of 1:1 during the breeding season. However, as seen in this study, the actual and projected sex ratio values exceed this limit and so the population dynamics can be threatened. Considering the ecological importance of loggerhead turtles, and the vulnerability of the Cape Verdean population (that nests on just a few kilometers of beach), it is important to adopt conservation measures to protect this endangered species. Changes in nesting patterns of loggerheads, such as altering the nesting season to fresher periods, nesting on cooler areas, making deeper nests or adapting the pivotal temperature to the new conditions, can prevent this tendency to feminization. However, the fast increase in this present climate change is leading us to believe that these natural adaptations may not be sufficient to save and preserve this species. In this sense, it is suggested that artificial options must be studied and considered in future conservation strategies for the species,

such as controlling incubation temperatures. I would like to thank the International Sea Turtle Society, the Western Pacific Regional Fishery Management Council, the U.S. Fish and Wildlife Service, the U.S. National Marine Fisheries Service and the International Sea Turtle Symposium for the Travel Grant I have received, that will help funding my travel costs and allow me to participate on the 32nd edition of the ISTS in Huatulco, Mexico.

PROSPECTIVE ANALYSIS ABOUT THE IMPACT OF ARTISANAL FISHING, ARTISANAL BYCATCH AND ILLEGAL TRADE OVER LOGGERHEADS IN CAPE VERDE ISLANDS

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Research conducted since 1997 have revealed that Boavista Island (Archipelago of Cape Verde, West Africa) constitutes the most important nesting ground for loggerhead sea turtles (*Caretta caretta*) in the Cape Verde Archipelago, hosting around 90% of total nesting. Cape Verde is likely the second largest loggerhead breeding colony in the Atlantic. Despite new environmental legislation that fully forbids the capture, trade and consumption of marine turtles in the archipelago, these animals continue being captured for human consumption. Nest poaching is not currently a major problem in Boavista but it is relevant on some other islands with low nesting activity (it is more difficult to capture females). Turtle meat from Boavista is mostly sold in Santiago Island, the capital of the Republic. Turtle slaughter on the beach has been evaluated since 2007 in Boavista Island when poachers slaughtered around 36% of nesting females that visited Boavista Island. Due to the increase of beach protection since 2008, turtle slaughter on the beach was reduced to less than 200 in 2010. It is well-known that local artisanal fishermen catch loggerhead in waters of Boavista Island as a target species to consume or sell their meat in an illegal trade. To quantify this threat, an intensive pilot study was realized in the Boavista, Maio and Santiago Islands. The study was based on one long questionnaire to fishermen, one to a fish dealers, one short questionnaire to local people (who were not fishermen), and port description. All the questionnaires included mostly closed questions and were completed in-person. Sea turtle photo illustrations were used for species identification. This effort provided the first fisheries characterizations on Boavista Island, revealed the widespread nature of bycatch, illegal catch and trade of sea turtle by artisanal fisheries. The information provided by fishermen suggest that sea turtle bycatch by artisanal fisheries in Boavista is lower than 20 individuals per year. A maritime route was designed illustrating the main landing ports and zone of illegal trade in the city of Praia, Santiago Island. We discuss lessons learned from this survey effort and recommend future study. Acknowledgements: This works was supported by grants fro the Canary Islands Government (D.G. Africa and D.G. Research), the Andalusian Government (Andalusian Environmental Office), FEADER program and Marine Turtle Conservation Found (USFWS). The authors thank the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service for having provided travel grants for assistance in attending the symposium.

SEA TURTLE STRANDINGS ALONG THE PORTUGUESE CONTINENTAL COAST: SPECIES ANNUAL, SPATIAL AND SEASONAL DISTRIBUTION PATTERNS AND FIRST INSIGHTS OF BYCATCH

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Information on sea turtles along the Portuguese continental coast is scarce and was limited to a few sightings or nationwide not standardized information of stranding data. The location of Portugal seems to be of special interest especially to loggerhead sea turtles *Caretta caretta* distribution and conservation due to the proximity of the Southern Coast (Algarve) to the entrance of the Mediterranean Sea, considered an important habitat for the species. This work is the first attempt to present a detailed analysis of sea turtle strandings (n=280) over an 11-year period (2000 to 2011) from the Western and Southern Portuguese coasts. Loggerhead turtles accounted for 73% of recorded strandings, while leatherback turtles, *Dermochelys coriacea,* accounted for the remaining 27%. An increasing trend in the annual number of strandings over the study period was detected in the last two years (2010-2011), especially for loggerhead turtles. Although in the Southern coast this must have been driven primarily by the recent improvement of a local stranding network (upgraded in 2010), thus increasing detection effort, other factors such as oceanographic (ex. currents) or climate related (ex. SST's variation) should not be discarded because the increasing stranding pattern was observed in the Western coast for the same period, where a local stranding network has been fully operating since 2000. Loggerhead turtles were mainly juveniles (mean ± SD curved carapace length from notch to tip [CCL]: 49.7 ± 8.9 cm; range: 20 to 80 cm, n=150) and leatherbacks size range varied (CCL: 135.7 ± 18.1 cm; range: 98 to 165 cm, n=51). Loggerhead strandings were far more frequent in the Southern coast (83.3%) in late spring and summer months (69.5% May to August), while leatherback monthly stranding distribution did not seem to show a geographical or monthly pattern. Obvious incidental capture insights accounted for 50% of the mortalities, while other 35% may have died also due to fisheries interaction or other human related causes, since the animals showed good physical condition and full stomachs. Interaction with gillnet fisheries was found to be the main cause of death (84% of turtles with likely mortality cause identified). Turtles showing signs of interaction with gillnet fisheries were slightly smaller (CCL: 49.5 ± 7.5 cm; range: 35 to 67.8 cm, n=28) than turtles stranded due to other causes (CCL: 49.7 ± 9.3 cm; range: range 20 to 80 cm, n=122; t=0.58, p=0.05) but this difference is not statistically significant and were more frequent in late Spring and early Summer months, showing a positive relation with SST´s in the Southern coast and possibly related to turtles migratory movements into the Mediterranean. Following the recent turtle stranding increase along the Portuguese coast, efforts to obtain more data are planned in order to validate patterns of distribution and crossing them with environmental or other factors, while better understanding the impact of

fisheries that seasonally and spatially are a serious threat to turtle populations so mitigation measures can take place.

MORTALITY, ILEGAL CAPTURES AND BLACK MARKET OF SEA TURTLES IN SAN ANDRES, PISCO, PERU*

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The area of San Andrés, in the South-Central Peruvian coast, is an important feeding ground for the endangered black sea turtles *Chelonia mydas*, and historically, a traditional sea turtle fishing area. In spite of international and national conservation measures, sea turtles continue to be directly and incidentally caught in San Andres. To assess and quantify mortality levels as a result of fisheries interaction and to investigate these changes through time, we recovered both systematic and anecdotic information from carapaces found in dump sites during two different time-frame periods: 1999-2000 and 2010-2011. For each carapace we determined the species and recorded date, Curved Carapace Length (CCL) and condition of the carapace. Moreover, evidence of the demand for different sea turtle products, their illegal commerce and consumption was reported. In a year sampled (July 1999–June 2000) a catch of 202 ± 17.6 sea turtles was estimated, conversely in two years sampled a decade later (November 2009–October 2011) an annual average of 228 sea turtles were recorded. In the 1999-2000 samples: 67.8% were blacks, 27.7% olive ridleys (*Lepidochelys olivacea*) and 2.9% leatherbacks (*Dermochelys coriacea*). Conversely in the 2010-2011 sample: black's were 92.4%, olive ridleys 6.3%, leatherbacks 1.1% and hawksbills (*Eretmochelys imbricata*) 0.2%. Regarding black turtle size, CCL showed a decline of more than 8 cm in one decade; mean CCL's were as follows: 68.7 cm in 1999-2000 and 59.9 cm in 2010-2011. If we consider 86.7 cm CCL, the mean size of black's nesting females in Galapagos, only 1% were adults in 2010-2011 (N=389). All the carapaces found corresponded to turtles used for meat, sea turtle meat was observed being sold in the Pisco Market at a price between 8 and 12 US$ per kg. The meat has different demands: for fishermen families' consumption, local trade and also "special" orders from Lima. Our preliminary analysis suggests an increase in the capture of sea turtles; probably as a consequence of the diminishing of fishing resources in the area, the lack of effective control and management measures, and also the poverty in the area that influence fisherman to take turtles for subsistence. The presented information should be used to improve management measures and effective control, which should be linked with the government entities and the private sector in order to succeed in the proper conservation of this endangered species. We wish to thank the following institutions: International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service for grant support.

CHARACTERIZATION OF HANDICRAFT AND MEAT TRADES OF HAWKSBILLS (*ERETMOCHELYS IMBRICATA*) FROM 2008 TO 2011 IN CARTAGENA DE INDIAS, COLOMBIA*

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Hawksbill turtles (*Eretmochelys imbricata*) are one of the four marine turtle species that nest in the Colombian Caribbean. Over the last century, millions have been killed for tortoise shell markets in Europe, USA and Asia. Hawksbills are one of the two sea turtles species classified by the IUCN as Critically Endangered worldwide. They are listed in Appendix I of CITES, which prohibit their international trade. Colombia also has national laws and treaties protecting them. However, in Cartagena de Indias (Colombian Caribbean), a constant demand of hawksbill products remains, primarily because of their colorful shells, made into handicrafts and sold to both domestic and foreign tourists. Nevertheless, the current marketing situation is unknown. The characterization of this illegal trade is an important and urgent issue needing immediate attention for the conservation of this species in the Colombian Caribbean. Our objective was to locate and describe the sale of handicrafts and hawksbill meat in Cartagena de Indias. From March 2008 to July 2011 we made continuous visits to the area in order to identify marketing sites of hawksbill handicrafts and meat, and conversational interviews were conducted at the points of sale to assess the socio-economic status of sellers, the price and place of origin of handicrafts and meat. The sale of handicrafts and meat was carried out only in the city center, reflecting a positive relationship with the high flow of tourists in this area. The trade of hawksbill crafts occurred at the center of the walled city and was restricted to hawking artisans of low income and low education. The supply of articles was diverse, from rings (USD3), bracelets (USD5-12.5) and hair combs (USD12-15) to large buckets (USD30). Prices of items varied in size, design, season and the origin of tourists. Shells and crafts came from important areas of foraging and development of juvenile and adult hawksbill turtles, mainly from the Alta Guajira (Guajira Peninsula) north of Colombia, and the lesser extent of the Corales del Rosario and San Bernardo National Park, 45 km southwest of Cartagena bay. Authorities in Cartagena seemed to be unaware of illegal activity, because the police was commonly found chatting with hawksbill artisans and crafts vendors and were not enforcing the law. In the Getsemaní quarter of the walled city, there are two restaurants offering hawksbill meat in their menu, such as turtle stew (USD12), turtle mince (USD6) or chopped socky (USD14). We found that the environmental authorities, artisans and tour guides in Cartagena seemed unaware of the regulations protecting sea turtles, indicating that it is essential to train and inform them better in this regard. We also recommend that tourists should be informed regarding regulations on turtle trade via clear advertisement such as: “Do not buy turtle souvenirs or meat”. A real impact on tourists would ultimately reduce captures of hawksbills and contribute to their conservation at local and regional level on the Caribbean coast of Colombia.

MAN-MADE MARINE DEBRIS ASSESSMENT ALONG THE SEA TURTLE NESTING BEACH AT PLAYA CALETAS, GUANACASTE, COSTA RICA

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Through The Science Exchange Sea Turtle Internship Program (www.thescienceexchange.org), we assessed the density of man-made marine debris and plastic pollution along the sea turtle nesting beach at Playa Caletas, Costa Rica during mid-July through August of 2011. Shoreline debris surveys identified and recorded individual items and characterized plastic pollution and other debris items that washed ashore by size class (micro, macro, large) and type (bottles, wrappers, etc.) along 5 meter-wide transects running perpendicular to the shoreline. Two hundred and twenty surveys identified a total of 6,116 pieces of debris. The most common items, in order of frequency, were plastic bottles, plastic fragments, styrofoam/foam fragments, plastic caps, wrappers, shoe/shoe parts, and bowls/containers/buckets. The average density of macro-debris was 0.14 pieces/m^2 and large-debris density was 0.01 pieces/m^2. Only one piece of micro debris was detected in the eleven 0.0625 m^2 quadrats randomly placed along transect surveys. Approximately 98.2% of all marine debris assessed was classified as composed of plastic. Marine debris density decreased from north to south along the beach, likely coinciding with currents and/or roadside dumping trends. Most debris was found at or above the wrack line in a region that is the most common for nesting of sea turtles. Significantly more turtle activity occurred in the middle area near the camp and the south area near the river. The south area had significantly less debris than the other two areas. Suggestions for improving the study are included. The magnitude of plastic pollution, such as we encountered at Playa Caletas, must be confronted head-on with local and international policies limiting short-lived plastic production and consumption, enforcing the reuse/recycling of all plastics purchased, and facilitating cleanups of areas essential to sea turtles.

ABUNDANCE AND TEMPORAL PATTERNS OF SEA TURTLE´S TAKE IN KAZUZAIN, MID-GUAJIRA, VENEZUELA

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Sea turtles (ST) are considered as a resource, shared by many people and countries worldwide due to their feeding and reproductive migratory characteristics. The Gulf of Venezuela (GV) represents an important feeding ground for five species of ST: *Chelonia mydas*, *Eretmochelys imbricata*, *Caretta caretta*, *Lepidochelys olivacea* and *Dermochelys coriacea*, as well as for the country and the Caribbean Region. These species contribute in the modeling and structuring of marine ecosystems; also, they are considered by the Wayüu culture as essential icons that are being exploited as a food, economic and cultural (magical-religious) resource. Nowadays, Kazuzain (a locality in the GV) reports one of the highest incidences of sea turtles, where a high percentage of community income depends on the artisanal fishing of ST, being referred as the possible reason for decrease in their populations. In order to estimate size frequency, abundance and temporal patterns of ST in Kazuzain (Mid-Guajira, Venezuela), we collected a total of 241 records and measurements of stranded, live or skeletal remains of ST, from 2009 to 2011, from beaches and fishing ports. From each record photographs were taken, and date, port or beach and specific name recorded. The results showed that the largest portion of individuals were juveniles (70.1%), followed by sub-adults (17.4%) and finally adults (2.4%); this high proportion of animals of smaller size may be due to the success of conservation projects on nesting beaches of the Caribbean area, bringing new recruits to the feeding grounds, and turning the GV feeding grounds into temporary residence areas. Previous research shows that a large part of the green turtle juveniles in the GV comes from Yucatan Peninsula (Mexico). Temporal patterns show a high percentage of ST from May to July (34.84%) and lower values from November to January (16.66%), this high income of ST to the GV between May and July may be due to the higher annual temperatures registered in those months; thereby increasing the intensity of trade winds (north-east direction), and thus an increase in the intensity of the ocean currents, resulting in higher productivity rates. Finally, *Chelonia mydas* was the dominant species with 89.2% of occurrence, followed by *Eretmochelys imbricata* (7.8%), *Caretta caretta* (1.2%), *Dermochelys coriacea* (1.2%) and *Lepidochelys olivacea* (0.4%); these results are consistent with historical data of the GV, corresponding with the bottom types proportions (and also, the diet items of each species) in this important feeding area, as reported in previous research (seagrasses, reef patches and sandy bottoms, in decreasing order). Kazuzain locality (within the GV) represents an important area for the recruitment and development of juveniles and sub-adults of ST, especially green and hawksbill turtles, requiring further research in ecosystem and conservation aspects. Keywords: size frequencies, temporal patterns, sea turtles, Kazuzain, Gulf of Venezuela.

RECORDS OF DEAD BLACK TURTLE *CHELONIA MYDAS AGASSIZII* (BOCOURT, 1868) EN CHIPANA BAY, IQUIQUE, CHILE

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Chipana Bay (21º 19'S - 70º 03'W) is located south of the city of Iquique, 10 km north of the mouth of the river Loa. Its sand coast has an extention of around 3 km and is the largest bay of the I Region, Tarapacá. It is protected from ocean waves, with particular oceanographic conditions, like higher temperatures than surrounding areas. Historically, the area has been defined as a turtle nesting site, but without scientific confirmation. Given the endangered conservation status of the black turtles in the Pacific, in 2001 a Sea Turtle Project of Tarapacá, supported by the EU project "Climate Variability and El Niño Southern Oscillation: Implications for Natural Resources and Management" (CENSOR), was established to examine the status of turtles in the area and its relation with the *Macrocystis integrifolia*, and *Lesonnia nigrecens*/*trabeculata* kelp beds. Between 2001 and 2007, with quarterly visits until 2005, and then monthly, 108 black turtle carcasses were recorded. Other aproximately 30 carcasses found in the same area between 1995 and 2000, were not properly recorded. Monthly diving between 2004 and 2008 under the CENSOR project, along three replicated transects (10 m length) assessed for *Macrocystis integrifolia*, *Lessonia trabeculata* and barren ground habitat, did not allow confirming turtles in association with the kelp beds and its contiguous sectors. 99% of adult specimens were females (58 individuals) and 1% males (1 individual). The specimen ages estimated from the age/carapace length relation by Zug *et al*. (2001) ranged from 5 to 33 years. 40.4% of individuals presented immature sizes and 59.6% of females were in maturity. The damage and the advanced stage of decomposition of 9 specimens did not allow measurements. From the analysis of the damage types presented by the turtles, its stranding date and the observation of fishing activities in the area, it was concluded that its major cause of death was its bycatch capture during fishing operations of illegal entry into the first mile from the coast, by artisanal purse seine 50 tons capacity vessels. The major damage types recorded were collapse, breaking, cracking and erosion of the carapax and/or plastron by squeezing with the net or winch, or fall on deck. In most cases the injuries were extremely serious and were the most probable cause of death after being released and ended up stranding on the beach. From the records it was concluded that until 2007 Chipana beach presented a permanent population of *Chelonia agassizii*, using the area as a foraging area. The presence of a high percentage of mature individuals and mainly females do not exclude the possibility of occasional nesting during ENSO warm periods. The absence of sightings after 2008 may indicate that the local population may have been decimated because of the lack of control of illegal purse seine fishing and of the by catch. The authors gratefully acknowledge the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service, for making possible the presentation of this work.

ADAPTATION OF FUSARIUM SOLANI TO SEA TURTLES NESTING ENVIRONMENTS AND CONDITIONS FAVORING EGG COLONIZATION AND PATHOGENICITY*

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The pathogen *Fusarium solani* has been described as the causal agent of mass mortalities in natural and artificial nests of the sea turtle species in Atlantic and Pacific beaches. The pathogen was found to occur in all nesting areas sampled, i.e, Australia, Cape Verde, Colombia and Ecuador. The *Fusarium* sea turtles isolates (STI) were physiologically and molecularly characterized and the conditions favoring the colonization of eggs were investigated. Other isolates, defined as non sea turtle isolates (NSTI), were also studied. The results show that the pathogen occurs worldwide and that STI are molecularly different from the majority of *F. solani* isolates so far studied. The STI were grouped in two clusters. All STI seem to be adapted to conditions required for egg incubation in sandy beaches since they have an optimal temperature for growth and germination that coincides with the optimal for the development of sea turtle embryos in natural conditions. In contrast, the NSTI had an optimum temperature that was lower than that of the STI. Conducive environmental conditions for disease development appear to be the presence of clay in the sand, increasing humidity and high levels of inoculum. The worldwide distribution of the pathogen added to its efficient physiological adaptation to nesting habitats and the presence of conducive conditions for disease development, makes this fungus to represent a serious threat for all sea turtle species.

INVESTIGATION OF THE INFLUENCE OF HULL SHAPE AND PROPULSION SYSTEM ON LOGGERHEAD SEA TURTLE INJURIES FROM BOAT STRIKES*

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Loggerhead sea turtles often show signs of injuries caused by impacts with commercial and recreational vessels in coastal waters. While it seems simple to attribute certain types of loggerhead injuries to boat strikes, difficulties arise in determining the type of vessel involved and/or the condition of the turtle (alive or dead) at the time of impact. Thorough investigation of these issues will aid in the development of management strategies to reduce vessel strike injury and mortality. The present work expands upon previous investigations of this topic presented by the authors and includes full-scale field tests of vessels striking model turtles. Two major thrusts of the current effort were 1) to develop and fabricate an improved artificial carapace to use in field testing, and 2) to explore the influence of hull design on the type and severity of injuries sustained by turtles. The previous investigation used a fiberglass carapace design with tensile strength per unit width as the target property. The current study seeks to match additional pertinent material properties of the organic material, as well as

the physical structure of turtle carapace bone. The model carapace is made using a sandwich composite composed of a polyurethane (PU) foam core with outer layers constructed of polyester resin infused with glass microspheres. A PU foam body provides a weight and buoyancy proportional to that of a real animal. Two deep-vee hull vessels (a 6.4 m inboard jet-drive and a 7.3 m outboard 4-bladed propeller) were selected for use in the current round of field tests. These types of vessels were chosen to provide a comparison with results from previous tests, which employed three other hull shapes. For each test, a turtle shell and body was loosely tethered at a specific position in the water column (at the surface or at propeller depth) and struck by the vessel at planing speed (40 km/h). After each test, the synthetic turtle was retrieved and photographed, and damage to the shell and body was measured and catalogued. As a basis for comparison, a number of cold-stunned green turtle carcasses (provided by local management authorities) were tested in a manner similar to that of the artificial carapaces. Damage to the real turtle carcasses was evaluated by biologists at the test site. The field test results revealed similar patterns and severity of injuries between the synthetic turtles and the green turtle carcasses. The influence of hull type alone on the severity of turtle damage appears to be minimal. None of the tests conducted using jet drive propulsion in the current or previous studies resulted in injuries to the shell that would be considered lethal to an actual turtle, regardless of the vessel hull type, speed, or position of the animal at impact. Conversely, injuries occurring as a result of a propeller and/or skeg impact at planing speed were always classified as fatal, regardless of vessel type.

EXPERIMENTAL DEGRADATION OF POLYMER SHOPPING BAGS (STANDARD AND DEGRADABLE PLASTIC, AND BIODEGRADABLE) IN THE GASTROINTESTINAL FLUIDS OF SEA TURTLES*

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Globally, marine debris such as discarded polymer bags has become an increasing hazard to marine life. To date, over 177 marine species have been recorded to ingest man-made polymers, causing life-threatening complications such as gut impaction and perforation. This study aimed to test the decay characteristics of three common types of shopping bag polymers in sea turtle gastrointestinal fluids (GIF): standard plastic, degradable and bio-degradable. Fluids were obtained from stomach, small intestine and large intestines from a freshly dead Green turtle (*Chelonia mydas*) and a Loggerhead turtle (*Caretta caretta*). Controls were carried out with salt and freshwater. The degradation rate was measured over 49 days, based on mass loss. The degradation rates of the standard and the degradable plastic bags after 49 days across all treatments and controls were negligible. The biodegradable bags showed mass losses between 3% and 9%. This was a much slower rate than reported by the manufacturers in an industrial composting situation (100% in 49 days). The GIF of the herbivorous Green turtle showed an increased capacity to breakdown the biodegradable polymer relative to the carnivorous Loggerhead, but at a much lower rate than digestion of natural vegetative matter. While the breakdown rate of biodegradable polymers in the intestinal fluids of sea turtles is much better than standard and degradable plastics, it is proposed that this is not rapid enough to prevent morbidity. Further study is recommended on the speed at which biodegradable polymers decompose outside of industrial composting situations and their durability in marine and freshwater systems.

ENVIRONMENTAL AND MANAGEMENT FACTORS THAT INFLUENCE THE SEVERE PREDATION OF GHOST CRABS OVER LOGGERHEAD NESTS IN CAPE VERDE

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Nest predation can have severe impacts on reproductive success for sea turtles as it have natural, ecological and demographic implications on their abundance and populacional dynamics. Understanding the trophic web and the dynamical relationship between predator and prey and their relative abundance has important implications on the development of effective management strategies to achieve conservation goals, particularly when the focus species are threatened of extinction. Cape Verde is known to be an important nesting area for loggerheads where the ghost crab, *Ocypode cursor,* is the most important nest and hatchling predator. Differently from mainland nesting beaches, islands have simple trophic webs that could explain extreme ecological interactions between pairs of species. Usually islands are free from mammalian predators, which could explain the high abundance of land crabs on islands due to the reduced predation pressure. The main goals of the present work were to improve the knowledge of the predator ecology, assess the levels of predation by *O. cursor* on the nests of *Caretta caretta* (Linnaeus, 1758), investigate the primary cue for nest detection by ghost crabs and compare the effectiveness of two conservation measures to mitigate the effect of predation in three nesting beaches of Boavista island, Cape Verde archipelago. The three beaches are in close proximity to one another, but vary in physical conditions and on levels of human use, where coastal dynamics, tidal inundation and depredation are the main natural threats to eggs and hatchlings. Although the species has been studied in the Mediterranean, namely Israel, Turkey and Cyprus, this study is the first to provide information on the ecology of *O. cursor* in Atlantic region. Aspects of the ecology and behavior of *O. cursor* were studied between June and October 2010. Most small burrows occurred near high tide mark, while larger crabs occurred higher up on the beach. Burrow numbers varied during the study period, increasing on August due to recruitment of juveniles and decreasing on September, probably due to the mortality of the oldest individuals or to the increase of *C. caretta*'s nest predation. *O. cursor* was primarily nocturnal and exhibited different feeding strategies. Results show that ghost crab was the only relevant nest predator and considerably reduce survivorship from egg to hatchling. In fact, more than 70% of the monitored nests on each beach showed signs of partial or complete nest predation, mainly at the end of the incubation. However, the nests end up been lost before having achieved the critical point of predation in years characterized by extremes tides The detection of nests by *O. cursor* could be related to chemical cues in the sand, to the increase of temperature at the end of incubation or by tactile cues from the hatchlings ready to hatch. However, little has been possible to improve the knowledge on this topic. The presence of researchers, surveillance personnel and moderate tourist activity on nesting beaches may also reduce depredation, while reducing crab density by human trampling. Overall, our results indicate that relocation of nests on hatcheries provide the most effective and adequate conservation measures that could allow an increase in hatchling production; although their choice and application should be based on the specific conditions based on nest density and threats of each nest.

GLOBAL ASSESSMENT OF BYCATCH IMPACTS ON MARINE TURTLE REGIONAL MANAGEMENT UNITS: A BLUEPRINT FOR GEAR-SPECIFIC BYCATCH REDUCTION STRATEGIES*

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Incidental capture in fishing gear is the most serious and acute threat to marine turtles globally. Published reports of marine turtle bycatch typically focus on specific fishing gears and/or in a certain area during a defined time period, which are quite useful for generating crucial data, but are insufficient by themselves to provide assessments of gear-specific, population-level impacts. Recent studies have taken a global view of marine turtle bycatch in multiple fishing gears, and have revealed patterns in bycatch severity as well as data gaps that highlight priorities for bycatch reduction and enhanced bycatch assessments. However, despite the utility of these global perspectives, bycatch impacts have yet to be assessed for individual marine turtle populations, which would provide a blueprint for bycatch reduction efforts by identifying the populations most threatened by bycatch, as well as particular fishing gears toward which mitigation efforts should be directed. To assess bycatch impacts by fishing gear on individual marine turtle populations, we first georeferenced all available reports of marine turtle bycatch from 1990 to 2011 (more than 1,000 records) and overlaid these data on marine turtle Regional Management Units (RMU), i.e. a framework for geographically and biologically explicit population segments for all marine turtle species globally. Next, we compiled total turtle bycatches, bycatch rates, amount of fishing gear observed, and mortality rates of marine turtles in broad gear categories (e.g. longlines, nets, trawls) and in more specific sub-categories (e.g. surface longlines, bottom-set longlines, pelagic longlines) reported to impact each RMU. Finally, we compared the relative severity of bycatch attributed to each fishing gear by integrating the information on bycatch rates, amount of observed effort, mortality rates, and conservation status of RMUs to identify 1) the gear(s) with the highest bycatch impact for each RMU, and 2) gears that consistently impact multiple RMUs, especially those RMUs with the most threatened conservation status. We anticipate that this study will provide guidance to decision-makers responsible for sustainably managing multiple fisheries and/or multiple marine turtle RMUs, and will provide a framework of priorities for targeted bycatch mitigation efforts as well as enhanced reporting of marine turtle bycatch in fisheries worldwide.

BYCATCH SURVEY REVEALS HIGH LEVELS OF SEA TURTLE SLAUGHTER IN TANZANIA*

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The Secretariat of the 'Memorandum of Understanding on the Conservation and Management of Dugongs and their Habitats throughout their Range' has developed a Standardised Dugong Catch/Incidental Catch Survey Tool as a mean of rapidly obtaining data on the status of artisanal fisheries and the level of dugong bycatch. The survey tool also captures data on marine turtles and cetaceans which face similar conservation threats to dugongs. The survey tool is of particular use in developing countries where sophisticated survey techniques have limited application. The main objective of the survey was to determine the level of bycatch in artisanal fisheries. The questionnaire survey was conducted in two districts in Tanzania: Mkinga District in northern Tanzania at the border with Kenya, and Mtwara District in southern Tanzania at the border with Mozambique. Both of these areas were considered to be data deficient in relation to endangered marine species bycatch. Surveys were carried out by staff from the Fisheries Development Division (Ministry of Livestock Development and Fisheries) and Sea Sense, a marine conservation NGO specialising in sea turtle and dugong conservation. 172 questionnaires were completed in five villages in Mkinga District and 206 questionnaires were completed in six villages in Mtwara District. The survey also had an important spatial component with fishers being asked to mark the location of important fishing grounds, seagrass and coral reef habitats and areas of frequent sea turtle and dugong observations on large scale maps. Five species of sea turtle (green, hawksbill, loggerhead and olive ridley) were reported to be observed regularly in Mtwara District with many fishers reporting a decline in population numbers. Subsistence hunting, incidental capture in gillnets and nest poaching were cited as the most common reasons for the decline. Green and hawksbill turtles were observed regularly in Mkinga District and fishers identified several important nesting sites for green turtles. However, nesting activity was also reported to be decreasing due to high levels of turtle slaughter. Most fishers in Mkinga District confessed to consuming sea turtle meat on a regular basis and were not aware that there were any laws protecting sea turtles. Hence, trade in sea turtle meat was conducted openly and there were no concerns about penalties being issued. There was a higher level of awareness of the protected status of sea turtles in Mtwara District, most likely due to the presence of Mnazi Bay- Ruvuma Estuary Marine Park (MBREMP). However, due to limited law enforcement within the Park, sea turtle slaughter was commonplace and several villages were identified as popular markets for sea turtle meat and carapaces. The survey yielded important information about bycatch but also produced critical information regarding other threats faced by sea turtles in Tanzania. Prior to the survey, nesting sites in Mkinga District were unknown due to the absence of a dedicated sea turtle conservation initiative. Furthermore, the extent of sea turtle slaughter in MBREMP was severely underestimated and has highlighted the urgent need to strengthen knowledge, understanding and capacity within those agencies responsible for protecting sea turtles.

IMPACT OF DREDGING ACTIVITIES ON THE DISTRIBUTION OF INTER-NESTING FLATBACK TURTLES (*NATATOR DEPRESSUS*) IN WESTERN AUSTRALIA*

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The east coast of Barrow Island in the Pilbara region of north Western Australia provides suitable nesting habitat for a large rookery of flatback turtles (*Natator depressus*). In 2009, Chevron Australia was granted approval to construct the Gorgon Gas Development on Barrow Island, with construction of a liquefied natural gas (LNG) plant and materials offloading facility (MOF) commencing in 2010. Construction also involved substantial offshore dredging for the MOF, an LNG turning basin and access channel, with up to 7.6 million m^3 of material being dredged. The offshore dredging program was identified as providing a medium inherent risk of impact to inter-nesting flatback turtles, resulting in a Ministerial Condition requiring Chevron Australia to monitor the spatial behaviour of the inter-nesting population prior to, and during the dredging program, and to investigate the flatback turtles' response to their altered habitat. In 2009-2010, Fastloc GPS satellite transmitter units combined with TDRs were deployed on 20 inter-nesting flatback turtles in order to establish the baseline spatial movement dataset prior to the commencement of the dredging program. A further 10 satellite units were deployed in 2010-2011 to coincide with the start of the dredging program and identify how inter-nesting flatbacks responded to the ongoing dredging in relation to the baseline dataset. The movement of one trailing suction hopper dredge vessel (TSHD) was also tracked using GPS, enabling the interaction of the tracked flatback turtles with the vessel to be investigated. The turtles tracked during the dredging program showed a strong preference for the dredging area, with a significantly greater proportion of time spent within the area compared to the baseline dataset. Dives transmitted within the dredging area were significantly deeper and longer in duration than dives transmitted outside of the area, and an average of 70% of the dive duration was spent within 2 m of the seabed in the dredging area. The inter-nesting GPS positions were an average distance of 3.3 km away from the corresponding position of the operational TSHD, with the closest GPS position located within 97 m of the vessel. The tracked turtles avoided the TSHD when the vessel was present in one dredging area, with the turtles located within another separate dredging area away from the vessel. The results suggest that flatback turtles are able to use the dredging area to rest more efficiently on the seabed and hence optimise their energy reserves for inter-nesting. One physical characteristic of the dredging area that may make it more suitable for these longer duration resting dives is the deeper seabed depth providing protection from strong tidal currents present along the east coast of Barrow Island. The reason for the tracked turtles avoiding the TSHD was unclear and may be due to noise and vibration produced by the vessel itself or the chains placed on the dredge vessel's drag head may be effective in disturbing turtles away from the area. These results have implications for the management of future dredging programs in proximity to flatback nesting habitat in Australia.

Special Session: Innovative Tools and Strategies

REVITALIZATION OR INNOVATING INNOVATION FOR MARINE TURTLE CONSERVATION*

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Conservation is routinely categorized as a science, or a special type of biology: conservation biology. Yet, conservation issues are rooted in socio-political aspects; they are conceived, designed, executed, and evaluated on the basis of social values, traditions, policies, and cultural considerations –elements that are well outside the prevue of biology and other scientific disciplines. The illusion of "conservation science" persists, particularly because of powerful financial and political interests. This is illustrated by the deliberate confounding of technology with science, which results in widespread convictions that better equipment means "better science", and this in turn fuels the incessant need to obtain the latest, most modern ("best") equipment. Conservation, especially when dubbed "conservation biology", closely follows this trend. However, when technology drives science and conservation, academic and social priorities are subjugated to commercial and political agendas. This realigning of objectives is commonly accomplished though revitalization movements: "deliberate, organized attempts to construct a more satisfying culture by rapid acceptance of a pattern of multiple innovations". The obsession with modernization is coupled with the common misinterpretation of "innovation" as synonymous with "the introduction of novelties", "a novel practice, method, etc." However, "innovation" can also refer to "a change made in the nature or fashion of anything", a political revolution, rebellion or insurrection; "the alteration of an obligation". If conservation is to be effective it must be constructed on social foundations and relevant to social and political processes; science and technology serve as informational sources and tools, but not as the only, or dominant, compass. The tail must not wag the dog. Hence, there needs to be a rebellion, or innovation, in the way that conservation is conceptualized and executed; it cannot support, much less depend on, consumerism through the visceral replacement of "old and useless" objects with newer, "better" materials. This change requires a full appreciation of the meaning of "innovation".

A NEW APPROACH TO MODEL SAND TEMPERATURE: USING MICROCLIMATE MODELS TO PREDICT THE IMPACTS OF CLIMATE CHANGE ON SEA TURTLES*

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Sea turtles are thought to be particularly vulnerable to climate change since increases in temperature may skew the sex ratio of their hatchlings, decrease hatchling success and thus threaten population persistence. Given the seriousness of the threat from climate change it is critical to understand the rate at which sand temperatures are likely to change and the

extent to which associated changes in hatching success and sex ratio will vary spatially as climate change progresses. This has stimulated the development of correlative models to assess and predict how forecasted increases in temperature may impact their reproductive output. Correlative models correlate climatic variables to soil temperature and hatchling sex ratio. These models have been widely used due to its simplicity and the flexibility of their data requirement. However, the potential error inherent in this approach has not been determined and it cannot be used when environmental conditions vary outside the range of the correlative model. Researchers working with other animals with temperature-dependent sex determination (TDS) have developed microclimate models to determine nest temperature and potential impacts of climate change to animals. Microclimate models use the interaction between climate, soil, and topography with physiology and nesting behaviour of animals to determine future production of hatchling sex ratios. Until now, this model has never been applied to sea turtles. Here we explore the applicability of using microclimate models to predict sand temperature at sea turtle nesting grounds. Further, to aid future decisions on which model to use we review the applicability and effectiveness of using each model (microclimate and correlative models) to predict soil temperature at key sea turtle nesting grounds. Our study, found that the two models accurately and congruently model current soil temperature and predict a feminization of the northern Great Barrier Reef green turtle population as climate change progresses. However, the microclimate model provides a more robust picture of the incubating environment as it has the potential for mapping the nesting environment at a nesting site level and regional level. Microclimate models can also be used to hypothetically test the potential of animals with TDS to counteract the impacts of global warming by changing nest depth and nesting distribution and to aid applied management. Adaptive management approaches can be refined with the use of microclimate models as they can provide explicit recommendations on site-specific scales for translocation of eggs and alteration of the nesting environment. In summary, microclimate models will revolutionize the way potential impacts and adaptations from climate change on sea turtles can be explored and thus should be explored as a new method to be used by sea turtle researchers.

SEA TURTLE STRANDING AND ITS RELATIONSHIP WITH FISHERY ACTIVITIES IN TWO NATURAL PROTECTED AREAS IN THE GULF OF CALIFORNIA, MEXICO*

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The human activities has modified the world-wide patterns, and with this the occurrence of species and ecosystems. The marine and coastal systems result to be ones of the most susceptible to the changes. The sea turtles require of these marine and coastal zones, in addition to the terrestrial to complete his life cycle, this contemplates nesting, foraging and reproduction habitats and important migratory routes. In this sense, Sinaloa has the presence of five species of sea turtles, where its North zone is for foraging, and the south is used for nesting. The San Ignacio-Navachiste-Macapule Lagoon System (SNM) in Guasave, Sinaloa is a foraging habitat, and the Altata-Pabellones Lagoon System (SAP) in Culiacan, Sinaloa is a nesting habitat. All the sea turtles species are cataloged with some category of risk of extinction; thus a need to study the human impact on the foraging and

nesting zones that are also critical and key habitats for their conservation arises. To evaluate the effect of these impacts we implemented a systematic sea turtle stranding survey (monthly) in the San Ignacio, Macapule and Vinorama islands in the SNM and the Lucenilla Peninsula in the SAP. We present the stranding data from SNM from January 2011 to December 2011, where 222 events were registered in 17 surveys, the main incidence occurred in June-September, with 95% of the records specimens identified as *Lepidochelys olivacea*, and 5% as *Chelonia mydas*. For some specimens it was possible to determine the cause of stranding, attributing it mainly to bycatch in long-line nets (63%), then boat impacts (32%), and finally harpoon (5%). The gender was determined in 49 organisms, resulting 51% females and 49% males, with a LCC range between 16-79 cm (n=203). In the SAP we registered 63 events in 17 surveys, the main incidence occurred in July-September, with 92% of the recorded turtles identified as *Lepidochelys olivacea*, and 8% as *Chelonia mydas*. The strandings were attributed mainly to bycatch in long-line nets (59%), boat impacts (31%), and harpoon (10%). The gender was determined for 5 organisms, 60% females and 40% males, and the LCC range was between 47-69 cm (n=41). Most of the stranded sea turtles presented a high degree of decomposition with evidences of advanced autolysis; representing a key limitation for this work. The results convicently show that these sea turtle populations are being negatively affected by human activities like direct take and incidental capture, as well as indirectly affected by pollution, although we did not find cases of synthetic materials ingestion. The months with the highest number of stranding coincide with the shrimp closed season, provoking a shift of fishing target species (like shark, rays and other fish species); as well as gear shift to the use of gill nets ("chinchorros"). The distribution of LCC frequencies indicates the presence of mature and immature organisms of both *L. olivacea* and *C. mydas* in the area. With such panorama it is necessary to continue with sea turtle stranding surveys, as it is an important tool to obtain robust sea turtle mortality estimates. Acknowledgment to the following organizations for the travel grant: International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service.

PHOTOGRAPHIC TURTLE IDENTIFICATION: PROTOCOL DESCRIPTION AND INTEGRATION OF A SIMILARITY INDEX-BASED MATCHING ALGORITHM*

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Individual identification of animals in the wild can provide critical information for behavioral and ecological studies. Because individual identification can inform analysis of key parameters such as habitat use, residency and migration patterns, and survivorship, it is an important tool in the design and evaluation of management strategies. The use of tags has proved to be an efficient method of individual turtle identification, but its applicability is limited because it requires capture and handling. The development of additional, non-invasive methods of turtle identification can therefore increase our capacity to obtain vital information about sea turtle life history. Here we i) describe a protocol for identification of green sea turtles (*Chelonia mydas*) using facial scales; ii) describe a web-based matching system, and

iii) report on the efficacy of the protocol and matching algorithm for accurately identifying individual turtles using photographs taken at a distance and in uncontrolled settings. Extending previous approaches, our identification protocol relies on facial scale scoring and includes simple rules that minimize ambiguity. We optimized our scoring system for the automated generation of a similarity index that allows us to mine our turtle identification database for potential matches. The algorithm provides a ranking of similarity based on a distance between the target and the archived scores of all individuals in the database, and allows for the use of wildcards to allow for uncertainty at any scale position. Distance between the target and an archive score is calculated summing and weighting the difference in the number of sides for scales at each position in the score. We show that this protocol is efficient in identifying individual turtles from photographs taken at a distance (1-5m), including low-visibility underwater photographs. For highly migratory species such as *C. mydas*, the contributions of any system for identifying individuals to advancing our understanding of natural history, or to improve management depends on its potential application across large spatial scales. We suggest that our approach can be the basis for a global open-access repository of facial scale scoring that will allow for the coordinated tracking of *C. mydas* individuals.

SIMULATED DISPERSAL OF PELAGIC LOGGERHEAD SEA TURTLES FROM MAJOR ATLANTIC ROOKERIES*

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Upon hatching, loggerhead turtles migrate offshore and are transported long-distances by ocean gyre systems; far from areas where direct observation is feasible. As a result, little is known about the pelagic life-stage of loggerheads. To examine the role of oceanographic conditions on turtles during this period, we simulated the dispersal of loggerheads from 16 rookeries across the Atlantic using the surface layer of the Global Hybrid Coordinate Ocean Model (HYCOM). We used ICHTHYOP (v.2), a particle-tracking program, to release “virtual turtles” throughout each rookery’s hatching season and record the daily position and temperature of each turtle. We also assessed the percentage of turtles that each rookery contributed to mixed-stock foraging grounds. In general our results are consistent with genetic estimates of the percentage of turtles from a given rookery entering a mixed-stock foraging area. However, our findings also suggest that present rookery-centric genetic analyses might oversimplify the population structure of juvenile loggerheads in the Atlantic. Numerous turtles from large rookeries (e.g. Melbourne Beach, USA and Cozumel, Mexico) are found in oceanic regions unsampled for genetic analyses, such as the Bahamas and Sargasso Sea. Likewise, turtles from 14 of the 16 rookeries cluster in the Sargasso Sea; the only two absent were those from Angola and South Brazil. Although loggerhead turtles from different rookeries often converge in similar locations, they can experience very different dispersal trajectories, which vary in rate of transport and temperature regimes. Turtles from some rookeries reach the Azores in less than a year (e.g. North Carolina, USA), whereas others take three or more years (e.g. Cape Verde Islands). Moreover, the temperatures that turtles encounter along this pathway differ greatly among rookeries. Because turtle growth depends in part on temperature, this suggests that turtles of the same age but from different origins could greatly differ in size when first reaching the Azores. For instance, very few turtles from the eastern U.S. remain in waters greater than 15°C throughout the simulation

whereas a majority of turtles from Caribbean and Gulf of Mexico rookeries remain above this temperature. Finally, for some rookeries, after hatchlings reach 10-20 km offshore, long-distance dispersal can occur with no further behavioral input by turtles (e.g. Quintana Roo, Mexico). However, at other rookeries, turtles remain in coastal waters for extended periods, suggesting that sustained offshore swimming would be required for them to reach currents that would promote long-distance transport (e.g. Florida, USA). Such swimming behavior may be necessary because coastal waters are thought to be places of intense predation on hatchlings and temperatures can drop below the lethal level. This study highlights some of the key benefits of using ocean circulation models and particle-tracking software to study the pelagic ecology of sea turtles. These techniques account for the contribution of individual rookeries to mixed-stock foraging grounds independently of genetic differentiation levels and can determine the likely pathways between nesting beaches and foraging grounds. Additionally, they are useful for generating hypotheses about sea turtle distributions and behavior that can be further tested with empirical research. We want to thank the Posgrado en Ciencias del Mar y Limnología, the Instituto de Ciencias del Mar y Limnología, the North Carolina State University, the Consejo Nacional de Ciencia y Tecnología.

INTRODUCTION OF THE BIOLOGICAL AND ENVIRONMENTAL MONITORING AND ARCHIVAL OF SEA TURTLE TISSUES (BEMAST) PROJECT*

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The 111th U.S. Congress provided funding to the National Institute of Standards and Technology (NIST) to expand its analytical measurement capabilities and specimen banking resources into the Pacific region through the NIST U.S. Pacific Islands Program that includes biorepository storage capabilities for the region. As part of this Program, NIST established the BEMAST Project in 2011 to archive tissues from sea turtles primarily for assessments of health and exposure to environmental contaminants. Conservation efforts for sea turtle populations have focused heavily on obvious human threats, like harvest of eggs or fisheries by-catch; however, the risks from less noticeable threats such as chemical pollution or diseases are less understood. For example, after decades of monitoring green turtle fibropapillomatosis (FP), the contributing factors leading to the spread of the disease or the expression of debilitating tumors are still mysteries. Likewise, baseline data on the exposure of sea turtles to environmental contaminants are completely missing for many sea turtle species from large regions of the world. The BEMAST Project was developed to address these kinds of scientific questions today, as well as provide an archive of samples for future retrospective studies concerning emerging contaminants or diseases. Samples are collected, processed and stored using stringent protocols to avoid inadvertent contamination and are maintained in liquid nitrogen vapor-phase freezers (-150° C) at the NIST Marine Environmental Specimen Bank (Marine ESB) at the Hollings Marine Laboratory in

Charleston, South Carolina. Samples are sub-sampled into homogenous aliquots, often using cryohomogenization techniques so that each sample can be available now (i.e. near real-time) and in the future (i.e. long-term storage) for analysis of various contaminant concentrations or health-related measurements. This highly collaborative Project unites the existing specimen banking and analytical chemistry expertise of NIST with sea turtle biologists and veterinarians. NIST's BEMAST collection began in Hawaii and currently green turtle blood and scute samples from two sites, Kailua Bay, Oahu (low to moderate FP rates), and Kiholo Bay, Hawaii (no FP) are maintained at the Marine ESB. Sampling efforts are also planned during fall 2011 for Kapoho Bay, Hawaii (higher FP rates). In addition, samples are collected from Hawaiian green turtles that strand with excessive FP tumors and require euthanasia. These samples will be analyzed for a suite of inorganic and organic contaminants to assess the exposure of green turtles to a variety of toxic chemical pollutants from sites with varying degrees of FP rates and severity. Also, the BEMAST collection includes scute, fat, and liver samples from eleven green, five olive ridley, one loggerhead, and two leatherback sea turtles captured in the Hawaiian and American Samoan longline fisheries operations. Future collections will attempt to repeat annual sampling efforts at one Hawaiian site and to add eggs from nesting beaches as well as tissues from additional species and U.S. Pacific Island sites.

BIOMARKER DEVELOPMENT TO EXAMINE SUBLETHAL IMPACTS OF STRESSORS IN MARINE TURTLES*

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Environmental stressors can exert sublethal impacts on organisms that may in turn affect individual fitness and population dynamics. The current knowledge of these relationships in marine turtles is very sparse because conventional laboratory studies are difficult to conduct on sensitive, long-lived vertebrates. We are developing novel biomarkers to investigate relationships between sublethal stressors (such as pollution, thermal stress and disease) and physiological condition using gene expression profiling. The fundamental advantage of this approach is that the response of many genes providing transcriptional messages can be quantified from a small amount of blood, serving as proxies for proteins and cellular regulation. We are sequencing and developing quantitative real-time polymerase chain reaction primers for a panel of relevant genes in green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles. This approach has great potential in marine turtle research because it yields important insight into physiological functions and subsequent health of free-ranging animals while utilizing minimally invasive, field-friendly sampling methodology. As next generation sequencing platforms and other genomic resources become feasible for use in non-model species, we are planning to expand this work in 2012 by building environmental stress transcriptomes for these species and apply them to investigate sublethal stressors in marine turtle populations. We would like to thank UC Davis, NorCal SETAC, SICB, and the ISTS Student Travel Award for providing funding and facilities for this research.

THE WAY TO THE NEST. INFORMATION FROM THE TRACKS OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) AT EL CUYO BEACH, YUCATAN

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El Cuyo beach (Yucatan Peninsula, Mexico) is one of the most important hawksbill nesting areas in Mexico. In this study we propose an innovative and not invasive approach to nest searching based on the straightness of nesting females' tracks (searching behaviour) in the supralittoral zone. Theoretically, the straight path indicates less searching. The objective of this study was to determine if differences in female nesting behaviour exists within the same population nesting under different conditions: 1) nests safely located in the supralittoral vs. nests inundated or affected by presence of buildings (spatial difference), and 2) nests constructed before and during the rainy season (temporal difference). We measured track angles for the way from the sea to the nest (sea-nest) and the way back from the nest to the sea (nest-sea). From pictures of tracks through image processing, we determined track straightness. For each track we recorded the distance of the nest from the water mark, and supralittoral environmental features consistent with sandy beach ecology studies: beach width, beach slope, sand penetrability. In addition we recorded distances of first vegetation from the shoreline and vegetation height. Finally, tracks were assessed to determine nests inaccurately or safely placed and nests laid before or during the rainy season. We analysed a total of 89 tracks. Track straightness was high, indicating a poor search of the supralittoral. Sea-nest angles were precise (perpendicular to the shoreline). Significant behavioural differences were only found between individuals nesting in different seasons: during the rainy season, the way sea-nest was less straight than the way nest-sea for the same individual, while the sea-nest angles changed significantly the direction in the group nesting during the rainy season with respect to the group nesting before. Environmental features also differed between seasons: during the rainy season the beach slope was gentler with lower substrate penetrability, and vegetation was more distant from the shoreline. However, linear regression models did not highlight the effects of supralittoral features on track straightness. The straight tracks of *Eretmochelys imbricata* on the beach and the non significance of environmental features on track straightness may indicate that only a slight role is played by the supralittoral cues. Such lack of determinant influence may be related to the low variability found across-littoral for environmental variables at this site. Consequently, in this population, the information gathered from the seaside is likely to play a major role in the search for the nesting site, as also indicated by the difference found in angles of emersion. These results indicate that the effect of the rainy season changes the amount of information along the land-sea direction, supplying directional cues to the turtles and allowing them to differently adjust their trajectory to the nest. Such relevance of the rainy season on the movements of nesting turtles has important long-term implications for climate change, such as precipitation and temperature alterations in the region, indicating that the effects of such changes are not limited to the known consequences on incubation for sea turtles clutches.

TORREÓN DE ZAPARA: A TOOL OF ENVIRONMENTAL COMMUNICATION IN ZAPARA ISLAND-GULF OF VENEZUELA

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The main economic activity of Zapara Island is the artisanal fishing. From 2005 to 2008, semi-structured interviews were conducted by the NGO “Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela” (GTTM-GV) showing that 70% of fishermen living on the island used as main fishing art, artisanal longlines, which affected between 147 and 490 individuals of loggerheads turtles (*Caretta caretta*) per year. In adittion, this island has some considerable patches of mangrove forests, dunes and a rocky coastline with high invertebrate and vertebrate biodiversity. Community based conservation and community sensibilization towards these marine ecosystems and species was the main focal point to achieve the protection and conservation of these ecosystems with which they interact daily, and in this way, decrease human impact on sea turtle populations in the Gulf of Venezuela. To do so, “El Torreón de Zapara” was reprinted in 2010 by the GTTM-GV, this is an informative material with an environmental and ecological vision created by Prof. Rene Ramirez (RIP) in 1993 as an instrument of communication for the inhabitants of the island. “El Torreón de Zapara” is published quarterly, it has several sections that not only reinforce the cultural history of the people but, also, seeks to explain the importance of ecological equilibrium of the different ecosystems on the island, as well as the status of species, with a clear and colloquial language. Thus, in the present study we conducted a SWOT analysis (strengths, weaknesses, opportunities and threats) of this community journal as a communication tool, studying its target audience, applying a series of semi-structured interviews with inhabitants and natives of the island to measure its relevance, and then determine its importance as a tool to promote cultural development in the region. 70% of the population in Zapara Island is illiterate, mostly adults, and education is relatively new to the island in a formal way, children who are the most noticeable sensibilized through the interaction with this journal at school. “El Torreón de Zapara” has been used as a publicity media to transmit local culture and natural attractions of the island, it was notable that 65% of our readers are tourists, having a great reception, allowing them to experience Zapara’s daily life of the population and its natural and historic attractions, promoting the sustainable development of conservation tourism in the area. Likewise, the community shows satisfaction with the publication and the interaction with children, 80% of people believe that it is an excellent tool to promote environmental education, encouraging environmental awareness and socio-economic development in the community allowing visitors and other generations to know their culture. The critical condition of sea turtles population in the Gulf of Venezuela, “El Torreón de Zapara” is an important tool of awareness of environmental

and sea turtle sensibilization of general audiences, both tourists and the community, seeking to spread the knowledge about environmental issues, with special emphasis on the conservation of sea turtles and the ecosystems in which these inhabit.

MONITORING HATCHLING ORIENTATION AND LIGHT POLLUTION; MANAGEMENT TOOLS FOR THE REAL WORLD*

Kellie L. Pendoley

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The Gorgon Liquid Natural Gas (LNG) project currently under construction on Barrow Island, on the North West Shelf of Western Australia, is located adjacent to six flatback turtle nesting beaches on the east coast of the island. Strict regulatory agency environmental conditions covering every aspect of the project include the female and hatchling flatback turtles that use these nesting sites. Light associated with night time construction activities is being monitored using a novel technique developed for the Gorgon project marine turtle monitoring program. A Santa Barbara Instrument Group All-Sky astronomy camera, modified to quantify standard star light emissions, is used to collect images of project related light spill from turtle nesting beaches. Post-processing of the images provides empirical data for low light levels, e.g. glow, that otherwise cannot be quantified in a field setting. The numerical results can be used to assess the success of project light management activities and to compare between different light sources. The camera images are also utilized in the interpretation of hatchling behaviour as they leave the nest and crawl to the ocean. A separate hatchling monitoring program collects data on the orientation of fanned out tracks that are left in the sand by hatchlings as they engage in sea finding. Data collected from the fanned out tracks include the angle of the fan spread and the angle of fan offset from the most direct line to the ocean. These data are used to derive an average orientation value for each beach and when combined with the Sky Cam images, provide a pictorial representation of light and hatchling behaviour in a single figure. These results are used by project Environmental Practitioners to assess the impact of night time construction activities on hatchling orientation. Results from the first year of Gorgon LNG construction monitoring show that, despite the high visibility of construction lighting on nesting beaches, the average hatchling orientation direction was seaward during the February 2011 peak hatching survey period.

OCEAN CIRCULATION MODELS 101: RESOLUTION AND INPUTS MATTER IN SIMULATIONS OF HATCHLING SEA TURTLE DISPERSAL*

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Upon hatching, sea turtles immediately migrate offshore and into ocean gyre systems that promote long-distance transport. Young turtles remain in the open ocean for a number of years -far from locations where large-scale studies on these turtles are feasible. To provide insights into this cryptic life-stage, researchers have turned increasingly towards the use of ocean circulation models and Lagrangian “particle-tracking” software. These powerful tools allow the dispersal of thousands of hatchlings to be simulated from nesting beaches anywhere in the world. Ocean circulation models have been used to study diverse aspects

of sea turtle biology, such as estimating the time it takes for turtles to reach distant foraging areas, predicting nesting rookery contributions to mixed-stock foraging grounds of juveniles, and relating patterns of nest abundance to offshore conditions that facilitate the movement of hatchling turtles to subsequent foraging grounds. Different ocean circulation models vary in a number of ways that can potentially influence the results obtained and the conclusions reached from particle-tracking experiments. More than fifty circulation models are in use, each of which has a variety of strengths and limitations. However, little attention is given to how model inputs and resolution affect the outcomes of simulations of sea turtle movement. Here I show how changing the spatial and temporal resolution of circulation models changes the inferences made about the dispersal trajectories of hatchlings. Second, I highlight how simulations that assume passive drift by young turtles should be interpreted with caution; as minimal amounts of oriented swimming can have large affects on the predicted distribution of turtles in the open-ocean. Third, I provide a simple outline to explain the characteristics of circulation models that are important to consider when designing studies on sea turtles. I conclude that, in general, there are no such things as "bad models," but there can be inappropriate implementations of them. As ocean circulation models are used with greater frequency, it will be important for the sea turtle research community to be able to assess the merits of modeling studies and judge whether the assumptions of the simulations warrant the conclusions drawn. Funding was provided by the NCSU Initiative for Biological Complexity.

THE ROLE OF OCEAN CURRENTS IN SHAPING THE SPATIAL DISTRIBUTION OF GREEN SEA TURTLE POPULATIONS*

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Green sea turtles (*Chelonia mydas*) are one of the many marine species that possesses an early pelagic dispersal phase, dominated by passive drift, followed by a more sedentary coastal stage, dominated by active locomotion. The dispersal patterns experienced by sea turtle post-hatchlings of different rookeries seem to shape the spatial distribution of the different stocks, making the study of sea turtle population connectivity a biophysical problem. This study aimed to verify the influence of post-hatchling dispersal on the connectivity of green turtle populations. We estimated the natal origins of green turtles at feeding habitats by 1) a Bayesian mixed stock analysis using published mtDNA data, and 2) a statistical model using surface drifter data. By comparing the results from these methods (multinomial distributions), we were able to assess the influence of ocean currents in the mixtures observed in feeding grounds. Akaike Information Criterion (AIC) was used as a means for comparison among models. When we used surface drifter data to build the prior for contributions to mixed stocks, the AIC decreased. We suggest that the development of a particle tracking code that predicts the relative importance of various feeding grounds for particular rookeries will enhance our ability to inform coherent conservation strategies.

SCUTE PATTERN VARIATION AS A PROXY FOR HATCHLING QUALITY IN LOGGERHEAD (*CARETTA CARETTA*) AND FLATBACK (*NATATOR DEPRESSUS*) TURTLES*

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Sea turtles currently face a number of threats that have resulted in the decline of many nesting populations. Often the proposed solution is to increase the hatchling production of a beach; however, little data are available on the quality of these hatchlings and whether they will survive to breeding age. Our study investigated the use of scute pattern variation as a proxy for hatchling survival. Typically the carapace consists of five different types of scutes: nuchal, vertebral, post-vertebral, costal and marginal. Variations in scute patterns are generally more prevalent in hatchlings than in adult turtles, and it is often assumed that these abnormalities indicate lower quality hatchlings, which experience higher initial mortality. This hypothesis had not been tested directly; therefore the objective of this study was to quantify effects of scute variation on hatchling size and locomotory performance. Between November 2010 and January 2011 we relocated 21 loggerhead (*Caretta caretta*) and 9 flatback (*Natator depressus*) nests to a hatchery at Mon Repos Conservation Park, Queensland, Australia. Hatchlings were collected at emergence and a random sample of 30 hatchlings from each nest were weighed, measured, scute-counted and photographed. Scute patterns were classified into two groups: normal, with the modal scute pattern; and major variation, with variation in the costal or vertebral scutes. All other hatchlings were excluded from the analysis. Hatchlings were then subjected to locomotory trials to measure their self-righting and crawling ability, and swimming effort for the first four hours. Following hatching, nests were excavated and any hatchlings or unhatched embryos found inside the nest were also scute-counted. We found that variations in scute pattern were significantly more common in unhatched loggerhead embryos than in emerged hatchlings ($Z=2.641$, $p<0.01$). In addition, variations in scute patterns were more common in flatback than loggerhead hatchlings ($Z=2.027$, $p=0.04$). Flatback hatchlings with major scute variation also had significantly lower mass ($F_{1,147}=6.66$, $p=0.01$) and smaller carapace ($F_{1,147}=15.54$, $p<0.01$) than normal hatchlings. There was no significant effect of scute pattern on either loggerhead size or mass, and scute variation did not have a significant effect on self-righting ability or crawling speed of either species. Swimming effort was significantly affected by scute variation in flatback hatchlings, with hatchlings with major variation producing more thrust than normal hatchlings ($F_{2,21}=5.194$, $p=0.03$). While the greater prevalence of scute pattern variation in unhatched embryos and differences in size suggest a detrimental effect, this was not reflected in hatchling self-righting or crawling ability. In addition, the greater thrust produced by flatback hatchlings with major scute variation suggest the difference in scute variation prevalence between hatchlings and adult turtles is not due to an increased initial mortality rate. This also suggests that abnormal scute pattern is not an appropriate proxy for hatchlings locomotor performance within the first few hours of emergence. We would like to thank the University of Queensland Graduate Student Conference Support Scheme, the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and the International Sea Turtle Symposium for their generous support.

"TAKING PICTURES, RAISING AWARENESS"

Pablo Antonio Trujillo Susunaga

Ayotzintli A.C., Mexico

As part of the "conscious young, responsible communities" Ayotzintli AC design-led photography workshops for young children in poverty associated with sea turtles nesting beaches in the Mexican Pacific, thereby seeking to engage in a much more active and participatory approach to the different social strata of the community conservation projects, which we glimpse the future better in community efforts, as well as an appropriation of resources inherent in the case of communities such as turtles and all natural resources in the areas of work. Historically, photography has been used to capture the perceptions of people without any pressure or manipulation, why will a shaft lines to the link between young participants and the rest of the community. The workshop was based on non-formal interventions and divided into three parts: Getting a camera, by designing a workshop, various activities were developed were gaudy show participants the basic functions of a camera and the basic principles of the use of light, exposure rates and other concepts of photographic composition. Photographing my community, there was several field trips to places of environmental interest and places of environmental conflicts, for through the picture show participants how to understand and analyze both contexts. The use of photography shots and allowed us to obtain more realistic explanations as there is no pressure on the participant, who at times can be obtained by other teaching methods. My resources, my responsibility, after having a base imaging was performed one year among all participants to name and an explanation to the selected photos, all under the concept of What do you want to say to the community with this picture? To finish editing and design will be held posters with the images selected to develop an awareness campaign in the community, with participants as part of the message. This axis serve to connect the program with the rest of the community, and that based on texts and images generated by the youth of the community will create a media campaign seeking to improve the daily practices and generating an environmental culture and involvement with conservation programs for sea turtles. With this project we have been able to train 200 participants in three communities, creating more than 300 posters alluding to the conservation of sea turtles and the environment in general, which are distributed in the same communities, surrounding communities and electronic media.

A GRAPH THEORETIC APPROACH FOR UNDERSTANDING SEA TURTLE SPATIAL ECOLOGY AND PRIORITIZING CONSERVATION EFFORT*

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Graph theoretic models have been used to analyze complex systems for over three centuries, but more recently they have been applied to dispersal and connectivity studies in marine and terrestrial systems. They also have applications in conservation biology and landscape ecology. We show the utility of graphs to study inter-relationships of sea turtle

demography, spatial ecology, and conservation and to provide spatial depictions of current conservation efforts and discover important data deficiencies. We used data on known North Pacific Loggerhead (*Caretta caretta*) nesting sites, juvenile and adult "hotspots", along with locations and working ranges of relevant conservation groups to build bipartite graphs with two alternate life history paths. One graph models where *Caretta* goes at which life stage, the second set models *Caretta* conservation networks. We then expand both *Caretta* spatial ecology graphs and conservation network graphs to encompass all Pacific sea turtle species and use these graphs to prioritize areas for conservation. We show the utility of graphs to study inter-relationships of sea turtle demography, spatial ecology, and conservation, and our results highlight the difficulties of conserving a highly migratory species.

Special Session: Mini Symposium-The Sea Turtles of Mexico

SEA TURTLE CONSERVATION STRATEGY BASED ON THE MAYAN COMMUNITY PARTICIPATION OF TULUM QUINTANA ROO, MEXICO*

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The main purpose of the Sea Turtle Conservation program Riviera Maya-Tulum is to contribute on conservation, research and recovery of the different sea turtle species that nest on the area involving the Mayan community of Tulum, to guarantee the existence of our natural heritage for future generations. We developed one of the most extend and long lasting programs in Mexico with 29 years of continuity. Despite sea turtles are protected by local, federal and international laws, on Tulum coasts poaching, and turtle hunting prevail as a common activity for the community, on one hand for necessity and on the other for lack of education, putting in special danger the loggerhead sea turtle, among the other species. Our project is located on Tankah beach; part of Tulum National Park, protected by Comisión Nacional de Areas Protegidas (CONANP) and an ONG, Grupo Tortuguero del Caribe A.C. Because the extension of the program and the lack of personnel only allowed carrying out diurnal walks twice a month in this area where green (*Chelonia mydas*), loggerhead (*Caretta caretta*) and sporadically hawksbill (*Eretmochelys imbricata*) nest, the occurrence of poaching was constant. This situation, allowed the community to get involved in protection duties such as night patrolling, female tagging, nest marking and hatchling release to increase awareness and generate a sense of belonging of the resource influencing their way of life. On 2009 we started working with youngsters around 17 to 25 years old whom performed protection duties on National Park Tulum. The strategy was successful since poaching decreased from 60% to 5% for loggerheads and from 33% to 0.3% for greens from 1996 to 2011. For these reasons we decided to develop a permanent strategy for more young people to get involve on conservation and research by employing, preparing and awaking environmental awareness for them and their families as a tool for solving the environmental problems that surround our state. We want to provide the community with dignified and educative sources of living, promoting the formation of citizens with values,

self worth, sense of identity and belonging of their natural resources and maybe ahead, the future conservation leaders.

GREEN TURTLE (*CHELONIA MYDAS*) MALFORMATIONS IN NESTS FROM NORTHEASTERN YUCATAN, A POTENTIAL INDICATOR OF ENVIRONMENTAL HEALTH

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One of the main causes of population decrease of sea turtle species has been the intense commercial exploitation in early 80's, and the degradation of critical habitats for feeding, nesting and resting. However, there are other unknown intrinsic or extrinsic factors that could contribute to degrade their health status such as chemical pollutants. The turtles' natural displacements increase the possibility of both long-term and accidental exposure to different kind of chemical pollutants. Sea turtles accumulate pollutants through the trophic chain which are transferred to hatchlings by the mother through the eggs, with consequences in both embryonic development and hatchling´s health. Malformations in embryos and hatchlings are relatively rare and may be caused by exposure to chemical pollutants. Although studies on the conservation and protection of sea turtles have increased, there are few studies which record malformations, or their possible causes. Hence, we examined 150 green turtle nests during the 2010 nesting season to record presence, number, and types of malformations in embryos and hatchlings. We recorded for each nest number of eggs, live and dead hatchlings, eggs with embryonic development, and eggs without embryonic development. When several malformations were present in an organism, each one was recorded separately and photographed. The incidence of malformations was estimated with prevalence and intensity indexes. The first one shows the proportion of organisms and nests in which there was at least one malformation. The intensity index indicates the number of malformations per organism and per nest. We found that 18 nests showed at least one malformed organism (13%), and 26 out of 618 (4%) organisms showed some type of malformation. Based on the total number of nests with a deformed organism, the mean intensity was 1.44 (±0.9) malformations per nest. An intensity value of 2.50 (±1.7) malformations per organism was also determined. We recorded 71 malformations grouped into 31 types, present in eight anatomical regions. The most severe malformations were: siamese twins, microcephaly, and cleft jaw. The carapace presented the highest malformation frequencies (29.6%), followed by jaws and flippers (22.5% and 15.5, respectively), and the tail showed the lowest frequency (1.4%). The most frequent type of malformation was complete upper scutes aplasia (12.7%), followed by albinism (9.9%), and cleft jaw (8.5%). Siamese twins and microcephaly had the lowest frequencies (1.4% each). Compared to previous studies or other sea turtles, prevalence and intensity were low. Since adult green turtles are primarily herbivorous, they could be less exposed to higher concentrations of chemical pollutants from their food (low bioaccumulation) than other species with a wider food spectrum and a higher trophic level in the food web. There is no quantitative information regarding the relationship between pollution levels and incidence of

malformations in sea turtle embryos and hatchlings. Long-term malformations assessments will provide base line information useful to evaluate and monitor the sea turtles' and their critical habitats' health to determine possible affectations by chemical pollutants on their populations. Finally, I want to thank the organizing committee of the 32 ISTS for rewarding me with a travel grant that made possible my assistance to this symposium.

GENETIC DIFFERENTIATION OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) NESTING COLONIES ALONG THE MEXICAN PACIFIC BASED ON MITOCHONDRIAL DNA*

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The olive ridley (*Lepidochelys olivacea*) is the most abundant sea turtle around the world. However, its historical abundance has severely declined in some areas due to anthropogenic factors. The second most important nesting area worldwide is the eastern Pacific, extending from de tip of the Baja California Peninsula to Costa Rica. While most nesting colonies in the Mexican Pacific coast have shown signs of recovery, the olive ridley is still classified as a vulnerable species by the International Union for Conservation of Nature and Natural Resources. Being a vulnerable species, it is very important to assess the level of genetic variability in the nesting colonies in order to properly identify management units and prioritize areas for protection of its habitat. Previous mitochondrial and nuclear DNA surveys along the Mexican Pacific have found levels of genetic differentiation among nesting colonies varying from null to significant. However, these results may be confounding geographic and temporal signals. Hence, here we analyzed the genetic differentiation of *L. olivacea* in 18 nesting colonies sampled along the Mexican Pacific during the 2002 and 2003 nesting season. Mitochondrial haplotype diversity was high in the olive ridley nesting colonies, the sample from Nayarit was the most diverse ($h=0.72$) whereas the one from Baja California Sur was significantly ($p<0.05$) less diverse ($h=0.19$) than the others. Nucleotide diversity values were low, the lowest and highest values were found in Baja California Sur ($\pi=0.0005$) and in Michoacán ($\pi=0.0024$), respectively. No significant differences were observed in nucleotide diversity among nesting colonies. A global exact test of differentiation revealed a heterogeneous haplotype distribution ($p=0.02$), and pairwise comparisons showed significant differences between Baja California Sur and both Nayarit and Michoacán ($p<0.05$). Gene flow was high among nesting colonies. A maximum likelihood phylogenetic tree showed low divergence among haplotypes. However, two strongly monophyletic groups can be distinguished, one linage (98% bootstrap), grouping only haplotypes from Sinaloa, Nayarit, Colima and Michoacán; and another linage (96% bootstrap), including some haplotypes from Baja California Sur to Oaxaca. The parameters of the sudden expansion model suggest that most of the nesting colonies have increased in population size, especially Nayarit and Colima; in Baja California Sur this increase has been on a lesser scale than in other colonies. Our results suggest that the colony of Baja California Sur shows marked genetic differences with the rest of the continental colonies. Therefore, we recommend maintaining a precautionary approach to management of the species at least for the nesting colony of Baja California Sur and continuing programs to protect and conserve the remaining colonies nesting in the Pacific

coast of Mexico. Finally, I want to thank the organizing committee of the 32 ISTS for rewarding me with a travel grant that made possible my assistance to this symposium.

ISLA SAN PEDRO MARTIR: AN OCEAN OASIS FOR RECOVERING BLACK TURTLES OF NORTHWESTERN MEXICO

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The East Pacific green sea turtle population (*Chelonia mydas*) of the Gulf of California declined rapidly during the 1960s and 1970s to fewer than one thousand nesting females due to severe overharvest. Thanks to comprehensive protection by the Mexican government since 1990 plus complementary conservation efforts on nesting beaches, the population is apparently rebounding. The Grupo Tortuguero de las Californias, AC (GTC) has provided additional protection for green turtles on their Gulf of California juvenile foraging grounds through community-based conservation activities lead by local fishers since 1996. Protection of key foraging habitat including both islands and lagoons could play an important role in the continuing recovery of the Mexican-nesting green turtle population. The Island of San Pedro Martir (2.9 km^2) serves as an oasis for a variety of wildlife including sea turtles because it is the most isolated island in the Gulf of California. Sea turtles were intensely hunted at Isla San Pedro Martír during the 1970s and 1980s. The island and its surrounding waters were officially declared a Mexican Federal Biosphere Reserve in 2002. The Comisión Nacional de Áreas Naturales Protegidas (CONANP) is implementing a comprehensive Monitoring Program that includes evaluation of the effectiveness of conservation and management of the coastal and deep rocky reefs, the algal forests and black coral forests, plus the oceanic system including sperm whales and the sea turtles. This monitoring is conducted by nine commercial scuba divers from Kino Bay trained and SCUBA certified thanks to the leadership of Comunidad y Biodiversidad, A.C., (COBI) in collaboration with CONANP. As part of the comprehensive Monitoring Program, the directors of the marine reserve invited GTC to teach a group of local fishermen from Kino Bay on how to conduct systematic sea turtle monitoring in the reserve. As part of the fisher training, the team of local fishermen attached ARGOS satellite transmitters to four juvenile green turtles to assess their habitat use relative to the island. Here we report results of both the monitoring and tracking of black turtles at Isla San Pedro Martir. Since 2007, underwater monitoring of the coastal environments of the island conducted by COBI has revealed increasing abundance of green turtles. Initial sea turtle censuses revealed extraordinarily high abundance of black turtles relative to other GTC monitoring sites in northwestern Mexico. Remarkably, mean displacement for the four turtles was under 100 km over a mean tracking time of 79 days. Kernel density plots reveal strong fidelity of tracked juveniles to Isla San Pedro Martir. Our findings suggest that ISPM functions as a foraging hotspot for juvenile green turtles. With improved wildlife enforcement, the ISPM Federal Biosphere Reserve could function as a green turtle refuge that could substantially contribute to population recovery.

EGG CORRAL AND BEACH TEMPERATURES IN THE KEMP'S RIDLEY RECOVERY PROGRAM AT RANCHO NUEVO DURING THE 2010 AND 2011 NESTING SEASONS

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Sand and nest temperatures were evaluated during the 2010 and 2011 nesting season for the Kemp's ridley at Rancho Nuevo, Mexico. The study was conducted in order to provide insight on the hatchling sex ratios produced in the Kemp's Ridley Recovery Program. Beach and egg corral temperatures were monitored at nest depth using temperature data loggers. Additionally, incubation temperatures were monitored in a subset of nests throughout the nesting season. General trends in temperature were evident during both nesting seasons. Temperatures were relatively cool during the start of the nesting seasons (i.e. below pivotal temperature), but gradually rose and were at, or above, pivotal temperatures by mid May. Temperatures then remained relatively high for the remainder of the nesting seasons, with the exceptions of time periods when tropical weather systems moved through the area and lowered incubation temperatures to near or below the pivotal temperature. Egg corral temperatures were consistently warmer than temperatures on the natural nesting beach. Collectively, the data suggest that female-biased sex ratios were produced during both the 2010 and 2011 nesting seasons at Rancho Nuevo. The results have implications for developing optimal management strategy for the Kemp's ridley. For example, it is plausible that the production of a female bias in the Kemp's Ridley Recovery Program may be enhancing the recovery of this endangered sea turtle.

SEA TURTLES IN NORTHWEST MEXICO: ADAPTING MANAGEMENT STRATEGIES IN RESPONSE TO CLIMATE CHANGE ON NESTING BEACHES

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The Eastern Pacific Ocean (EPO) is home to some of the most endangered populations of leatherback (*Dermochelys coriacea*); hawksbill (*Eretmochelys imbricata*), black (*Chelonia mydas*) and olive ridley (*Lepidochelys olivacea*) sea turtles. Northwestern Mexico is the northern limit for regular nesting. In the late 1970s sea turtle protection camps were established on beaches with high nesting density with the aim of mitigating the threats of egg poaching for local consumption and sale. Management includes the transfer of clutches to protected areas of the beach (hatcheries) and/or incubation in Styrofoam boxes. Here we present data from 8 protected primary beaches over 10 to 35 years in the states of Baja California Sur (BCS) (n=2), Sinaloa (n=3), and Nayarit (n=3); and from one project that has seven years in which it has established an "in situ" nest protection at the beach (BCS). We also present information on historic and recent nesting on the beaches furthest to the north (Sonora and Sinaloa). An analysis of seasonal and temporal trends of nesting and compared results of reproductive success, embryo mortality, and incubation duration is also presented. We also document the strategies used to mitigate the effects associated with longer periods of lethal incubation temperatures which result in lower hatchling production, longer droughts and/or excessive rainfall and changes in beach profiles due to erosion and flooding. We propose a regional initiative of planning, monitoring and evaluation.

THE EFFECTS OF ARTIFICIAL INCUBATION ON NEST TEMPERATURE IN OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) CLUTCHES IN NAYARIT, MEXICO

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Artificial incubation (the use of Styrofoam boxes to incubate relocated clutches) has become a common conservation tool used in many sea turtle hatcheries along the Pacific coast of Mexico. This is attributed to high levels of illegal poaching and lack of funds to protect hatcheries. Previous research suggests this method of conservation may produce a male-biased sex ratio. The aim of this study was to investigate the effects of artificial incubation on nest temperature, and to compare results with previous research on pivotal temperature in olive ridley nests in order to assess sex ratio output. At El Naranjo beach, in Nayarit, Mexico, temperature data loggers were planted with relocated nests in styrofoam boxes during the nesting season of 2010 (n=2) and 2011 (n=7). The data loggers were set to record nest temperature every hour for the duration of incubation. A data logger was also planted in the hatchery to gauge beach temperature for this location. Our results revealed significantly lower temperatures in the Styrofoam box nests compared to the beach hatchery. Furthermore, using pivotal temperatures identified in previous studies as a reference, sex ratio output is estimated to be male biased. These findings have exposed an area which requires immediate revision of current incubation methods in order to ensure the future reproductive viability of the olive ridley populations in this area. Our results also highlight a potentially useful strategy in light of concerns regarding the future feminisation of sea turtle nests due to climate change.

CONSERVARTE: EMPOWERING YOUTH AND EDUCATORS TO PROTECT SEA TURTLES THROUGH CURRICULUM ENRICHMENT, PARTICIPATORY MURALISM, AND FIELD EXPERIENCE*

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Global assessments are revealing sea turtle bycatch and poaching hotspots that offer great conservation leverage. Engaging the coastal citizens who interact most with sea turtles represents unusual conservation opportunity, especially in developing nations where wildlife management can be weak despite strong conservation legislation. In the waters of Mexico´s Baja California peninsula, extremely high bycatch can occur where intense fishing overlaps with a loggerhead turtle nursery hotspot. The Grupo Tortuguero's long-term partnerships with fishers have yielded important reductions in bycatch mortality of endangered loggerhead turtles through voluntary changes by fishers in fishing gear and practices. To complement these direct fisher partnerships, we developed ConservArte to empower local youth and educators with knowledge and personal experience of their natural environment through a semester long program of curriculum enrichment that culminated with collective muralism, a marine conservation fair, and an extended field experience. We partnered with the Secretariat of Public Education of Baja California Sur and regional NGOs including ProNatura, Niparajá, Magdalena Baykeeper, Ecology Project International, WWF and

CONAGUA, to design and implement the curriculum enrichment program to exceed federal standards for environmental education during spring 2011 at the Republic of Cuba primary school in Puerto López Mateos BCS, the fishing community that historically has interacted the most with endangered loggerheads in the region. We worked with 5-6 grade science teachers to deliver enrichment classes during the spring semester that focused each week on a different locally important environmental theme including mangroves as nursery habitat, cetaceans, shorebirds and seabirds, water conservation, and of course sea turtles. Through an art contest the students selected ideas, perspectives and imagery to be incorporated into a public mural. The semester culminated with a conservation fair during which specialists from regional NGOs teamed with students to convert each classroom into a conservation experience for all of the school's students and parents. During the fair, under the guidance of two local artists, each participating student then painted her/his own section of a 2 x 18 m mural at the highly visible school entrance on the town's main boulevard. Following the fair the students travelled to an isolated estuary to participate in a sea turtle census led by local fisher partners of the Grupo Tortuguero. Based on a range of metrics ConservArte was successful in a) engaging and inspiring students and teachers, b) in building strategic partnerships with education authorities, and c) in reducing environmental impacts of local citizens, including both poaching and bycatch of sea turtles. Due to strong partnerships with state and federal educators plus regional NGOs ConservArte was both inexpensive and strategic. With strong support from the Secretariat of Education and partnerships with RED Turismo and Ecology Project International, in 2012 we plan to expand to offer ConservArte, to each 6th grade class, around Magdalena Bay area. There is great potential for developing similar programs at sea turtle and other biodiversity hotspots.

RESULTS OF CONSERVATION OF KEMP'S RIDLEY (*LEPIDOCHELYS KEMPII*) IN THE COAST OF TAMAULIPAS, MEXICO

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The Kemp's ridley (*Lepidochelys kempii*) has been a sea turtle species of interest due to its critical situation. It is endemic to the Gulf of Mexico and its main nesting area is concentrated in a beach strip of just over 200 km along the State of Tamaulipas, mainly in the municipalities of Soto la Marina and Aldama. In the historical records of Kemp's arribadas it was estimated that approximately 40,000 Kemp's ridleys were nesting at Rancho Nuevo beach in 1947. During the early 1960's the number of kemp's ridleys was reduced probably due to overexploitation of eggs, meat and skin, bringing the species to a critical condition; in the year 1976 a total of 671 nests were recorded, which represented around 290 sea turtles. Because of this, the Mex-US Bi-national Recovery Program for the Kemps ridley was agreed in 1978, which allowed joint conservation measures that resulted in an increase of the nesting population. The objective of this paper is to show the results of the protection and conservation activities for the Kemps over the past 5 years, at nesting beaches in the state of Tamaulipas. Over the last decade, the kemp's ridley population has shown a remarkable recovery. In 2007 only for Rancho Nuevo Sanctuary more than 6,000 Kemp's ridleys were recorded in one arribada; during 2011 in Tamaulipas state 20,570 kemp's ridley nests were recorded. Of these, 80% of nesting occurred in the Rancho Nuevo beach Sanctuary. In

conclusion bi-national efforts accumulated over the years and the strategies used for the recovery of a species, are showing successful results.

FIRST FORAGING ECOLOGY STUDY OF BLACK TURTLE (*CHELONIA MYDAS AGASSIZII*) IN THE STATE OF SINALOA

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The knowledge that we have about the nesting ecology of black turtle (*Chelonia mydas agassizii*) is very extensive, as well as the genetic and morphological differences of this subspecies. However, only few studies have been conducted to investigate their movements, habitat use or feeding ecology in foraging areas. The knowledge on this last aspect is fundamental for conservation, because it can identify important food sources, guide decisions about the sea turtle population management and help to mitigate the effects of anthropogenic impacts. Many studies on foraging ecology in the peninsula of Baja California in Mexico have been made; however, many areas in the eastern Pacific are still understudied, as well as the size distribution in different areas, the population density and total abundance, the individual growth and residence times of juveniles and the connectivity between feeding areas. Although the state of Sinaloa has been considered as a migratory corridor to the feeding area of black turtle in Baja California, a study on feeding ecology has not been conducted in Sinaloa. Recently, on the beaches of the main islands of Guasave and its coastal zone, we captured two individuals that came to this area to feed on red algae *Gracilaria parvispora*. This abstract contains the preliminary results from the project of black turtle (*Chelonia mydas agassizii*) foraging ecology of in the lagoon system of Navachiste, Sinaloa, but it is noteworthy that the state of Sinaloa is not only a migration corridor but a feeding area for the black turtle.

HISTORICAL EXPLOITATION OF SEA TURTLE IN THE NORTHERN CARIBBEAN SEA*

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Our hypothesis is based on the premise that all sea turtle species that inhabited the Caribbean Sea once reached populations of millions of adults. The virtual ecological extinction of these organisms forced a significant change over the ecosystems structure and function in this region. This change has been overlooked in previous sea turtle population assessments due the shifting baseline syndrome take place. This study describes and

characterizes the population exploitation in the northern Mexican Caribbean of the green turtle, *Chelonia mydas,* and the hawksbill turtle, *Eretmochelys imbricata*. It describes the pre-Columbian uses; the dimension of the exploitation during the Colonial and Independent periods; we compared the twentieth century harvest data against the oral history data; and finally, we identified possible historic nesting beaches and feeding grounds through oral history. A detailed analysis of the historic record and the oral history identified that the first evidence of sea turtle use in the state of Quintana Roo date back to the Postclassical period (1,000–1,517 d.C.) and reached 1,100 years of continued use. Based on the historical records we characterized the pre-Columbian use of the sea turtle as a commercial type, because of its regional extent reaching along the Mayan navigation route and along the Quintana Roo coast. Although the records for the Colonial and Independent periods were limited in number, we were able to document the qualitative dimension of the sea turtle exploitation. The historic record analysis suggests that the hawksbill turtle populations collapsed long before the 20th century. The 19th century records allowed identifying the bias of using solely data. On the other hand, the historic records showed that the green turtle populations of Quintana Roo were able to sustain a commercial fishery during the 1960s. Although this study was not able to quantify the level of decline, the historic records displayed that the populations reached the 20th century with a considerable decline, in particular the hawksbill turtle. The study concludes the need to evaluate several sites identifed as critical habitats for each sea turtle species that may have been extirpated before the population surveys began. Without specific knowledge of past abundances as a reference point we can underestimate the real extent of the decline of sea turtle populations. In this study we proved the value of historic records in evaluating the exploitation patterns of vulnerable and/or endangered species using as model the sea turtles.

ACTIVITIES AND CONSERVATION POLICIES RELATED TO MARINE TURTLES IN THE COAST OF OAXACA

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The described activities were assembled by the Fondo Oaxaqueño para la Conservación de la Naturaleza -FOCN- (Oaxacan Fund for the Conservation of Nature) in seven communities where turtle camps are located and attended by community members, in the context of a signed agreement with the support of the “Red de los Humedales de la Costa de Oaxaca” to complete specific tasks and actions. An integral management program was created to: a) train the members of the turtle camps in the correct practice of eggs collecting at the nesting beaches, b) establish pacts with other organizations and institutions to strengthen the program, and c) instruct people from the fishing civil associations in the use of “G” type hooks and fishing lines of low environmental impact to reduce bycatch. Environmental education activities were organized with courses given by specialists, who worked with the turtle camp guides in order to improve the methods for collecting eggs and reinserting them during the night trips in the beaches where turtles arrive. Also, the personnel were trained to extend ecotourism activities for improving services and attention to the visitors, including the distribution of a map of the coastal region in many localities. Materials like t-shirts with allusive images of the arriving turtles were freely brought out and put to sell for the public. A PVC poster with all the information about the turtles was also set in each camp. An agreement with the CONANP was signed in order to elaborate an “Illustrated Guide of Marine Turtles for the Camps” with the objective of informing and

sharing information about the biological, ecological, historical and legal issues about the turtles catch and protection. A cooperation agreement was made with WWF in order to establish a Conservation Strategies Program that covers two areas: a) turtle arriving beaches, and b) marine fishing zones where bycatch occurs. WWF has worked in Puerto Angel, Oaxaca in collaboration with 13 fishing organizations, 277 fishermen, employers, governments and INAPESCA, to transform the longline fleet by replacing 10,821 "J" type hooks for circle hooks, in 89 small vessels. In order to reduce sea turtles snagging and tangling, modifications were made to the fishing line and a surface longlines with floatline integrated prototype was designed to be used in nesting areas for olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*) and green turtles (*Chelonia mydas*), thereby mortality has been reduced. These works are part of Sea turtle bycatch reduction in longline fishing craft and mitigation measures in Eastern Pacific Ocean.

TEN YEARS OF BLACK SEA TURTLE RESEARCH AND CONSERVATION AT TWO COASTAL LAGOONS IN NORTHWEST MEXICO. WHAT DO WE KNOW?*

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The coastal lagoons systems on the Pacific coast of Baja California Sur, Mexico, are considered critical foraging and developmental habitats for the East Pacific green or black turtle (*Chelonia mydas*). Due to overexploitation the black turtle suffered a population crash in the 1980's, with a reduction of 98% of nesting females in Michoacán. Even after more than two decades of banning sea turtle capture and consumption in Northwest Mexico, between 8,000 and 33,000 turtles die every year due to bycatch and poaching. To evaluate the success of conservation efforts, survivorship rates, abundance, growth and foraging habits and site fidelity were studied over a period of ten years at two important foraging grounds in the Pacific of Baja California Sur: Estero Coyote-Punta Abreojos (PAO) and Estero Banderitas-Magdalena Bay (BMA). The estimates of survivorship were generated through mark-recapture analysis, using CJS (Cormack-Jolly-Seber) models. From July 2000 to July 2010 a total of 1,833 black turtles where captured, including 351 recaptures. For BMA two different survivorship estimations gave the best fit, for transients (phit=0.49 ± 0.05) and residents (phir=0.82 ± 0.02). For PAO the best model generated a higher survivorship estimate of phi=0.93 ± 0.013. PAO presented a significantly higher turtle abundance (1,481 ± 665 turtles/km^2) than BMA (205 ± 32 turtles/km^2). Sea turtle capture in BMA remains a serious problem in the areas leading to much lower survivorship and abundance when compared to PAO. Growth rates were 2.51 and 1.72 for PAO and BMA respectively. The von Bertalanffy growth function (VBGF) showed that the time needed for a turtle to reach maturity is much longer in BMA (25 years) when compared to PAO (16 years). This is probably strongly dependent on the different types of food ingested, at PAO the assimilation of animal protein analyzed by stable isotope of nitrogen was significantly higher (δ^{15}N=11.30 ± 1.28) than for BMA (δ^{15}N=8.40 ± 1.09). The Resultant Index (Rw), which relates volume (%V) and frequency (%F) of food items, indicates the more important components in the diet (V≥5%). In the case of BMA, *Gracilaria vermiculophylla* was the most important component (Rw=21.64, %V=62.03 and %F=69.57), while in PAO, *Ruppia maritima* achieved the highest value in the diet (Rw=32, %V=32.33 and %F=89). Water temperatures are responsible for

the significant differences in growth between summer and winter recorded at both sites. Stable isotopes of carbon and sulfur in skin samples indicate that black turtles have high foraging site fidelity. There was a clear latitudinal gradient, confirming fidelity to their feeding areas (BMA, $\delta^{13}C$=-18.27 ± 0.81, $\delta^{34}S$=17.49 ± 1.25; PAO, $\delta^{13}C$=-14.72 ± 1.61, $\delta^{34}S$=15.28 ± 1.92). This information is relevant for understanding the ecology of the black turtle, and survivorship data shows that more conservation efforts are necessary on Magdalena Bay.

SEA TURTLE FESTIVALS OF NORTHWESTERN MEXICO: EVALUATING EFFECTIVENESS AND SYNTHESIZING KEY ELEMENTS OF THE GRUPO TORTUGUERO'S FESTIVAL NETWORK

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Despite strong national and international protection, isolated coastal communities can have disproportionate impacts on sea turtle populations, principally through consumption and bycatch. Because local impacts are rarely monitored and enforcement is often lacking, reducing sea turtle mortality can depend largely on coastal citizens. Northwestern Mexico's waters host five species of sea turtles, several of which are endangered. The richness that attracts turtles from around the North Pacific also brings intense fishing and coastal use that result in high levels of both bycatch and poaching. In 2003 the Grupo Tortuguero joined local leaders to produce the first of a network of regional sea turtle festivals. At Baja California Sur, high mortality of endangered loggerheads results from the overlap of intense local fishing with a turtle foraging hotspot. We designed the festival to celebrate loggerheads and their hotspot as an extraordinary natural treasure akin to the locally revered and valuable gray whales. Key messaging included background information on sea turtle status, the impacts of fishing, and that the future of the loggerhead turtle rests largely in the hands of local fishers an their families. Production drew on the traditional town and whale festivals and included a festival queen, live banda music, a parade plus a variety of art, culinary, and sports competitions. This combination has resonated so strongly that the Annual Loggerhead Festival has become a cultural tradition, a forum and ritual that figures prominently in the social fabric of the region. According to semi structured interviews the annual festival has contributed directly to reductions in both poaching and bycatch of turtles. With the great success of the Annual Loggerhead Festival the the Grupo Tortuguero has been invited to facilitate and co-produce turtle festivals in other strategic communities in northwestern Mexico and beyond including San Carlos, San Juanico, Pescadero, and San Ignacio in BCS, Guasave and Mazatlán in Sinaloa, Cocodrilo, Cuba, and Omotehama and Tanegashima, Japan. With the growth of the GTC festival series we have identified key festival ingredients, planning elements and realistic conservation outputs that we share with new festival partners. We evaluate festival success through metrics including level of local leadership in festival planning and production, level of government involvement and investment, proportion of local and regional population participating and attending, press coverage and festival longevity. In this presentation we will synthesize the GTC's decade of producing and facilitating sea turtle festivals in order to share a prescriptive methodology that can be applied by other interested groups. Sea turtle festivals represent a cost-effective opportunity for creating local and regional fora through which to engage and empower the public in marine conservation with global applicability. With preparation and some luck

festivals can grow into self-perpetuating cultural phenomena that maintain a sea turtle conservation ethic.

APPLICATION OF "OVOCESAREA" IN EGGS OF OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*), WITH COMPLETE EMBRYONIC DEVELOPMENT BUT WITH DIFFICULTIES FOR HATCH

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This work presents an innovative technique which we have named "ovocesarea", which has served to help complete embryos to hatch when having problems to break the shell. The Turtle Camp in Ceuta Beach, Elota, Sinaloa, Mexico, has been operated by the Universidad Autonoma de Sinaloa since 1976. During many years of conservation of the olive ridley turtle (*Lepidochelys olivacea*), it has been observed that after the nest has hatched, some eggs with live embryos which could not break the shell still remain inside. Usually, these eggs were buried again in the hope that they will complete their incubation period and hatch, but frequently that was not the case. Nowadays, these embryos are helped to hatch through the technique of "ovocesarea" which consists of manually breaking the shell and then separating the amnion membrane and allantoids, leaving only the yolk sac. The embryo is wrapped in a damp cloth and then placed in special containers where it stayes between three and five days, ending the vitelo resorption and getting released. Most of the eggs which have been undergone ovocesarea usually are embryos with albinism type mutations that do not develop the caruncula, a small horn on the tip of the nose to break the shell. This winter (2011-2012), some "normal" embryos have been aided by this technique because they present a strange and unusual sort of gel on the region of the caruncula, which prevents them from hatching. Apparently the extreme cold weather may cause the presence of this strange gel.

ANALYSIS OF SEA TURTLE BYCATCH BY THE SHRIMP FLEET IN THE PORT OF MAZATLAN, SINALOA, MEXICO, FROM 1989 TO 1995

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Sea turtles, as well as many other fish, mollusks and crustaceans are captured during shrimp fishing activities, considering them as bycatch because they are not the target species. Nevertheless, all these species are caught in the nets, and it seriously affectsthe survival of endangered reptiles like sea turtles. This work evaluated sea turtles incidental capture using data collected by observers on shrimp fishing based at the port of Mazatlan, Sinaloa, Mexico. The fishing fleet operated between the southern coast of Sonora and Punta Mita, Nayarit, in the 1989-1990 and 1994-1995 fishing seasons. Two sea turtles species were recorded as

bycatch, the olive ridley turtle (*Lepidochelys olivacea*) (90% of the records), and the black turtle (*Chelonia agassizii*) (10% of the records). The catches ranged from 600 to 1500 turtlescopies per season, although in the 1991-1992 season it reached 6,000 turtles, possibly due to a shift of the fishing grounds, moving to the North of the areas of sea turtle greater abundance associated with "El Niño" event, that year. The gender proportion was 3 females per 1 male for olive ridleys, and 1.5 females per 1 male for black turtles; however, during the 1992-1993 season only females were caught, and only males in 1989-1990. The largest captures of both species were recorded in October, declining in the following months of the year, although *L. olivacea* showed an increase in February, close to the end of the shrimp fishing season. Olive ridleys were caught up to 50 fathoms in depth, but they were more frequently caught between 19 and 30 fathoms. Black turtles were captured in depths around 30 fathoms, but were most commonly caught between 0 and 20 fathoms. Geographically, most of the captures occurred off the coast of Nayarit, but in the 1991-1992season, during the event of "El Niño", bycatch events were more frequent in the northern coast of Sinaloa. This is the first formal preparatory work for TED (Turtle Excluder Devices) implementation in a shrimp trawling fleet in Mexico, which are binding from the publication of the standard official Mexican emergency NOM-EM-001-CFSP-1996.

ADVANCES IN THE STUDY OF THE BEETLE *OMORGUS SUBEROSUS* IN NESTS OF *LEPIDOCHELYS OLIVACEA* AT THE SANCTUARY PLAYA LA ESCOBILLA, OAXACA, MEXICO*

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For the past two decades the presence of *Omorgus suberosus* (Coleoptera, Trogidae) has been documented in nests of *Lepidochelys olivacea* at the Sanctuary La Escobilla. Field and laboratory data suggest that this beetle, aside of feeding on dead eggs also attacks living eggs, adding it to the list of mortality factors of the olive ridley on this important nesting beach. Further, it suggests a change of feeding habits, as this species of beetle usually feeds on dead animals, principally feathers, hair and skin (keratophagous habits). The high density of nests on this beach provides an abundant and readily available food resource for *O. suberosus* for most of the year. Because information on different aspects of turtle–beetle interactions in the Sanctuary La Escobilla is scarce and dispersed, we developed a research program that considers the following topics: 1) Spatial distribution of *O. suberosus* in nests of *L. olivacea*, 2) Temporal variation in abundance and spatial distribution of *O. suberosus*, 3) Determination of life cycle and keratophagus reproductive biology of *O. suberosus*, 4) Prospection of chemical agents involved in nest detection and intra-specific communication, and 5) Implementation of a control program to decrease the population size of *O. suberosus* and to diminish its impact on *L. olivacea* in order to increase the survival rates. Preliminary results suggest that both adults and larvae have an aggregated distribution, with higher values in areas with high sea turtle nest density. Damages on eggs were threefold greater

in areas with high nest density, and abundance of beetles appears to be synchronized with sea turtle arribadas. In the long term we expect that this research contributes to improve the management program and conservation of ridley turtles in the Sanctuary La Escobilla.

RELEVANCE OF NORTHWEST MEXICO AS A FORAGING AREA AND GROWTH OF BLACK TURTLES (*CHELONIA MYDAS*) FOR RECOVERY THIS POPULATION*

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The Grupo Tortuguero de las Californias (GTC) is a network of individuals, communities, organizations, and institutions from across the Baja California peninsula, mainland Mexico, the U.S. and the world dedicated to sea turtle conservation. Formed in 1999 by a small group of concerned fishermen, scientists and conservationists, the Grupo Tortuguero is now a large and diverse network throughout Northwestern Mexico. It wasn't until 2001 that the methodology for the monitoring of black sea turtles (*Chelonia mydas*) was standardized in a systematized database with a total register of 2,079 turtles caught, measured, tagged, almost all with photo identification. 358 turtles have been recaptured at least once, 17% of the total; 92% are juveniles and sub adults. An important result of the recaptures is that only five turtles were found at different locations from where they were first tagged. Also, the high number of recaptures at each single site points to a high site fidelity. This information shows that this region is important as a foraging and nursery area for black sea turtles, hence key for the recovery of this population. The coastal lagoons of the Eastern Pacific such as Bahía Magdalena, Laguna Ojo de Liebre, Laguna San Ignacio and Punta Abreojos are noted for their abundance, which has increased in recent years. In the case of the Gulf of California, Isla San José near the Bay of La Paz and Bahía de Los Angeles in the upper Gulf of California stand out for their abundance and particularly for higher indices of adults in comparison with other monitoring sites along the Gulf. There is evidence that the black turtles of this region come principally from Hawaian stocks, Islas Revillagigedo and Michoacán (Colola & Maruata beaches), with sporadic occurrences from other nesting sites in the Northwest. The opportunities that the coastal lagoons of the bays of the Gulf of California present for feeding, shelter and development of black turtles, justify these sites to be included into specific management areas with special programs to develop sustainable fisheries in order to ensure the complete recovery of this species. The GTC believes that although the data generated during 10 years of monitoring show a significant increase in the abundance of black turtles, this preliminary result should be interpreted with caution, taking into account the large number of juveniles and sub adults with a complex life history. We propose to continue the research and conservation efforts in the region with special emphasis on areas of Sonora and Sinaloa, where even though in 2010 the 20th anniversary of the ban imposed by the Mexican government was celebrated, direct fishing and consumption remain high.

HAWKSBILL NESTING (*E. IMBRICATA*) INSIDE A COASTAL LAGOON IN SOUTHEASTERN MEXICO

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The Yucatan Peninsula is home to one of the largest hawksbill turtle populations in the Atlantic basin. Hawksbill nesting occurs in diverse environments and it seems that the characteristics of the Yucatan Peninsula are very appropriate for this species. Laguna de Terminos, in the State of Campeche is one of the largest coastal lagoons in the Gulf of Mexico (7,209.73 km^2), and a habitat for a great biological diversity, which includes nesting hawksbill females. The hawksbill nesting activity has not been widely reported for narrow small beaches on interior estuarine systems, there are only reports of nesting on the coast near the national Tacarigua Lagoon Park in Venezuela, and on the Cuban main island and keys associated with spawning within the mangrove; but perhaps the most recent report is the one for Jiquilisco Bay in el Salvador. Inside of the Laguna de Terminos, an important hawksbill turtle nesting activity is recorded annually, being the South-East of the Isla del Carmen (inside the lagoon) and the eastern part of Laguna de Terminos -Victoria, Chacahito and Xicalango- the most important nesting zones. The number of nests in this area ranges between 50 and 100 nests; but it can reach up to 200/yr. The amount of recorded nests in Laguna de Terminos makes it especially important for the whole State of Campeche, contributing with a significant number of hawksbill nests, and harboring feeding and shelter sites for immature hawksbills in the region.

ASSESSMENT OF PHYSICAL INCUBATION CONDITIONS FOR GREEN TURTLE (*CHELONIA MYDAS*) AT LAS COLORADAS BEACH, YUCATAN, MEXICO

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The Yucatan peninsula harbors important green turtle nesting beaches along its eastern, northeastern and southwestern beaches. Las Coloradas is a nesting beach located inside the Biosphere Reserve Ria Lagartos, at the northeastern corner of the peninsula. In the past two years it has been recorded an average of more than 2,000 green turtle nests in 21 kilometers of beach (about 96 nests/km). The physical conditions of nests incubation has been poorly studied in this region until recently. The objective of this study was to evaluate the temperature regime inside green turtle nests and its correlation with physical features of the nesting beach. We monitored 12 green turtle nests laid by August 2010 using equal number of temperature data loggers inside the nests along the whole incubation period. We also took sand samples from inside and outside of the nest for grain size assessment, and recorded depth of the nest, distance to vegetation and distance to high tide mark. Only five of the 12 nests successfully hatched, the rest were lost to flooding. The temperature data series were split in thirds in order to evaluate the influence of the physical variables on different incubation stages. During the first third the temperature remained constant in all

nests with an average of 29.62ºC (±0.13), for the second third (sex determination period) there was an average of 29.30ºC (±0.41), while for the last third it was recorded an increase in temperature with an average of 30.69ºC (±0.65), possibly explained as a reflect of metabolic heat produced by the hatchlings. This metabolic heat was estimated to be around 2.18ºC (±0.65) and this value was proportional to the number of eggs laid in each nest. For all the nests, the sand inside and outside was characterized as fine and very fine sand, without any differences in the samples along the nesting beach. We didn't find a significant correlation between temperature with depth of the nest, nor distance to vegetation neither with distance to high tide mark. These results are part of an initiative of characterizing the incubation microhabitat for sea turtles at Las Coloradas beach, setting a base line for future sex ratio assessments and temperature variations in the incubation habitat.

INCUBATION METHODS IN THE OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*) AT SAN JUAN CHACAHUA, OAXACA, MEXICO

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The high level of egg deprication in the Olive Ridley turtle (*Lepidochelys olivacea*) suffer on the Oaxacan coast, has prompted research and conservation groups to relocate the nests to incubation corrals. The artificial incubation nests at hatcheries are built to be as similar to their original nests as possible. It has been pointed out that the environmental conditions in the hatcheries require the maximum care to guarantee the maximum hatching success as possible. In order to find the best method for eggs incubation with the highest hatching success for olive ridley turtles, we evaluated three incubation methods hatcheries located at San Juan, Chacahua, on the Pacific coast in the state of Oaxaca, Mexico. We compared hatching success in buried nests by using local methods, then by measuring the turtles' rear fins, and finally, using measures proposed in the literature. The effect that temperature and moisture or humidity have on hatching success was also assessed. All monitored nests during this research were collected from October 2008 to March 2009. A total of 159 olive ridley turtle nests were included in this analysis. We found one method to be different to the other. Local nests showed 50% hatching success, 30% less than flipper nests and nests buried by literature techniques. An analysis of temperature and moisture measured during this research did not reveal any significant effects on success in hatching. Beta values suggest moisture has an effect more related to temperature and different effects in each method. Depth has an effect in hind fin measured nests and width has an effect in local nests.

POPULATION TRENDS OF *E. IMBRICATA* AND *C. MYDAS* IN CAMPECHE, MEXICO*

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The State of Campeche represents the main site for reproduction of *Eretmochelys imbricata* in the Gulf of Mexico, and one of the 4 main nesting beaches for *Chelonia mydas* in the Mexican Atlantic. Long-term results 1977-2011, corresponding to the annual abundance of nesting of the two species monitored, were analyzed generating positive trend lines but inadequate growth as indicators of real population trend. Base on standard methods for demographic assessments, the numbers of nests were transformed into lambdas (λ) (Nt/Nt-1) and expressed in percentage values R=(λ)-1*100, noting that the trend in growth decreases to more reasonable values (*Eretmochelys imbricata*=0.3%, and *Chelonia mydas*=4.8%). It suggests a number of historic events that could positively impact the nesting activity in the region, such as the complete ban in Mexico, the obligatory use of the TEDs; but also some factors negatively affecting the nesting activity such as the commercial fisheries in the region, and the cyclones that could influence the recruitment of breeders during this period. The positive and negative effects coincide and are reflected more clearly on *Eretmochelys* imbricata trend than in *Chelonia mydas*.

NEST EXCAVATION INDICATES BEETLE PREDATION CONCERNS AT LA ESCOBILLA, MEXICO

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La Escobilla is a major mass nesting (“arribada”) beach of olive ridley sea turtles, and may have the largest population of arribada nesters. However, hatchling production is negatively impacted by many adverse factors, resulting in a reduction of hatching success and emergence of live hatchlings that has been observed over the last five years. The mass nesting reproductive strategy seems to compensate for this deficiency with an enormous quantity of eggs laid, representing an enormous reproductive effort by the species. Beetle predation is causing considerable pressure to hatchling production at La Escobilla and has been recognized over the years as a troubling problem. In this poster we confirm that beetle predation is the principal impact affecting eggs that survive other sources of destruction (nest destruction or overlap by other females, erosion from waves or opening of estuaries, poaching, among other factors). In this poster we evaluate hatchling production during the 2010 season, using a method of sample plots in which all the nests in a one square meter area were located, excavated, and closely examined. We observed the most hatching success in the more humid area of the beach that is reached by the tides, likely because of the scarce presence of beetles, and the appropriate temperature and humidity conditions. We observed less hatching success in the drier area of the beach next to the vegetation. In

that area, the incubation conditions are less adequate and there is a greater number of beetles than in the lower areas of the beach. Many authors attribute low hatching success on arribada beaches to diverse factors related to density; La Escobilla is not immune to this situation and requires timely and long-term monitoring of hatching success to better understand the future prospects of the nesting population in the short and long term.

HAWKSBILL NESTING ON THE CENTRAL MEXICAN PACIFIC COAST: THE NORTHERN NESTING DISTRIBUTION FOR THIS DECIMATED POPULATION

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The Eastern Pacific (EP) hawksbill Regional Management Unit (RMU) was recently identified as one of the eleven most endangered sea turtle RMUs in the world. Nesting beaches in El Salvador and Nicaragua have recently been identified as the most important in the region. However, despite the RMU's advances in hawksbill conservation, abundance remains critically low. In Mexico, conservation efforts for hawksbill turtles have been mostly concentrated on large rookeries on the Caribbean coast (Campeche, Yucatan, and Quintana Roo states), and little focus has been given to the Pacific coast due to minimal reports of isolated nesting. Here we report data on 3 hawksbill nesting sites located on the Mexican Pacific coast documented over the past 7 years; Punta de Mita (Nayarit), Playa Rosa and Playa Teopa (Jalisco). Continued nesting during monitored years suggests these sites represent potential rookeries and not isolated nesting events. Although nesting is low we believe these sites to be of significant importance within the region, representing the northern most location where EP hawksbills are reported to nest. We recommend continued monitoring and conservation efforts at these potential rookeries, accompanied by investigation of beaches where hawksbills have historically been reported to nest.

SEX RATIO EVALUATION OF THE OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) ON A MASSIVE NESTING BEACH IN MEXICO

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The olive ridley sea turtle (*Lepidochelys olivacea*) is the most abundant species nesting in the Mexican Pacific coast. Despite the protection status, *L. olivacea* is potentially exposed to environmental stressors which may affect natural populations. For instance, the temperature-dependent mechanism of sex determination in olive ridley makes it particularly vulnerable to environmental changes. Since temperature is a crucial factor for sex determination, global warming may affect not only the breeding and nesting times but also

the sex ratios of this species. Therefore it is important to monitor sex ratios in wild populations. The nesting beach we selected to perform this study was “La Escobilla” in Oaxaca. We selected this beach because of several reasons: 1) it is a massive nesting beach with more than 200,000 nests per year, 2) most nests are left to develop in situ, 3) there are no previous records of sex ratios, 4) several embryos and hatchlings die of natural causes, so no animal has to be killed for this purpose, and 5) there is a genuine interest to monitor sex ratios due to the potential effects of climate change. Samples were obtained during summer (July-September 2010) and winter (November 2010-February 2011) nesting periods, and processed by histology with hematoxylin-eosin-phloxine staining for sex identification. Main sexing criteria were based on the thickness of the surface epithelium (cortex in females) and development (in males) or fragmentation (in females) of medullar cords. Sex ratios were female-biased in summer in spite of climatic events taking place (La Niña), whereas no bias was observed in winter. We decided to compare the temperatures recorded in the nesting seasons for 2009 and 2010, as warmer temperatures would be expected to produce an even higher female-biased sex ratio. Summer and winter mean temperatures were close to the pivotal temperature (28-32°C and 28-31°C, respectively) during the thermosensitive period. The temperature increment from 2009 to 2010 was -1.7°C, indicating that 2010 was indeed cooler than 2009, whereas in winter the temperature increment was 0.07°C from 2009-2010 to 2010-2011. Temperature data explained (at least in part) why in Oaxaca the nesting season is longer than in other locations as sand temperature is quite stable throughout the year, so embryonic development and hatching take place under proper conditions. We suggest continuing sampling (work in progress) in order to know the trend of sex ratios using a predictive mathematical model of population dynamics over time, taking into account climatic events such as "El Niño", "La Niña" and the contemporary climate change.

INCIDENTAL CAPTURE OF SEA TURTLES IN FISHERIES OF QUINTANA ROO, MEXICO

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This work evaluates the mortality due to bycatch in fisheries that occur in the coast of Quintana Roo State, that affect the three species of sea turtles distributed in the area: loggerhead, hawksbill and green turtle. Using interviews with fishers in the main fishing areas we described and quantified the fishing gears that cause sea turtle bycatch, and evaluated mortality rates. The state of Quintana Roo has 700 km of coast, but it’s the north area the one that concentrates the largest population of fishers, fishing authorizations and communities with the largest number of inhabitants; in consequence it concentrates the largest number of nets and longlines that affect sea turtle populations. Fishing effort increases each year, in spite of the State restriction on the issuing of new authorizations for scaly fish and shark fisheries. Data suggest that gillnet fisheries have higher rates of bycatch and mortality than longline fisheries. The most used gear for scaly fish fisheries is the surface fixed gillnet with mesh size of 10 to 13 cm, which comprised 63% of all captures recorded. The gears that caused the highest sea turtle mortality were 30 cm mesh size gillnets, and shark longlines. The most impacted sea turtle species was hawksbill (55.4%), followed by loggerhead (31.3%) and green (13.3%). The most frequently recorded sea turtle individuals

were larger than 70 cm straight carapace length, representing 48% of the total number of incidental captures.

THE EFFECT OF CLIMATE CHANGE ON A NESTING BEACH IN THE SOUTH OF THE GULF OF MEXICO: CHENKAN CASE STUDY

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In recent years, the potential effects of climate change on sea turtle populations and the assamblages with their habitats have caused great interest, augmented by the endangered conservation status that these species have. The beach of Chenkan, Campeche, receives one of the three largest hawksbill nesting populations in Mexico, and it one of the top five in the Atlantic basin. Nowadays, the mean number of nests per year is around 500, and aproximately 150 nesting females, with a hatching success percentage above 70%. Phylogenetically the two haplotypes present in this rockery are considered as endemic. Following the strategy proposed and put forward by the WWF in its Toolbox of adaptation to Climate Change, we present some actions and results of adopted and implemented measures based on such regional strategy. Nowadays, one of the most evident effects of climate change in this area is the beach loss estimated at 7 m/yr, which combined with loss of dune vegetation cover repercutes on the females´ nesting behavior when selecting the site for egg laying. It has also been evaluated the effect of rainfall on embryonic mortality during egg incubation, as well as the effect of sand temperature on the hatchlings´ sex determination.

COMPUTER ASSISTED PHOTO-IDENTIFICATION OF GREEN SEA TURTLE (*CHELONIA MYDAS*) IN CAMPECHE, MEXICO

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Recognition of individuals within a population is a key issue for behavioral and ecological studies of threatened and endangered species, among which all species of sea turtles are included. We investigated the suitability of a photo-identification technique based on computer-assisted processes using nesting turtle facial profiles, and based on the position and shape of scutes, with the assumption that individuals do not display the same scute patterns in the right and the left facial profiles (both sides were used to characterize each individual whenever possible). The computer-assisted system was the software Wild-ID based on the Scale Invariant Feature Transformation (SIFT algorithm), which selects key points and gathers gradient information around them in a descriptor vector. We obtained 220 nesting green turtle photographs of both sides; 207 confirmed individuals, validated by metal tags data. All photographs were organized in a database according to the series tag,

individual number, date and site sighting. Therefore, it was possible to validate the photo-ID method by later comparing its results with the ones obtained by traditional metal tagging method. The matching test succeeded for all the profiles. We considered as recaptures only the recaptured individuals already identified with metal tags, and recorded a total of 49 recaptured individuals. The software Wild-ID correctly identified 28 individuals matching both profiles; this represents a 62.22% of all compared photographs; however, 10 individuals were identified as false positive. The results obtained from software Wild-ID were validated considering three premises: 1) The SIFT algorithm values obtained in each trial, used a minimum value of 0.00503 to determine the similarity between two photographs, 2) Visual comparison; and 3) Comparison of the results obtained by the method of photo-identification and the traditional metal tagging. The software correctly identified 110 images, confirmed by visual observation of facial scale patterns. The results of the validation, based on 116 profiles, resulted in 94.8% efficiency. Facial profiles that recognized greater number of females was right-left (27.3%), the right (25.5%) and the coincidence of the three profiles (20%); the frontal profile only allowed the recognition of two images. It was observed that tympanic, temporal and post-ocular scales presented greater individual variation in *Chelonia mydas* females. We considered that the photo-identification technique described in this paper is validated as a long-term recognition method; tag loss problems will be minimized though it is necessary to standardize the photographing process for best results. Keywords: photoidentification, ecology, cumputer assited.

CIRCULATING VITELLOGENIN, SEX STEROID AND THYROID HORMONE LEVELS OF IMMATURE EAST PACIFIC GREEN SEA TURTLES (*CHELONIA MYDAS*). DO THEY REALLY MATURE AT THE AVERAGE NESTING SIZE IN BAJA?

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Understanding the reproductive status and population dynamics is elemental for sea turtles conservation. The Baja California Peninsula provides favorable habitat for feeding and growth of immature East Pacific green turtles (*Chelonia mydas*), which remain in this area for decades prior to reaching sexual maturity. The information about the normal endocrine patterns of this population is scarce despite its utility in health status assessment and as basic data for understanding the effects of environmental endocrine disruptors to wild populations. The objective of this study was to determine the levels of sex steroid hormones (T, E2), thyroxine (T4) and vitellogenin (Vtg) in serum samples by direct competitive enzyme immunoassays (ELISA) in green turtles captured alive in Punta Abreojos (PAO), Laguna San Ignacio (LSI) and Bahía Magdalena (BMA) during 2005-2007. Morphometrical data were recorded and a relative body condition index (Krel) was estimated using length and weight data. The average nesting size (77.3 cm straight carapace length, SCL) was the criterion used to identify adult organisms. Correlations between the endocrine parameters and the morphologic variables, Krel, blood biochemistry parameters (lipids, total proteins, calcium and glucose) and the concentration of xenobiotics (trace elements and organochlorine pesticides) of the sea turtles were evaluated by study site. Juveniles were the predominant (90%) size class. This study confirmed previous suggestions that the size

of the organisms (>77 cm SCL) and the absence of secondary sexual characters (e.g. tail size), are not good indicators of the gender and/or reproductive stage of the East Pacific green turtles when used alone. One individual captured in LSI, misclassified as juvenile given the absence of secondary sexual characters and its small size, and only one of the three organisms classified as adult females presented sex steroid levels within the range reported for adult sea turtles during the nesting period. Without considering these 2 outliers, T levels in the three study sites were <10 ng/mL, E2 levels <145pg/mL and T4 <3.4 µg/100mL. The T concentrations did not suggest sexual differences between individuals in a bimodal distribution. Every sample analyzed showed detectable Vtg levels (0.13-0.87 mg/mL) without being correlated to T, E2 or T4 levels. There were no significant differences in the hormone concentrations and Vtg among size classes. Temporal differences reflected higher levels of T4 and Vtg during those periods with higher Krel (PAO, summer 2006; BMA, 2005). Nevertheless, the levels of E2, T, T4 and Vtg were not correlated to the Krel in any study site. The triglycerides concentration was correlated to E2 content ($r=0.75$, $p=0.03$), total protein levels to E2 concentration ($r=0.42$, $p<0.01$) and T (T, $r=0.45$, $p<0.01$) and glucose concentrations with T4 levels ($r=0.41$, $p=0.01$) and Vtg ($r=0.64$, $p<0.001$) concentrations, suggesting their utility as biomarkers of nutritional status of the green turtles. The hormone levels were correlated to the concentration of many xenobiotics such as Sr, Si, DDT and aldrin. The minimum blood concentrations of OC found in the sea turtles were not correlated with the Vtg levels, a potential biomarker of endocrine disruption.

INDIRECT ASSESSMENT OF SEA TURTLE INTERACTIONS WITH ARTISANAL FISHERIES IN WATERS ADJACENT TO YUCATAN, MEXICO

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The waters adjacent to the Yucatan peninsula in Mexico are an important region for sea turtles from different rookeries in the Wider Caribbean and Gulf of Mexico that is used for mating, migrating and feeding, making turtles vulnerable to different anthropogenic activities such as artisanal fisheries. In the region there is not previous information about the spatial distribution of the artisanal fleets working around the peninsula, but it has already been reported that different fishing gears used by those same fleets are incidentally catching turtles during their fishing labors. The present study aimed to indirectly assess the sea turtle bycatch frequency in the region by artisanal fisheries, and describe the spatial distribution of the fishing effort in the region and their coincidence with known feeding areas. We used semi-structured interviews to obtain the data from fishermen at 7 ports in Yucatan, asking about their fishing gears, fishing techniques and sea turtle bycatch frequency. It was also included a map with a 20 km^2 grid for the definition of their most visited fishing grounds in the area. We did a total of 516 interviews from September 2009 to January 2010. The gillnets are the most frequently used fishing gear at Celestun (48%) and Holbox (50%); and an artisanal longline is the most used technique at Progreso, San Felipe and El Cuyo. The gillnets are the most dangerous fishing gears for sea turtles in the region with the higher number of bycatch records of sea turtles in the study area. Most of the studied ports showed a spatially differentiated use of the coastal area, with the fishing grounds for gillnets closest to shore than those for the use of longlines; Celestun was the only port that didn´t show such spatial structure. We found spatial coincidences between areas of high fishing activity with

feeding grounds of previously satellite tracked post-nesting hawksbill and green females in the region. This is the first report in the region showing the spatial distribution of artisanal fleets and their potential interaction with sea turtles using the waters adjacent to the Yucatan peninsula, Mexico. This spatially explicit information is an excellent tool for the decision makers in order to identify bycatch hotspots. Keywords: bycatch, sea turtle, fishing effort, fishing gear, spatial distribution.

ARE PARASITES AND/OR FIBROPAPILLOMA INFLUENCING THE HEMATOLOGICAL AND BIOCHEMICAL VALUES IN HAWKSBILL AND GREEN TURTLES AT NESTING SITES IN YUCATAN PENINSULA?

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Historically, the presence of parasites and/or fibropapilloma is linked with health issues in marine turtles. Some studies strongly suggest that their presence in wild populations might be reflected in the hematologic and biochemical baseline values. In the present study frequency, abundance and location of ectoparasites and fibropapilloma in hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) nesting turtles, on the east coast of Yucatan, were evaluated in relation to hematologic and biochemical values. Our samplings were obtained in two consecutive years at two of the major nesting beaches for both species. The extraction of blood samples was performed in the dorsal cervical sinus in 80 specimens of *E. imbricata* and 100 *C. mydas* nesting adults with and without parasites. We measured the curved carapace length (CCL) and curved carapace width (CCW) to estimate their age. We determined the mean, standard deviation and minimum and maximum values. Hematologic and biochemical values were determined with commercial spectrophotometric techniques (Kits). Electrolyte determinations were done by spectrophotometric atomic absorption and emission. The obtained hematological and biochemical values for blood were significantly different from those reported for immature specimens of the same species. Some values such as hematocrit, hemoglobin, total protein, albumin, calcium, uric acid, and creatinine were postively correlated with the level of parasitosis. During the monitoring it was observed that *E. imbricata* was more susceptible to parasites than *C. mydas*. For hawksbills, it was observed that 25 of 80 turtles (31%) had some type of ectoparasites, while 16 of 100 (16%) *C. mydas* presented ectoparasites. This sugests that anatomic and physiological features of *E. imbricata*, or its specific habitat, may influence the diversity and composition of ectoparasites on it. Fibropapilloma was observed on both *E. imbricata* (1.25%) and *C. mydas* (2%). These tumors were histologically identified as fibroids constituted by a discreet number of fibroblasts and abundant collagen fibers. The guards showed papillary dermal fibropapillomas characterized by a moderate to marked degree of hyperkeratosis, as well as

the presence of horny pearls and a moderate hyperplasia of stratified squamous epithelium. All cutaneous fibropapillomas resulted positive for the herpesvirus PCR. This is the first known report of fibropapilloma on *E. imbricata*, at least at regional level. Our data suggest that may be involved more than one virus, while confirming the presence of herpesvirus in both species of sea turtles.

ECTOPARASITES IN NESTING SEA TURTLES, *ERETMOCHELYS IMBRICATA* AND *CHELONIA MYDAS*, OF THE NORTHERN YUCATAN PENINSULA, MEXICO

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The aim of this paper was to determine the frequency, abundance and localization of ectoparasites on *E. imbricata* and *C. mydas* nesting individuals. In 2008 and 2009 on the beaches El Cuyo and Las Coloradas in the northern coast of the Yucatan, we examined *Eretmochelys imbricata* (n=80) and *Chelonia mydas* (n=84) nesting sea turtles for ectoparasites and epibionts. At least 25 *E. imbricata* and 16 *C. mydas* showed parasites. Barnacles were separated per species and placed in formalin (10%) with a pH 7.2, the leeches were collected from the cloaca of turtles using forceps and dissecting needles, and placed in petri dishes with saline (0.65%); and crustaceans were preserved in alcohol (70%). Results showed a higher percentage of the barnacle *Platylepa hexastylos* attached to the neck, axillary and inguinal fins in *E. imbricata* (90%) than in *C. mydas* (5%). The barnacle *Chelonibia testudinaria* was found attached to the shell of 70% of *E. imbricata,* and 10% of *C. mydas*; while the barnacle *Chelonibia caretta* was present in 63% of *E. imbricata* and 2% of *C. mydas*. The leech *Ozobranchus margoi* was found attached to the cloaca of 31% of *E. imbricata* females (mean=2 parasites per turtle, range:0-8). The crustaceans *Idotea sp* were found attached to the neck in 15% of *E. imbricata* females (mean=8 parasites per turtle, range:10-40). Keywords: Hawksbill turtle, *E. imbricata*, green turtle, *C. mydas*, epibionts, ectoparasites, leeches, crustaceans.

HEAVY METALS AND SE IN MARINE TURTLE *CHELONIA MYDAS AGASSIZII* OF THE CANAL DEL INFIERNILLO, SONORA, MEXICO

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The pollution of the oceans represents a problem of great impact to the health of wildlife, humans and ecosystems. In particular, heavy metals have a great relevance in ecotoxicology because they are highly persistent and their potential toxicity to all organisms. They have been listed as one of the potential synergic etiologies of marine turtle fibropapillomatosis. With current anthropogenic changes in marine ecosystems, heavy metals are a threat to marine turtle populations worldwide. Blood has been successfully used as a tissue to measure heavy metals and metalloids due to the vital functions performed by blood cells and their susceptibility to intoxication. The processes of absorption, accumulation and circulation of heavy metals, correlated to their bio-availability and potential toxicity can be observed in blood. This study reports baseline levels of selected heavy metals in blood of Black turtles (*Chelonia mydas agassizii*) in Sonora, Mexico. Clinically healthy Black turtles were in Punta Chueca, Sonora (25012'48.3"N, 109003'12.5"W). 8–10 ml blood samples were collected from the dorsal postoccipital sinus using 10 ml heparinized Vacutainer tubes (Becton Dickinson, Franklin Lakes, NJ), and 21x1.5 in needles. Heavy metal concentrations (based on wet weight) were determined using an optical emission inductively coupled plasma atomic spectrophotometer (ICP-AES) model OPTIMA 4300™ DV (Perkin-Elmer). Analytical wavelengths (nm) were Cd=228.8; As=188.9; Ni=231.6; Hg=253.6; Pb=220.3; Zn=206.2; Cu=327.3; Mn=257.6; and Se=196.0. All statistical analyses were performed using StatSoft STATISTICA 8.0.550. In the heavy metals analyzed, Zn was the most prevalent metal in blood (63.58 µg/g) follow by Se (7.66 µg/g). The concentration of Zn was higher than levels reported in liver, kidney and muscle in Japan and Mexico. Our study reported higher levels of Cd (0.99 µg/g) than Cu (1.71 µg/g) and Mn (1.22 µg/g), and less than other tissues in studies around the world. Mean concentrations of metals followed this pattern: Zn>Se>Ni>Cd>Cu>Mn. In conclusion, the use of the blood like analysis tissue was used to measure the recent exhibition to the polluting agents studied in *C. mydas agassizii*, and their importance like centinel specie. The coastal species show a major degree to exposition and contamination by inorganic polluting agents. Combined to it, previously has been published that exists a significant correlation between the metal concentrations in blood and other weaves, particularly in toxic metals like Cd, As and Hg, and the metalloid Se.

IN-WATER SURVEYS OF HAWKSBILL (*ERETMOCHELYS IMBRICATA*) AND EAST PACIFIC GREEN TURTLES (*CHELONIA MYDAS*) IN PUNTA DE MITA, NAYARIT, MEXICO*

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In-water distribution and abundance of sea turtles in Punta de Mita, Nayarit (20°46´15" N, 105°32´35" W) was assessed from November 2010 to June 2011 through in-water surveys and interviews with local biologists, fishermen and dive guides. In-water surveys were conducted using SCUBA, a total of 19, 30 minutes transects, were completed with water depth varying between 3 and 18 meters. Turtles were also captured using an entanglement net during a 4 hour night survey. In interviews 65% of people have seen one or more hawksbill turtles in Punta de Mita during the last three years. During the SCUBA surveys, five turtles (four East Pacific green turtles and one hawksbill) were sighted and one of the green turtles was captured by hand. The capture per unit effort (CPUE) was 0.52 turtles/hr; this CPUE is low compared with areas in the Caribbean. We also captured two East Pacific Green turtles with the entanglement net (0.5 turtles/hr). Green turtles captured were juveniles or subadults (53-74 cm CCL). This is the first report of the presence of juvenile and subadult East Pacific green turtles in Nayarit. We propose Punta de Mita as a potential stopover feeding area in the middle of their migration route.

MOLECULAR GENETICS OF HAWKSBILLS FROM MEXICAN HABITATS IN THE CARIBBEAN AND GULF OF MEXICO

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After remarkable increments in the nesting abundance of Mexican hawksbill rookeries in the Gulf of Mexico and Caribbean in the 90s that consolidated this breeding assemblage as one of the largest in the Atlantic basin, an alarming and as of yet incompletely explained steep decline occurred 2001-2005, with lowest abundances in 2007. Although the causes for the drop are probably multifactorial, understanding the genetic structuring among the Mexican

populations is critical to track the distribution of individual population units as they disperse among developmental and foraging sites in the region, and experience multiple levels of exposure to existing threats. To gain insight into how the Mexican rookeries are structured and the level of contribution by individual stocks in marine aggregations, we re-sequenced an 800bp segment of the mtDNA control region of rookery samples from Veracruz to Quintana Roo and from foraging grounds off Campeche and Yucatán. Additional variation afforded by the longer sequences allowed us to identify four management units (MU): 1) islands off Veracruz (1 small rookery; "IV"), 2) South Campeche (Chacahito to Sabancuy; "SC"), 3) Central Campeche (Chenkan to San Lorenzo; "CC"), and 4) Northern coast of the Yucatan Peninsula (Celestún to Holbox; "NYC"). Differentiation among MU generally involved frequency shifts of endemic haplotypes with the surprising exception of IV which contained haplotypes common only outside Mexico (EiA01, EiA11, EiA12) suggesting a recent colonization from distant origins. This suite of mtDNA markers allowed us to test for natal homing of individual Mexican MUs and their level of contribution to regional FG with published results. For example, many-to-many mixed stock analyses showed a high level of juvenile natal homing with a tendency to discriminate between Yucatan and Campeche FG but not between sites within a single state (e.g. Campeche FGs). Thus, haplotype composition of Campeche FGs were not significantly different from each other and were composed mainly by Campeche MUs (71%) with a small NYC component (20%) and a very low contribution by foreign rookeries (<10%). In contrast, the NYC management unit contributed 50% of turtles at the Yucatan FG, Campeche sources 28% but a relatively high input was from foreign rookeries (22%). Both of these results are consistent with our particle drift modeling. All adults at the Yucatan FG exhibited NYC haplotypes and when these were removed from the analysis; even though the NYC contribution dropped it still remained the highest overall (44%). Contribution from Mexican MU to Cayman FG were low (<3%) with no discernible differences between the MUs; for the Puerto Rico FG, though the total Mexican contribution was low (7%), the lack of haplotypes endemic to central Campeche (EiA39), suggests the absence of the CC management unit from that region. The results are discussed in the context of current conservation needs for the species and evolutionary and oceanographic phenomena that can explain the observed stock composition and distribution.

ABUNDANCE AND PREDATION OF NESTS OF THE SEA TURTLE *LEPIDOCHELYS KEMPII* IN THE COASTAL REGION TOTONACAPAN, VERACRUZ

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The Kemp's ridley sea turtle is endemic to the Gulf of Mexico, its main breeding areas are along the coast of Tamaulipas, mainly the Sanctuary Rancho Nuevo, and northeast of Veracruz. There are few studies related to the Kemp's ridley turtle, therefore this work documents the nesting sites, abundance and predation in the beaches of Papantla de Olarte and Cazones de Herrera in Tecolutla, Veracruz, which is located on the central coast of the Gulf of Mexico. Fieldwork was conducted from April to late August 2011. We recorded the nests abundance and nest predation, in situ and ex situ (after being relocated to beach enclosures). The temporal variation between populations show marked trends, as well as throughout the nesting season. Predators were mainly dogs, but occasionally coyotes and

raccoons. Predation was higher in situ than ex situ. We discuss the possible variables that may have influenced each result.

ASSESSMENT OF PHYSICAL VARIABLES INSIDE HAWKSBILL TURTLE NESTS AT CAMPECHE, MEXICO

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Marine turtles are generally considered as vulnerable to many changes in climate conditions, as their environment significantly affects their biology and life history. Hence, for instance it seems reasonable to assume that some of the most observable consequences of climate change will occur during the eggs incubation phase on land. To understand how climate change, especially changes in temperature and humidity, will affect sea turtle populations in the middle and long term, it is necessary to define the base line of how these features influence the nesting habitats in a specific region today. This thesis studied 19 hawksbill nests (four in hatcheries and 15 kept in situ) at Chenkan beach, Campeche, Mexico, from June to August 2010, to evaluate the influence of physical parameters of the nests' incubation environment (sand water content, temperature, grain size distribution, depth to top egg of each nest, distance to high tide mark, distance to vegetation line, sun exposure and beach zone) on hatching success. Water content within the sand of the nest surroundings increased with the presence of coarse grains and decreased with high temperatures, and hatching success deteriorated with increasing water content. Multiple correlation statistics revealed that sand water content provided the greatest impact of all physical parameters on hatching success. As no quantitative data on the hatchling's sex ratios were recorded, an indirect approach based on the mean temperature was used to estimate sex ratios. A general trend for female biased sex ratios became apparent as mean average temperatures were above the pivotal point of 29.3°C that has been previously detected by other authors. Water content of the sand was the dominant physical factor determining hatching success at the beach of Chenkan. Changes in precipitation patterns might increase water content even further, thus possibly reducing hatching success. Furthermore, future increase of temperature according to global warming projections might not only deteriorate hatching success, but should also shift the sex ratio towards female dominance.

SEA TURTLE NESTING IN SAN JUAN DE LOS PLANES, BAJA CALIFORNIA SUR, MEXICO: 2004-2011 SEASONS

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San Juan de Los Planes (SJLP), B.C.S., Mexico, is a coastal County, in the state of Baja California Sur, to the south of the Bay of La Paz, endowed of a long strip of beach, approximately 15 km long (from El Sargento to Punta Arenas), which is a sea turtle nesting ground. Besides, the adjacent waters are used by turtles as mating and feeding grounds. This is the first long term study of sea turtles nesting in SJLP, and it has shown to be of importance within the peninsula. Unfortunately, human activities, such as the presence of local inhabitants, as well as tourism are altering the conditions of the beach. Besides, there are several proposals for developing housing and touristic infrastructure in the area that would probably have a great impact on the turtle nesting population. It is an urgent need to develop an environmental plan, that consider the protection of the nesting sites and feeding areas, otherwise, the risk of losing this nesting population is very high. The nesting protection program developed for this area is an effort focused on the conservation and research of these sea turtles, and on the preservation of their nesting habitat, which involves the local community through several social and environmental actions. It is hoped that promoting the local involvement, the development of the communities, the opening of new seasonal economic alternatives and educational projects, the conservation of the turtles will be one step forward towards a permanent protection of this important coastal natural resource. The 2010-2011 season was a success with 222 nests, of which 164 hatched, producing a total of 9,527 young olive ridley turtles. Besides, in this season there was also one leather-back nest that produced 123 hatchlings.

ECOLOGICAL ROLE OF SCARABS (*OMORGUS SUBEROSUS*) IN THE OLIVE RIDLEY NESTING BEACH ESCOBILLA (OAXACA, MEXICO)

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Trogid scarabs, *Omorgus suberosus*, were first observed in nests of olive ridleys at Escobilla in the 80´s. An important number of eggs were perforated by these insects and did not produce hatchlings, so the scarabs were considered egg predators. Some authors agree with this position and others disagree, considering them as facultative necrophagous-saprophagous. Three decades later, the discussion about their ecological role persists. The main objective of the present study was to clarify the ecological role of this insect under experimental conditions at Escobilla. In November 2008, we placed four groups of clutches in a hatchery, in attempts to reveal the ecological role of the scarabs according to their feeding preferences: 1) predator: clutches carefully incubated, following every recommendation used for relocation and supposedly with a high number of living embryos; 2) necrophagous: clutches with fresh carcasses of 38-day-old embryos, exposed to sun for 12 hours; 3) saprophagous: clutches exposed to sun for 12 hours before incubation with no

embryo development; 4) control: clutches isolated from scarabs by a wire mesh cage and buried with sieved sand. Unexpectedly, at day 38, only 6.4% of the eggs from group 2 still had live embryos; most of the content of the nests were small pieces of eggshell. After 45 days of incubation, we opened the nests to check their content. We found adult scarabs (range 0-123 per nest) and larvae of different stages (range 0-31 per nest) in all the groups, including in the control where a few number of scarabs could get in through the sieve or the mesh, which suffered corrosion. We did not find significant differences between groups 1, 2 and 3 in the number of scarabs and larvae, and in the damage produced (understanding damage as the number of eggs perforated or reduced to pieces of eggshell). Surprisingly, small pieces of eggshell were the most frequent content of the nests in groups 1, 2 and 3, with a mean of 93%. In the control group we obtained a hatchling success of 21%; 43% of the eggs were undeveloped (with no obvious embryo) without scarab damage; and 14% were unhatched eggs containing embryos in different stages of development with no scarab damage. Only 22% of the eggs were lost due to scarabs. It was not possible to determine in group 1 if we had an important number of live embryos dying by scarab predation or, as it happened in the control, they were undeveloped eggs and embryos dying for other reasons. The control group showed that even without scarabs, a high number of eggs do not produce hatchlings due to other factors, probably related to the high nest density characteristic of an arribada beach. We suggest evaluating separately the effect of biotic (scarab, microorganisms, fecundity) and abiotic factors (incubation temperature, oxygen availability, moisture) in the hatchling success at Escobilla, as well as considering the ecological service of scarabs which consume the huge quantity of organic matter left in the beach because of unhatched eggs. Acknowledgements: The authors thank Secretaría del Medio Ambiente y Recursos Naturales for permits granted (SGPA/DGVS/09145/08). UMAR and Centro Mexicano de la Tortuga (CONANP) provided logistical support. We thank the following persons who helped in the field: Erika Peralta, Isabel Raymundo, Janet Solís, Guadalupe Paz and Edgar Cruz.

IXTAPILLA, MICHOACÁN, MEXICO, AN INITIATIVE FOR TECHNICAL SUPPORT AND TRAINING FOR CONSERVATION EFFORTS MADE BY A NAHUA INDIGENOUS COMMUNITY IN AN OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) ARRIBADA BEACH

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The olive ridley is the species of sea turtle that nests most frequently in the Mexican Pacific. It is capable of forming large concentrations of females that nest simultaneously in a behavior known as “arribada”. This behavior has high biological value because it can only be observed at a few beaches in the world. Ixtapilla beach, in the state of Michoacan, joined this short list only a few years ago. Adjacent to Ixtapilla beach is a small community of the same name, that belongs to the community of indigenous nahuas of Ostula, in the Aquila municipality. In 1994, some years before arribadas were observed; the community formed

a committee to undertake sea turtle protection. To their surprise, in 1997 the first arribada occurred on that beach. At first, the community attributed this event to the protection activities that they had undertaken, which strengthened their dedication and interest in conservation of the species. Soon, the spectacular mass nesting attracted the interest of the inhabitants of the region and of the neighboring states, and the beach began to be visited by a growing number of tourists. The leaders of the community committee implemented a plan to take advantage of this interest by charging a small fee for beach access; at the same time, they focused most of their effort on relocating as many clutches as they could, on the same beach. Lack of an appropriate management strategy caused the massive and uncontrolled wandering of visitors on the beach, especially during arribadas. The relevance of this beach also attracted the attention of some academic and governmental institutions, as well as non governmental organizations. Some of these understood that the best strategy to get appropriate management of the beach was to strengthen the technical and organizational abilities of the community. Thus, an alliance was created with the National Commission of Protected Areas (Conanp) through the Regional Office for West Central Pacific and the Mexican Turtle Center, and COSTASALVAjE, A. C., supported by "Canada Fund for Local Initiatives", having the local community as main axis, through its committee. Conanp initially provided the community some social programs, and studies in order to get basic information about the sea turtle population; COSTASALVAjE joined this initiative promoting a media strategy and raising funds from the Canadian Embassy. Because of this, several workshops with local community members and other activities were conducted. This alliance has allowed the people of Ixtapilla access to the tools for adequate management action, based on ecotourism and recognizing that active participation of women and children is necessary for sea turtle conservation. After four years, the point of view of the community about sea turtles has changed, as well as the mechanisms of participation. This initiative represents a good example of the fact that conservation efforts have an increased chance of success when communities are the platform.

THE MONITORING PLAN TO ASSESS THE NUMBER OF NESTS OF *LEPIDOCHELYS OLIVACEA* IN SANCTUARY PLAYA DE ESCOBILLA, OAXACA, MEXICO, DURING THE 2008-2010 NESTING SEASONS*

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The present work describes the monitoring plan of the overall nesting activity of the olive ridley turtle (*Lepidochelys olivacea*) in Santuario Playa de Escobilla (Oaxaca, Mexico) to estimate the number of nests, and assess the hatching success percentage during the 2008-2010 nesting seasons, and also includes advances on the results of 2011 nesting season. Results show an important recovery of female population based on the number of nests

estimated since 1980, when the Mexican government began to register the nesting activity of *L. olivacea* in this area, now considered a "Sanctuary" because of its importance to protect this species categorized as a endangered species under Mexican official standard 059, and vulnerable under IUCN Red List. Since 1999, the increase in nesting numbers in the phenomenon of "arribada" caused a change in the method of registration and estimation of the number of clutches laid by female turtles. In 2008, the Valverde-Gates (1999) method was adopted as the standard method for surveying the mass nesting behavior in this beach. Results of the estimation of the total nests by years 2008 to 2010 are presented as well as the detailed spatial cycle nesting behavior in this period. During the last four years an average of eight arribadas occurred every season. The current estimate gives us an average of 1,000,000 nests each season. The average of hatching success for the 4 seasons was 12%. A discussion on the concept of "arribada" and the spatial nesting behavior of this species is considered by its methodological implications and use of human resources on field surveys. We appreciate the financial support of Roldan Valverde of the Southeastern Louisiana University, granted for the implementation of the method; as well as to Ernesto Albavera and Martha Harfush of Centro Mexicano de la Tortuga for their collaboration in the planning and implementation of the transects method in Santuario Playa de Escobilla.

DETERMINATION OF THE PRESENCE OF HERPESVIRUS IN SAMPLES OF FIBROPAPILLOMA ON OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*), IN TURTLE CAMP FROM "LA ESCOBILLA" BEACH, OAXACA, MEXICO

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The fibropapilloma is a neoplasm that has been described in many species of sea turtles, including the olive ridley. This tumor is characterized by the presence of exofitic cutaneous nodules and occasionally white, yellow multinodular surface in the viscera. Histologically, in the dermis it causes acantholysis, hyperqueratosis, proliferation of fibroblasts and mixed inflammation. The etiology of this neoplasm is uncertain. At the present time, pathologic and molecular findings have been reported allowing relating the development of this disease in the green turtle with a viral infection by the herpesvirus of the same species (GTHV). With the objective of proving the presence of GTHV in samples of fibropapillomas in olive ridley turtle an internal control using the aph gene as a template was built; at the ends specific sequences of GTHV DNA polymerase were added. This internal control was used to standardize a PCR employing 31 samples of green turtle fibropapillomas that were previously diagnosed by histopathology, and in none of which it was achieved the amplification of 441 bp fragment of the GTHV DNA polymerase. The results obtained differ from the published reports for green turtles, in which GTHV was considered as the principal etiologic agent of the fibropapilloma, bringing out other different factors as etiology of this neoplasm such as virus, mutations in the GTHV or multifactorial.

BLACK TURTLES (*CHELONIA MYDAS*) IN THE LAGOON SYSTEM CHACAHUA-PASTORIA, OAXACA, MEXICO*

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In recent years, the number of studies on black turtles outside their nesting beaches has increased. In Mexico, most of these investigations come from the Baja California Peninsula, even though the presence of black turtles in coastal lagoons of Oaxaca has always been recognized. Authors specifically mention the Superior and Inferior Lagoons at the Isthmus of Tehuantepec and the Lagoon System Chacahua-Pastoria (LSC-P). In order to contribute to the knowledge of feeding grounds of this species, we studied the black turtles in the LSC-P. In a prospection, we found no evidence of the presence of sea turtles in the Pastoria Lagoon (in contrast to a previous study) so the sampling effort was centered only in the Chacahua Lagoon. From June 2009 to May 2010, we made monthly visits to the area. During this period, 23 black turtles were sighted and 25 captured in entanglement nets, nine of which were recaptures of individuals that spent from one to six months in the LSC-P. All turtles were adults with a sex ratio of 1:1, differing from other feeding grounds where adults coexist with juveniles. The average catch per unit of effort (CPUE) was 0.097, one to two orders of magnitude less than the CPUE obtained in feeding areas of the Baja California Peninsula. The mean condition index recorded in LSC-P was 1.37, similar to values reported for other feeding grounds of the species in the Eastern Pacific. Eight black turtles showed injuries mainly on the carapace, probably caused by the impact of boat propels. The samples of esophageal and mouth content collected from a few turtles, showed that during the study period, they were feeding mainly on the Rhodophyta marine algae, *Gracillariopsis lemaneinformis*, a species distributed in the margins of the Chacahua Lagoon and in the channel that communicates it with Pastoria. Our results suggest the existence of feeding areas scattered along the Pacific coast of Mexico, were black turtles congregate in lesser abundance than in the Baja California Peninsula, or other areas out of the country. In the future, it will be interesting to find out if these black turtles are i) those that sporadically reproduce and nest along the Pacific coast, that feed in local lagoons; or ii) they come from the main rookeries and eventually use these habitat during their migrations. The knowledge generated, would promote local communities to engage in activities for the conservation of the sea turtles that use the lagoons of south Mexico as feeding grounds. Acknowledgements: The authors thank “Secretaría del Medio Ambiente y Recursos Naturales” for permits granted (SGPA/DGVS/07771/08 and SGPA/DGVS/00722/10). This work was funded by Comisión Federal de Electricidad through the project “Caracterización de la fauna y calidad del agua del sistema de humedales, sistema lagunar estuarino y zona costera de la región baja del Rio Verde, Oaxaca” directed by Auxilio Esparza (UMAR). We also want to thank Parque Nacional Lagunas de Chacahua (CONANP), Jesús Lucero from Grupo Tortuguero de las Californias and Kutzari A.C. And finally, we thank Francisco Villegas, Francisco Becerril, Sacnicté Pacheco, Guadalupe Paz, Edgar Cruz, Elisa Guzmán and especially, Luis García.

ORIGIN OF THE "ARRIBADA" POPULATION OF IXTAPILLA, MICHOACAN, MEXICO

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In 1997, the indigenous Nahua community of Ixtapilla, located on the Pacific Coast of Mexico, received an "arribada" of more than 10,000 *Lepidochelys olivacea* nesting females for the first time. This fact generated surprise because there were no previous reports of "arribadas" at that beach, and it generated uncertainty as to the origins of the turtles among the indigenous community originally responsible for conservation activities. In response to this question, some authors have worked unsuccessfully with molecular tools in identifying the origin of these "arribadas", due to a single panmitic population that extends from Mexico to Costa Rica. An alternative to study the origin of this nesting population is to follow the post-nesting movements of the females in order to determine their route of interaction with females of other nesting populations. In this paper, we discuss the post-nesting movement of a female followed by a tracking satellite for 126 days and for a distance of 6,293 km. The pattern of movement is different than those reported by other female *L. olivacea* tracked with transmitters in the Mexican Pacific, and this suggests new possibilities with respect to the origin of this nesting population.

BYCATCH STUDY OF SEA TURTLE IN COASTAL FISHERIES IN TEHUAMIXTLE BAY AND CHALACATEPEC, PLAYON DE MISMALOYA SANCTUARY, JALISCO, MEXICO

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Fishing is one of the oldest activities undertaken by men; it played an important role in the colonization of the coast of Jalisco. During the decades of the 1950's, 1960's and 1970's with the increasing number of inhabitants in the coastal area, and the difficulty to provide food, the consumption of turtle grew due to the abundance of them during this time. It was common to find turtle's meat or eggs in the markets of the cities because it was considered a fishery resource and was exploited like any other. The increase in demand for turtle skin generated a very important industry for the regional economy, and despite the 1973 decree that banned the catch of sea turtle in Jalisco, they continued to give permits for capture. The fishery continued legally operating until the publication of the total ban decree in 1990. But, the illegal capture, killing, skinning and marketing of meat, eggs and turtle shells in Mismaloya Sanctuary still continues until these dates. The major communities engaged in these actions include cooperatives of fishermen in Tehuamixtle and La Cruz de Loreto, in Cabo Corrientes and Tomatlan municipalities. Nowadays, coastal communities play an important role in the conservation of sea turtle, especially the fishing cooperatives, who are constantly blamed for the dead turtles in the beaches. While the systematic capture of sea turtles has considerably declined in the area, there have been no studies to estimate the

current impact on sea turtles caused by bycatch. For this reason we talked to the captains and owners of boats that dock and fish in the area of influence of Mismaloya Sanctuary, to allow our team to go onboard their vessels during their activities in order to observe interactions with sea turtles in the area. We recorded data as the vessel register, crew, port or site of shipment and disembark, geographic coordinates of the site, art fishing (networks and longline) and the type and forms of interaction (entangled or hooked, part of the body, injuries, etc.). Our study demonstrated that their fishing does not always result in interactions with sea turtles.

ASSESSMENT OF GENETIC DIVERSITY OF THE KEMP'S RIDLEY SEA TURTLE (*LEPIDOCHELYS KEMPII*) IN TAMAULIPAS, MEXICO

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The Kemp's ridley (*Lepidochelys kempii*) is the smallest of all sea turtles and the only one that massively nests during the day in Mexico. The ridley population declined during the decade of the 1980's from 160,000 individual to only 5,000. An important characteristic of the species is its restricted geographic distribution, with more than 90% of the total world population nesting in the Mexican state of Tamaulipas. When a population undergoes a dramatic reduction in size or demographic bottleneck, it may also experience a genetic bottleneck, where significant losses of genetic diversity in the population occur through genetic drift. Molecular biology techniques are used as a reference to assess the genetic diversity of wild populations, and these studies supported by morphological characteristics, can determine if the individuals are genetically different or grouped into the same population. In this study, we report the genetic diversity assessment of the Kemp's ridley in Tamaulipas, Mexico using microsatellite markers. A successful DNA extraction method from three different types of tissue from dead hatchlings along Tamaulipas coast was established. Molecular biology techniques are used as a reference to assess genetic diversity of wild populations, and these studies supported by morphological characteristics, can determine if the individuals are genetically different or grouped into the same population. Additionally, we report the genetic diversity assessment of the Kemp in Tamaulipas, Mexico, using microsatellite markers. Results from samples of 300 nests from 7 different camps collected during 2010, indicate that all individuals sampled along Tamaulipas coast belong to the same population. Markers proved to be informative (combined non-exclusion probability 0.01) with a mean of 7.5 alleles per locus. Fisher's method showed no significant differences on genotype segregation among rookeries ($p>0.05$). Population is under Hardy-Weinberg equilibrium. We recommend the increase of markers to provide a broader perspective. The absence of differentiation may be due to the female´s philopatry tendency, mating with males borne on different nesting sites, which would be translated on alleles shared by the hatchlings even if they were born on different beaches.

RECENT ECOLOGICAL RECORDS FOR JUVENILE LOGGERHEADS AND GREEN TURTLES AT NORTHWEST OF MEXICO

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Juvenile North Pacific loggerheads (*Caretta caretta*) and East Pacific green turtles (*Chelonia mydas*) may spend more than 25 years in the rich waters of Baja California until they reach sexual maturity. At the moment, two ecological studies, framed to understand the ecology of these two species are underway, to learn their interspecific relationships and diet. Our goal is to understand the use of resources by sea turtles in relation to its availability in a particular habitat. In addition, we are assessing relationships with other species in their ecosystem -in this case, their epibionts- to understand loggerhead and green turtle roles as hosts for other marine species. As part of monitoring of juvenile loggerhead turtles, during two field trips in July 2011 we collected epibiont samples from the carapaces of 10 individuals (mean curved carapace length=69.4±6.9 cm, range=55-78.5 cm; body mass range=24.3-63.5 kg) captured at Golfo de Ulloa along the Pacific coast of the Baja California Peninsula, Mexico. All turtles had barnacles (*Chelonibia testudinaria*), amphipods, and red algae, *Polysiphonia sp*. The microbivalve, *Cymatioa pulchra,* was present on one individual; the shell-loving oyster (*Ostrea conchaphila*) and the winged pearl oyster (*Pteria sterna*) were present on one and two individuals, respectively. It should be noted that the sizes of oysters suggests that they had been attached to turtles for several months. With respect to turtle diet, in 2009 we collected food samples from the esophagi from 21 green turtles (body mass=14-65 kg, and CCL=40.3-73.4 cm; mean CCL=54.83±8.36 cm) captured in Laguna Ojo de Liebre, El Vizcaino Biosphere Reserve. The anemone, *Palythoa ignota,* was present in 18 samples, comprising 68.76% of the total diet sample volume. To our knowledge these are the first reports of *C. pulchra*, *P. sterna* and *O. conchaphila* associated with loggerhead carapaces and the first account of anemone consumption by green turtles. These represent a contribution to knowledge of the ecology of these species in Baja Californian waters, and both studies are continuing in an effort to augment the information presented here. We want to thank Grupo Tortuguero for their support in field trips, and International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and the U.S. National Marine Fisheries Service for their economic support.

CHANGING THE TRADITIONAL METHOD OF PEN, TO IMPROVE THE ENVIRONMENT INCUBATORIO OF SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) NESTS

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During the 2007 nesting season at the beach of Caimanero Rosario, Sinaloa, Mexico, under the direction of the Sea Turtle Conservation Camp by the Autonomous University of Sinaloa, we evaluated the effects of controlling the incidence of sunlight in the incubation

environment of *Lepidochelys olivacea* clutches, comparing humidity and temperature values between nests kept in shade and exposed to sunlight. The method used was the one proposed in the "Manual of conservation techniques and research of sea turtles" by the Marine Turtle Specialist Group. Obtained results are as follows: 1) the modification of the nests' incubation environment by diminishing the sunlight intensity had significant positive effects on *Lepidochelys olivacea* hatching success, and lower hatchlings mortality; 2) the temperature among treatments was significantly different; however, it was not possible to properly fit any correlation between environmental temperature and hatching success and also, diurnal variation of the sun intensity seemed to cause higher hatchling mortality than in shaded clutches; 3) humidity ranged between 3.7% and 6.4% (mean=4.3%) for the shaded clutches, and from 2.6% to 6.4% (mean=3.8%) for clutches under sunlight; 4) in the sun treatment , 1953 eggs were incubated with 54 eggs per nest on average (Coefficient of Variation (CV)=32%), with a minimum of 33 and up to 117 eggs and most nests (75%) had between 40 and 60 eggs; (5) 2123 eggs were incubated in a changed environment , with an average of 59 eggs per nest (CV=25%) with minimum and maximum of 34 eggs and 96 eggs respectively; (6) the birth rate in the traditional pen without modification ranged from 0% to 82.5%,the geometric mean (G) was 23.7%, most births (82%) occurred in 40 and 33 nests with eggs in the smallest of clutches analyzed in this treatment and in the hatcheries birth changed from 58.6% to 100% with a of 88.8%, and a CV of12.9%; (7) the mortality was high in the traditional poultry hatching eggs, from 1953 eggs 1296 were lost, of which 308 were hatchlings that died at hatching and the rest were eggs that did not hatched, total mortality ranged from 17.5% to 100%, G was 56.3% whilein the shaded treatment mortality was from 1.6% to 41.4%, and G was only 9.2%; (8) total hatching in the traditional treatment was 50% (range: 5.5% - 90%, G=42.3%)for 1953 eggs incubated in this system, only hatching 965 eggs while in the shaded treatment from 2123 eggs 2100 hatched.with a hatching rate from 58.6% to 100% , a G of 88.8% and CV of12%.

THE UNTOLD STORY ON THE STRATEGY WHICH LEADS UP TO THE 1990 SEA TURTLE BAN IN MEXICO: CONSERVATION IMPLICATIONS AND ECOETHICAL PERSPECTIVE

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Unsustainable over-harvest of sea turtles and their by-products in Mexico prior 1980 was depleting olive ridley populations in Pacific Mexico. In spite of measures to lower harvest quotas, illegal sea turtle capture continued. Trade investigations in Japan, Mexico and Caribbean, revealed that imports to Japan exceded "officially declared" exports by Mexico as it had become laundering port for sea turtle products, as it had refused to sign Cites. Limited government action triggered universities and NGO´s to implement conservation efforts on nesting beaches and VIP´s alerted high government officials, about illegal poaching and commercialization. Mexican poet, Homero Aridjis, publicly denounced corruption and information was shared and strategies designed in 1989 ISTS. International

pressure began and hundreds of letters and faxes reached the Mexican president, tourism ministry, and embassies of Europe, America and Australia, declaring they refuse to come to Mexico if turtle killing did not stop. Salinas received letters from VIP´s and on official visit to Germany and Great Britain was embarrassed in by Greenpeace´s manifestations. Earth Island Institute threatened with Lacy Act implementation by the U.S Government to Mexico for omitting use of TED´s in Mexico. Mexican Universities and NGO´s involved in conservation, were summoned by Fisheries Ministry to propose solutions, and on May 30th 1990, the total and permanent ban on sea turtles was declared publicly by President Salinas with the corresponding indemnity to sea turtle fishermen. Inventory of remaining existing "legal" sea turtle skins was supposedly made to control final shipments to Japan, the main buyer. The Sea Turtle Museum at Mazunte was constructed as an income alternative for the people of Mazunte and San Agustinillo, one of the last places where intense legal turtle harvesting occurred. Today, entry fees to this government museum are re-channeled to the operating budget for the Commission for Protected Areas, institution officially in charge of sea turtle conservation. Tourist influx brings indirect economic benefit to the community. Mazunte Cosmetics, inspired by "The Body Shop" products is an authentic alternative source of income for a cooperative in Mazunte. After the ban, Mexico moved forward to sign CITES since international trade in sea turtle skins was no longer an impediment. As a result the destiny of olive ridley in Mexico has been changed and is abundant throughout Pacific and attracting many tourists; however, not all sea turtle species are so fortunate. The kemps ridley is recovering, but for other reasons. The leatherback is near extinction. Egg poaching occurs and is being openly commercialized in the market places in spite of Profepa´s efforts to control poaching and illegal trade. What would have happened if the ban had not been declared? The ban had seemed impossible, but, the objective was clear and strategic efforts joined towards a clear common goal. Sound biological data and socio-economic considerations, joint actions by academics, various NGO´s, together with artists and VIP´s plus high level political "recommendations" were the ingredients to achieve the sea turtle ban in Mexico 1990.

ESTIMATE OF SEA TURTLE MORTALITY AT BEACHES OF LOS CABOS MUNICIPALITY, BAJA CALIFORNIA SUR-MEXICO: ANALYSIS OF 11 YEAR OF DATA

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Sea turtle conservation programs in Baja California Sur have been in place with a growing presence on nesting beaches since the mid-nineties. The data collected in the intervening years demonstrate the importance of this region as nesting areas for leatherbacks (*Dermochelys coriacea*), black turtles (*Chelonia mydas agassizii*) and olive ridleys (*Lepidochelys olivacea*), all present at different times of the year. Hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta* careta), black (*Chelonia mydas agassizii*) and olive ridley (*Lepidochelys olivacea*) turtles are reported to feed in different areas of Baja California Sur. The Municipality of Los Cabos is important because harbors the majority of the nesting of the different species in Baja California Sur and it harbors feeding areas. Since 2000 the Municipal Government of Los Cabos, started a sea turtle conservation program, and eventhough monitoring methodologies have varied somewhat, they are characterized by

night patrols to protect nest, measure and tag nesting females. The program has recorded stranding and predation of sea turtles during beach patrols, quantified carcasses and indentified species, sex, life cycle stage, tags and possible cause of dead. All occurrences of dead turtles on the beaches are recorded. This work presents data on dead sea turtles discovered on Los Cabos beaches during patrols using ATV, or by reports from the local community, and presents an analysis of those records from 2000 to 2011. Preliminary results show that leatherbacks, black, olive ridleys and hawksbill turtles were recorded. While the cause of death could not be determined with certainty in most cases (48.94%) due to its advanced state of decomposition, the main suspected cause of death was poaching (30.85%). The most abundant dead individuals were olive ridleys (88.30%), then hawksbills (6.38%), and black turtles (5.32%). There were only two reports of dead leatherbacks. The participation in this event, it has been made available through generous donations by the following organizations: H. XI Ayuntamiento de Los Cabos, B.C.S.; WWF; International Sea Turtle Society; Western Pacific Regional Fishery Management Council; U.S. Fish and Wildlife Service; The U.S. National Marine Fisheries Service and the 32nd International Sea Turtle Symposium Committee.

MIGRATION MOVEMENTS OF BREEDING MALES OF BLACK TURTLE (*CHELONIA AGASSIZII*) IN THE COAST OF MICHOACAN, MEXICO

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Sea turtles are well known to be migratory animals, their movements at sea between feeding and nesting zones implies long-distance journeys than can last weeks or even months of navigation. Studies about migratory movements of black turtle (*Chelonia agassizii*), especially males are scarce. The use of satellite transmitters has made possible to map long distance movement routes that black turtle males follow during their feeding season, making possible to identify the main foraging areas for this population, and promote their conservation. A satellite transmitter was attached to the shell of a male black turtle to track its movements along his geographic range. The obtained route map included environmental data such as bathymetry, chlorophyll-α concentration and sea surface temperature. Using GIS and statistical tests, the migratory movements of the specimen and the relation with the environmental variables was analyzed. The total traveled distance in a period of 23 days of transmission was 180.1 km (range=0.5-23.26), the mean swimming speed was 7.83 km/day, the mean depth along his displacement was 67 m (range=0.11-966.1 m); the mean SST along the displacement route was 25.9°C (range=23.57-28.12°C) and the mean chlorophyll α concentration on the sea surface along the route was 5.45 mg/cm^3 (range=1.5-13.68 mg/m^3). The tests showed a low significant correlation between the migration movements and the depth, SST and chlorophyll-α concentration. This information is very important for the conservation planning strategies for the breeding black turtle population in the Eastern Pacific. Acknowledgements: Financial support granted by CONACYT. Special thanks to J. Seminoff and Dr. Abreu-Grobois for their wise counsel on satellite telemetry. And in the same way I am grateful to the community members of Colola, especially Perfectino and Guillermo for their assistance in the field.

SEX RATIOS OF *LEPIDOCHELYS OLIVACEA* HATCHLINGS ESTIMATED FROM NEST TEMPERATURES IN THE MEXICAN PACIFIC

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The sex ratio of *Lepidochelys olivacea* offspring was estimated in four hatcheries located in Mexican Pacific nesting beaches: Los Cabos, B.C.S.; Elota, Sinaloa; Armería, Colima; and Tecpan de Galeana, Guerrero. The Girondot model to estimate sex ratio from mean incubation temperature during the middle third was adjusted. All available data from incubation experiments under controlled temperature were used; either our own or from the literature. Temperature was recorded in nests in the sand with programmable digital temperature sensors in the four areas of study. With a total of 76 nests a statistical model was calibrated in order to predict the temperature of the nest from the surface sensors, so that the sample was increased to a total of 2,703 nests containing 232,884 eggs using only the surface temperature in those areas. The sex ratio was calculated in each nest at each location from nesting data (date of spawning, hatching date, number of eggs and incubation temperature). The highest incidence of nesting was the months of September and October, when the sex of the offspring was biased to females. In the months of November, December and January the proportion of males was higher, the final sex ratio of males in each nesting area were 22%, 33%, 28% in Los Cabos, Sinaloa and Guerrero during 2009 respectively and 22% and 34% for season 2010 in Los Cabos and Sinaloa.

UPDATE ON THE STATUS OF THE LEATHERBACK TURTLE IN THE MEXICAN PACIFIC: 2000 TO 2011*

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It has been 17 years since the first presentation calling for concern about the situation of the leatherback turtle in the Mexican Pacific. Since then, the development of a coordinated inter-institutional effort in Mexico known as “Proyecto Laud” (Leatherback Project) has attempted to revert the declining trend in the nesting numbers of this population, increasing the protection of females, eggs and hatchlings, and monitoring in standardized way important reproductive parameters. This presentation shows the estimate of the abundance for Mexico and the results of the conservation and monitoring activities for the leatherback nesting population of the Mexican Pacific during the last decade, from the index beaches Mexiquillo, Tierra Colorada, Cahuitan and Barra de la Cruz from 2000 to 2011. From 1996 to 2006 aerial surveys were conducted along the coast of the Mexican Pacific. These surveys showed a constant decline of the nesting population counting 1,177 nests in 2006. As part of the strategies of the National Action Program for the Leatherback (PACE Laúd), a new

aerial survey was conducted in 2011 which resulted in 615 nests counted in the same area. The daily nest counts on index beaches show for the last 5 years an apparent stability in the number of nests, even a slight increment for 2010 was recorded. Since 1996 the protection effort has increased up to 95% in the index beaches with average hatching success of 50% in relocated nests. This has been accomplished thanks to the participation of the Mexican Navy (SEMAR), the Federal Attorney for Environmental Protection (PROFEPA) and the important participation of the local communities that summed to the conservation efforts. The recovery of the eastern Pacific leatherback depends on many factors. In Mexico the protection of females and clutches for recruitment has reached high levels. It is necessary a larger international effort to decrease the interactions with fisheries along the migratory route in national and international waters.

ANNUAL SURVIVAL OF LOGGERHEADS NESTING IN QUINTANA ROO, MEXICO*

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We deployed 30 Pop-off Archival Transmitting (PAT) satellite tags on nesting loggerhead turtles between July 7th and the 11th 2010 at Xel-Ha, X'Cacel, and Playa Aventuras beaches in Quintana Roo, Mexico. The tags were programmed to transmit once a month, if possible, and then, after 1 year, to release itself from the turtle and transmit continuously for the remaining battery life. The tags also were programmed to release prematurely if the turtle/tag maintained a constant depth for more than 1 week. After one year, 29 of the 30 tags had transmitted at least once. One turtle appeared to have died as it was a 2000 m for several days before the tag released prematurely and transmitted; one tag was found in August 2010 on the beach at Playa Aventuras; five tags transmitted early with the turtles diving normally just prior to release of the tag; three tags transmitted after the full one year of deployment; the remaining 19 tags checked in during the year but did not transmit after one full year. A Known Fate estimate of annual survival from these data (S=0.92) suggests that this estimate is consistent with a previous estimate of annual survival (S=0.85) using mark-recapture data from Quintana Roo nesting loggerheads. In addition to estimating survival, we identified several different foraging areas for Quintana Roo nesting loggerheads. Most turtles went to the southern Gulf of Mexico -just north of the Yucatan Peninsula, some remained off the nesting beaches, some went to Honduras/Nicaragua, one went to Cuba, and one went to the southern Caribbean off Columbia.

USE OF GULF OF MEXICO WATERS BY ADULT KEMP'S RIDLEY SEA TURTLES TRACKED FROM RANCHO NUEVO, MEXICO*

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Use of northern Gulf of Mexico waters by adult female Kemp's ridley turtles (*Lepidochelys kempii*) that nested on Texas beaches has been extensively documented using satellite telemetry. However, females nesting in Texas comprise only a fraction of the overall adult Kemp's ridley population, most of which nests in Tamaulipas, Mexico. Prior to this study, 20 females were outfitted with satellite transmitters after nesting in Rancho Nuevo, Tamaulipas. These two studies were conducted in the 1980s and utilized early satellite transmitter technology and attachment techniques. Most of the tracking durations were short; the four longest were 56-127 days. The turtles exhibited coastal movements in waters less than 50 m deep. Based on two tracks and one tag return, only three females were documented in northern Gulf of Mexico waters, all off the Texas coast. None were documented moving through or establishing residency in Gulf of Mexico waters off Louisiana, Mississippi, Alabama, or Florida. In this study, 14 Kemp's ridley turtles were outfitted with satellite transmitters after nesting in Rancho Nuevo between 2010 and 2011. As found for adult females tracked from Texas nesting beaches, most of these post-nesting Kemp's ridleys left the vicinity of the Rancho Nuevo nesting beach when the nesting season was over. Tracking durations for 10 of the 14 were more than 134 days, thus enabling longer term documentation of habitat use than was possible before. Most traveled to northern Gulf of Mexico waters and established long-term residency off upper Texas, Louisiana, Mississippi, and Alabama. Two established long-term residency in waters off the Yucatan Peninsula, whereas none previously tracked from Texas nesting beaches established residency there. A lower portion of the females tracked established residency in the southern Gulf than in the northern Gulf. In contrast, more females tracked in other studies traveled south after leaving the nesting beach than traveled north, but because tracking durations were relatively short, it is difficult to make inferences about trends in their residency locations. Twenty-five adult male Kemp's ridleys were outfitted with transmitters between 1999 and 2005 after being captured in near-shore waters off the Tamaulipas coast. Whereas most females tracked for more than a few months migrated away from the nesting beach after the nesting season was over, most of the adult males tracked remained resident off the Tamaulipas coast year-round. Combined with tracking results for adult females in Texas, these findings document that near-shore waters of the entire Gulf of Mexico coastline, in the U.S. and Mexico, must be considered important migratory and foraging habitat for this species. Furthermore, they underscore the vital importance of northern Gulf of Mexico waters to adult female Kemp's ridley turtles, and thus to conservation of the entire population.

UNIVERSITY PROGRAM OF MARINE TURTLE CONSERVATION AT THE UNIVERSIDAD AUTONOMA OF SINALOA IN PLAYA CEUTA, SINALOA

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The marine turtle programs exist to support and to implement investigations that promote the restoration and survive of those species' populations, involving the local communities by taking conservation in their hands. A special case is the commitment since 1976 by the Universidad Autonoma of Sinaloa (UAS) to protect, conserve and research on these organisms, the habitat (ocean and coast) in which we can find them, as well as, to support the educational activity in all related academic practices and projects of thesis. This program is coordinated by the Facultad de Ciencias del Mar and Escuela de Biologia of the UAS, respectively; and the activities executed have been: recording and collection of sea turtle nests, nests relocation to hatcheries, hatchling releases, research and divulgation. During the 2011 nesting season we registered 300 nests, 200 of those nests were protected, with a mean 40% hatching success. The nesting peak was on August and September, during the rainy season, ironically, precipitation volumes and temperature may have been the main cause of low hatching success.

MARINE TETRAPOD STRANDING NET IN PLAYA CEUTA, MESETA DE CACAXTLA AND ENSENADA PABELLONES SINALOA, MEXICO

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The proper analysis of stranded marine tetrapodes, caused by accidental and non-accidental capture, animal predation, natural death, etc, is a powerful tool that allows us to elucidate aspects of their naural story such as ecology, pathology, growing, intra and interspecific interactions. Each year numerous stranding of marine tetrapodes occur in the coast of Sinaloa, Mexico. The goal was to determine species and sizes of stranded animals in the center zone of the Sinaloa State. Between January and December 2011, the beaches: Ceuta, Meseta de Cacaxtla and Ensenada Pabellones were monitored, registering field data, waypoint of the stranding place. The olive ridley turtle *Lepidochelys olivacea* was the highest encountered and the Californa Sea Lion Zalophus californianus was found in a lesser extend. Besides, stranding of species never registered in the area was described.

MATERNAL TRANSFERENCE OF HEAVY METALS IN GREEN TURTLE (*CHELONIA MYDAS*) ALONG THE CENTRAL COAST OF QUINTANA ROO, MEXICO*

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Heavy metals are found in the environment, because of this, sea turtles acquire these pollutants from food, being the main path of entry to the body. Nevertheless, during vitellogenesis and oviductal egg retention, maternal transference is a source of heavy metals. Although, this maternal transference is necessary for successful development of the embryos, sea turtles use it as a way to excrete heavy metals from their organism. The objective of this study was to assess the metals levels in blood, carapace, eggs and hatchlings of nesting green turtles from four beaches along Quintana Roo, Mexico. Heavy metals levels were measured in blood, carapace and eggs of 30 nesting females, and six hatchlings that perished during emerge in the 2009 nesting season. Negative correlations between carapace size and concentrations of Zn in yolk, and Pb in female carapace, were found. Also, positive correlations between carapace size and concentrations of Zn in blood, and Hg in yolk, were found. In addition, a positive correlation between concentrations of Pb in egg shell and Pb in hatchling carapace, were found. Mercury levels were higher in blood than in egg shell samples, Cd levels were higher in hatchling liver than in blood samples, and Pb levels were higher in hatchling liver and in female carapace than in egg shell samples. Levels reported in the present work are considered low and are not a threat for the green turtle population along the central coast of Quintana Roo. The negative correlation between carapace size and concentrations of Zn in yolk may indicate that the transference of this essential element is regulated by factors as homeostasis. The correlation between Pb levels in carapace and egg shell may be related to the Pb mobilization from bones associated with Ca requirements for eggs formation. The presence of metals in eggs indicates maternal transference; nevertheless, the higher levels of metals in hatchling liver may indicate that eggs are exposed to contaminants in the nest environment during incubation. Thus, future studies about heavy metals levels in the nest environment are recommended.

CONSERVATION OF THE MEXICAN PACIFIC LEATHERBACK TURTLE IN PLAYA BARRA DE LA CRUZ, OAXACA

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From its beginning, the main objectives of “Proyecto Laúd” (Leatherback Project), conducted by Centro Mexicano de la Tortuga and Kutzari, Asociación para el estudio y Conservación de las Tortugas Marinas A.C, over several nesting seasons at Barra de la Cruz, have been to monitor the nesting population of the leatherback turtle (*Dermochelys coriacea*), in order to increase the efforts for its recovery, as well as to evaluate some aspects of its reproductive biology like the effect of incubation temperatures in hatching success, to locate potential nest and females poaching areas, and to protect the largest possible number of nests, in order to release a large number of hatchlings to the wild population. These activities will guarantee the recovery of the leatherback population in the Mexican Pacific. The results obtained over the last four nesting seasons indicate that Barra de la Cruz is an important area for the nesting of leatherback turtles in the State of Oaxaca. In fact, from 2009 to 2011 it was the most important nesting beach for this species in the Mexican Pacific. This work presents results for number of nests, protected clutches, incubation temperatures and its related recruitment success for nesting seasons 2007-2008 to 2010-2011. Season 2009-2010 was the one with the largest number of nests in the period of study, with 161 nests and 148 clutches protected in the hatchery, with 3,462 hatchlings produced (37.7% of recruitment) and a maximum incubation temperature of 33.1°C.

ANTIOXIDANT MICRONUTRIENTS IN MACROALGAE ON THE FEEDING GROUNDS OF GREEN TURTLES (*CHELONIA MYDAS*) IN BAHIA MAGDALENA B.C.S., MEXICO

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Coastal lagoons at the Baja California peninsula are important areas for the feeding and development of East Pacific green turtle (*Chelonia mydas*), an herbivore that exhibits seasonal differences in the consumption of macroalgae species throughout the year. Micronutrient antioxidants contribute to the health in many animals in the context of oxidative balance, immune function, and nutrition; however, these antioxidants are dependent on dietary intake. Dietary antioxidants such as vitamin C, vitamin E and polyphenols inhibit lipid peroxidation, while a number of trace minerals have an essential role in supporting the function of many antioxidant enzymes. Diet selectivity and season are environmental variables that might predict the quality and quantity of the nutrients ingested; therefore, the objective of this study was to investigate the micronutrient availability in the main species of

macroalgae and seagrass consumed by East Pacific green turtle in Bahia Magdalena. Six algae species (4 Chlorophyta, 3 Rhodophyta) and one seagrass species was analyzed to determine the concentration of trace minerals Cu, Zn, Fe, and Se and antioxidants (vitamin C and polyphenols) and to examine seasonal differences in antioxidant availability and differences between species. Our results showed that trace mineral content varied among species and between seasons. The highest polyphenol content was found in summer when *Zostera marina* had the highest content (133.5 mg/g), followed by *Caulerpa serturaloides* (71.3 mg/g). *Codium cuneatum* and *Codium amplivesiculatum* (Chlorophyta) had the highest amount of vitamin C; the content of this vitamin did not change between seasons. These data provide new information on dietary components with beneficial effects against oxidative damage that might contribute to better understand the feeding ecology of the East Pacific green turtle.

TOURISM AS A STRATEGY FOR THE CONSERVATION OF SEA TURTLES IN THE NATURAL PROTECTED AREAS OF LOS CABOS, BAJA CALIFORNIA SUR - MEXICO

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In recent decades, non-extractive use in the form of turtle watching tourism at the ocean or on nesting beaches has been gaining popularity worldwide. Studies by Troëng and Drews in 2004, show that non-extractive use can generate a higher gross income and at the same time produce less impact on turtle populations than extractive use, showing that sea turtles are worth more alive than dead. This research presents an analysis of Natural Protected Areas in Los Cabos, the conservation of sea turtles and their relationship with eco-tourism; and discusses the importance of sea turtles as an umbrella species for encouraging environmental sustainability and biodiversity conservation in beaches without any official decree or legal protection. As a case study, this research describes the wide participation of the tourism industry through The Sea Turtle Protection Network in Los Cabos, which appreciates the potential of sea turtles as an important generator of amenities, natural alternative attractive for visitors, and as an effective conservation strategy in the area of Los Cabos. We present a geo-referenced map of sea turtle records and polygons of the protected areas on the coastal zone of Los Cabos. We also, describe the regulatory framework of the Natural Protected Areas, and identify the current operating rules for sea turtles associated with the implementation of extractive uses not related to conservation and eco-tourism. After three years of sea turtle watching in the Municipality of Los Cabos as a tourism attraction; the models and strategies followed for different participants coupled with the economic gains, show that sea turtle watching implemented in the Natural Protected Areas, and beaches without protection in the Municipality of Los Cabos, is in a consolidation process and potentializing the programs as to be self-financing programs. Another alternative to explore is "The Sea Turtles Protection Committee in Los Cabos" supported by The Municipality of Los Cabos which requested to the Federal Government Sea Turtle Program the co-administration of a sea turtle camp to operate it in a comprehensive manner in all nesting beaches, but also with the formal granting operating under a regulation for the autonomy of the committee, this would avoid risks to the continuity of the program by the vagaries of changes in local government administration. This new figure for greater participation would allow social responsibility on behalf of sea turtles, and coastal

communities and the expansion of a new range of alternative tourism for Los Cabos, one of the most important touristic places in Mexico. Participation on ISTS has been made available through generous donations by the following organizations: H. XI Ayuntamiento de Los Cabos, B.C.S.; WWF; International Sea Turtle Society; Western Pacific Regional Fishery Management Council; U.S. Fish and Wildlife Service; The U.S. National Marine Fisheries Service and the 32 International Sea Turtle Symposium Committee.

THE SERIAL KILLER FILES: THE WHO, WHAT, WHERE, HOW AND WHY OF THE WORLD'S MOST TERRIFYING MURDERERS. THE CROW (*CORVUX CORAX*) SERIAL MURDERER OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) AND LEATHERBACK (*DERMOCHELYS CORIACEA*) HATCHLINGS IN LOS CABOS, BAJA CALIFORNIA SUR, MEXICO; LIKE A CASE STUDY

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Away from the film “The Crow” Written by Don Hoffman and based on the comics with the same name, in which a poetic guitarist is brought back to life by a crow a year after he and his fiancée are murdered. And the crow guides him through the land of the living, and leads him to his killers. One by one, the musician gives these thugs a taste of their own medicine; becoming in a serial murderer linked in a supernatural way with a crow. These works describe the patterns leads to a serial murderer of olive ridley (*Lepidochelys olivacea*) and leatherback (*Dermochelys coriacea*) hatchlings at on site nest and hatcheries observed in Los Cabos, BCS, Mexico. The common crow (*Corvux corax*) has coexisted for thousands of years with humans, and in some regions is so abundant that it is considered harmful. Part of their success is due to their omnivorous diet, the common crow is extremely opportunistic, feeding on carrion, insects, food waste, grain, berries, fruit and small animals. Several studies have revealed that this species show solving of problems, suggesting that the common crow is very intelligent adding to his ability to speak after practiced a surgery in the tongue. Crows are fascinating animals and among one of the most intelligent among birds. Its intelligence is demonstrated in the hatcheries where their presence is detected during the day just before the sea turtles hatch. The crows learned to remove the protective fences with a unique technique, showing no doubt that some intelligence is required to develop it. Their systematic killing in which the crows eats each one of the hatchlings that finds during their journey to the sea (in situ nests), or in the hatcheries after removing the protector fence, moments during which the crow can kill one by one all the hatchlings that see, taking only some of them to its nest to feed their chicks or themselves, leaving the vast majority of hatchlings dead on the beach. The beforementioned lead us to think about the killing of a systematic murderer. Finally, we present a simple technique to prevent crows in the nursery. This consists of installing horizontal and perpendicular fishing lines on the top of the nursery at each 2 m, preventing the crows to enter the nursery. The technique is highly economical and simple, with excellent results. The participation in this event, it has been possible thanks to generous donations by the following organizations: H. XI Ayuntamiento de Los Cabos, B.C.S.; WWF; International Sea Turtle Society; Western Pacific Regional Fishery

Management Council; U.S. Fish and Wildlife Service; The U.S. National Marine Fisheries Service and the 32nd International Sea Turtle Symposium Committee.

SEA SURFACE TEMPERATURE AND CHLOROPHYLL "A" BY REMOTE SENSING IN A SEA TURTLE FORAGING AREA IN NORTHERN SINALOA, GULF OF CALIFORNIA, MEXICO

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The San Ignacio-Navachiste-Macapule Lagoon System and its coastal marine area are located in the Southern Gulf of California, in the coast of the state of Sinaloa in northwestern Mexico. The coastal marine area of the system is located in a zone of high phytoplankton productivity, where lower temperatures are related to those found within the lagoon system, this is because the platform water is cooled by ocean-atmosphere interactions and particular oceanographic processes such as coastal upwelling and cold subsurface water rich in nutrients with greater intensity in winter and spring. Therefore sea turtles find this place as an important feeding zone. The aim of this study was to determine the distribution of Sea Surface Temperature (SST) and Chlorophyll a (Chlo a) as an indicator of phytoplankton biomass, from satellite imagery and its relationship with the sighting of sea turtles. For this study, weekly compounds of SST and Chlo a, obtained from the website MODIS Aqua sensor, with spatial resolution of 4x4 km per pixel for the period May 2007 to June 2011 were used. The sectioning of study area, the average imaging and graphical representation seasonal cycle were performed using the software MatLab (Matrix Laboratory). SST was variable throughout the study period, the overall average was 25.5°C, lower temperatures recorded in front of the San Ignacio-Navachiste-Macapule Lagoon System which coincides with the continental shelf boundary, suggesting the influence of coastal upwelling. Chlo a concentrations showed spatial variability associated with changes in temperature, the overall average was 1.2 mg/m^3, with the highest concentrations near the coast and decreasing towards the open sea. The seasonal cycle explained the 92% of SST variability and 62% of Chlo a's, both variables had a correlation coefficient of -0.82 which also was influenced by other factors and processes such as coastal upwelling. By presenting optimal conditions for primary producer's development, the succession of species allows the presence of food within the trophic network, and therefore sea turtles find abundant food in this area, allowing its optimal development.

PHOTO-IDENTIFICATION OF *DERMOCHELYS CORIACEA* IN THE COAST OF OAXACA, MEXICO

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Tagging sea turtles is a strategy to estimate populations of different nesting areas through identifying recaptured turtles, studying movements, reproductive biology, stranded animals, distribution and growth tax, thanks to different kind of tags. Tag loss is one of the biggest issues when it comes to identifying individuals. In leatherback turtle tag loss is very high greater than 30% within one year; the percentage of tag loss only increase with time. Photo identification is a natural and no intrusive alternative to conventional method of tagging (it is not a tag method but a natural identification technique) and it has been already used in different species of marine turtles. Because of the pineal or pink spot, present on the superior part of its head along with particular characteristics such as small white stains, the photo-identification of leatherback turtle (*Dermochelys coriacea*) nesting females is possible. On three beaches of the Coast of Oaxaca, a photo-identification study was conducted to prove the efficiency of the technique and to find an alternative (easier and cheaper for communitarian people) to expensive and specialized tagging methods. In two different seasons (2007-2008 and 2009-2010) the head of leatherback females found on the beach during nesting activities were photographed using a basic digital camera Nikon L10. Each photo was printed in black and white on regular printing paper; a minimum of five characteristics for each specimen was defined and circled and compared to other pictures in order to identify them. Since the pictures were not taken in a consistent position (Tomatal in 2007-2008), it made photo-identifying each female more challenging. In 2008 in the beach of “El Tomatal”, five leatherback females were photographed and one was identify thanks to photo-identification; in 2009 in the beach of “El Venado” only one turtle was photographed with no chance of using the technique, and in the same season in the beach of “La Ventanilla” also five females were spotted and one was identified with photo-identification supported by metal tags data which is the best way to prove the efficiency of the technique. A catalogue was created to use during next seasons with all pictures of the spotted females and data. Photo-identification can be a successful tool in case of no financial support or no tag application training (or technical specialized support), but is necessary to use the correct technique to accurately recognize details and don’t perturb the turtle during nesting activities. We recommend photographic identification to communities to improve the individual recognition along secondary beaches. Keywords: photo identification, pink spot, tag, leatherback, Mexico.

DIVE BEHAVIOR AND ACTIVITY BUDGETS OF GREEN TURTLES, *CHELONIA MYDAS*, AT A WARM TEMPERATE FORAGING AREA IN THE GULF OF CALIFORNIA, MEXICO*

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Green sea turtles, *Chelonia mydas*, along the Pacific coast of Mexico have increased substantially over the last decade, due to a broad spectrum of conservation efforts at nesting beaches and in foraging areas. While this increase in population size is promising, there are several conservation obstacles that remain, and recovery efforts would benefit from knowledge about green turtle habitat use and behavior in coastal ecosystems. Data on diel movements, depth utilization, and daily activity budgets by green turtles are especially important for pinpointing the specific habitats and times where green turtles are most susceptible to human impacts such as coastal fishing. From 1999 to 2003, we studied the dive behavior and daily activity of 23 green turtles at Bahía de los Angeles, a warm temperate foraging habitat for large immature and adult turtles in the Gulf of California, Mexico. We fitted time-released time-depth recorder (TDR) drogue systems to turtles ranging from 55.0 to 99.0 cm in straight carapace length and from 27.2 to 145 kg in weight. Drogues were made of syntactic foam and equipped with a VHF transmitter for retrieval. These devices were attached to turtles with an automatic release mechanism consisting of two interlocking plates; one fixed to the turtle's carapace with a 5-minute quickset epoxy and the second attached to the TDR drogue enabling retrieval by conventional telemetry techniques. Upon dissolution of a magnesium link, the plates separated and the drogue floated to the surface, where it was tracked and recovered via the VHF tag. To our knowledge, this is the first study of green turtle diving behavior along Pacific Mexico. Of the 23 turtles, a total of 110 hours of TDR deployments revealed a maximum dive depth of 48.5 m, with mean dive durations consistently greater during night hours, but a variable relationship between day and night dive depths. A mean of 38.8 ± 3.81 resting dives was observed each day, with a mean time allocated to resting behavior per 24-h period of 8.59 ± 0.72 h (35.8 ± 3.01%), and a mean resting depth mode of 10.35 ± 1.36 m (range=7.5–13.5 m). The mean daily surface activity (< or =2 m depth) per 24-h period was 1.41 ± 0.21 hours (5.87 ± 0.88%). All previously documented dive types (Type 1–Type 6) were observed during all periods of the 24-h cycle. However, the shorter length of day dives vs. night dives suggests that turtles are more active during day periods. The knowledge gained from this study about the dive behaviors and depths achieved by these animals combined with the previously documented foraging and movement patterns of turtles at this foraging area will allow us to more adequately determine the potential effects of human activities as well as guide data analysis of future aerial survey efforts based on their surface activity.

HEAVY METALS IN SEA TURTLE *LEPIDOCHELYS OLIVACEA* FROM GUASAVE, SINALOA, GULF OF CALIFORNIA, MEXICO

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Currently, oceanic's ecosystems have been affected by anthropogenic activities. Pollution impacts can be notice in coastal areas, where anthropogenic pressure has increased dramatically. Heavy metal pollution has been reported in sea turtles all around the world, particularly in *Chelonia mydas* and *Caretta caretta* species. However, there are few studies about pollution in sea turtles species at Gulf of California, Mexico. The objective of this work was to determine the levels of heavy metals in blood tissue of *Lepidochelys olivacea*. During 2008, 17 blood samples were collected from *L. olivacea* sea turtles in coasts of Guasave, Sinaloa, Mexico (25012´46"N, 109002´44.8"W). The curved carapace length (CCL) and weight were used as a relative indicator of age determination in sea turtles. For evaluation of Zn, Ni, Mn, Cu, Cd and Se metals, 0.5g (wet weight) of blood samples were taken, and an acid digestion was applied using a 5ml HNO_3, HCl and H_2O_2 mix in 2:2:1 proportional parts. An optical emission induced (ICP-OES) plasma spectrophotometer model OPTIMA 4300DV (Perkin-Elmer) was use for the readings of the evaluated metals. Detection limits for each element were 0.01 µg/g for Cd, Ni, Hg and Pb, and 0.04 µg/g for Zn, Cu, Mn and Se. Each reading of analyzed metals was obtained using a wavelength (nm) recommended by the distributor: Cd=228.8; Ni=231.6; Hg=253.6; Pb=220.3; Zn=206.2; Cu=327.3; Mn=257.6; and Se=196.0. *L. olivacea* showed the highest concentration of Zn (37.12 µg/g) in regard to all other analyzed metals, followed by Se (µg/g), while Cu showed the lowest concentration (1.05 µg/g), even lower than toxic metals analyzed. The metal analysis distribution was: Zn > Se > Mn > Ni > As > Cu > Cd. In conclusion, the heavy metal concentrations analyzed from blood of sea turtles of the species *L. olivacea* is comparatively minor to the reported by other authors in different tissues of species like *Caretta caretta* and *Chelonia mydas*. However, in semi-enclosed seas, *L. olivacea* seems to present a toxic metal concentration, particularly Cd, higher than other species like C. caretta.

MORPHOMETRY AND ALLOMETRIC RELATIONSHIPS IN HATCHLING OLIVE RIDLEY TURTLES (*LEPIDOCHELYS OLIVACEA*) IN NUEVO VALLARTA, NAYARIT

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The shape of turtle bodies is one of the most important expressions of the phenotype and has an influence on hatchlings survival. With the aim of determining morphometric relationships of olive ridley (*L. olivacea*) hatchlings in Nuevo Vallarta, Nayarit (20º42'05'' N,

105º17'59'' W); we registered 12 morphometric variables from caparace, plastron, head and front flippers, as well as the wet weight of hatchlings. Data were analyzed using descriptive statistics, linear regressions and correlations. A total of 300 hatchlings were measured, with an average of 4.13 cm straight carapace length (SCL) and 16.3 g wet weight. The length and weight was bigger than the previously informed for Mexico, but the length is smaller than reported in Baja California, showing a possible latitudinal gradient. All measurements showed a negative allometric linear relationship with SCL (b<1). The results are similar to previous studies for other species and, using a discriminant function, can be used like a non-lethal method for sex assessment.I am very thankfull for the generous support of the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and the U.S. National Marine Fisheries Service

SEA TURTLES ALONG THE COAST OF TABASCO, MEXICO

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This study aimed to determine the presence of sea turtles along the coast of Tabasco, with emphasis on the green turtle (*Chelonia mydas*). A survey was conducted using field observations to assess the condition of the 160 km of coast line in September 2010. Also, 55 structured interviews were conducted with fishermen and inhabitants of the coastal zone to gather information on nesting and feeding sites of sea turtles. Interviews indicate the nesting of hawksbill (*Eretmochelys imbricata*) and Kemp's ridley (*Lepidochelys kempii*) recently. The last observed nesting activity of loggerhead (*Caretta caretta*) and green turtles occurred at least 60 years ago. Nesting of the first two are considered occasional. The leatherback (*Dermochelys coriacea*) does not nest in Tabasco; however, its presence is noted in the local waters. We conclude that the beaches of Tabasco are not important for the nesting of the species recorded, nor for the effective recruitment of hatchlings, due to the physiographic and hydrological characteristics of the coast. It tends to flood, is severely eroded, contains sandy sediments, and also muddy components which are likely to store and concentrate heavy metals. We confirmed that Tabasco is an important feeding area for all turtles, but not mating. Laguna El Carmen is a feeding and growth area for Kemp's ridleys, greens, and hawksbills. Also, the nutrients discharged by the Grijalva River promote the abundance of leatherbacks off the coast.

Special Session: Mitigation of Turtle Interaction with Fishing Activities

SEA TURTLE BYCATCH IN TRADITIONAL FISHING NETS IN CONGO: WHICH ARE THE MOST NOCIOUS GEARS AND PRATICE? MODIFICATION PROPOSALS TO REDUCE THE RISK

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Five of the seven sea turtles species of the world occur along the Congolese coast. Traditional fisheries are one of the main threats for these species in Congo. A study was carried out to estimate the bycatch risk in various fishing gears and techniques.The results showed that the standing gillnets are causing most of the sea turtle bycatch in Congo's waters. Large mesh gill nets were shown to catch significantly higher number of sea turtles than small meshes. The nets with small meshes are, however, of little selective and can compromise the renewal of the resource. The Congolese regulations authorize only a mesh size superior to 10 cm. According to the literature, other factors can influence the risk of sea turtle bycatch. The nets poorly tightened or not vertical increase the risk, the implementation of delusions or phosphorescent or bright elements may reduce the risk. These results will be used to experiment a standing gill net fulfilling to the local regulation requirements and meeting the characteristics identified as able to reduce the frequency of sea turtle bycatch while maintaining the efficiency to capture commercial species (fishes and shellfishes).

POUNDNET ESCAPE DEVICES (PEDS) CAN MITIGATE BYCATCH OF SEA TURTLES IN JAPANESE COASTAL FISHERIES*

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To address high rates of bycatch mortality of adult and subadult loggerhead and green turtles in pound nets of the Japanese archipelago, we initiated an international multi-sector program to develop and test bycatch mitigation solutions. We convened three International Pound net Escape Device (PED) Workshops combined with experimental trials at Suma Aqualife Park (Kobe, Japan) and Minamichita Beachland Aquarium (Mihama, Japan) from

2009-2011 with fishers, gear manufacturers, government representatives and marine scientists from three countries that host the Japanese-nesting loggerhead population - Japan, Mexico and the USA. Pound net fisheries are common worldwide and known to cause high bycatch rates of sea turtles. In Japan, pound net bycatch results in mortality of many loggerhead and green sea turtles and are likely a major obstacle to the recovery of the North Pacific loggerhead. Pound nets in Japan operate nearshore in depths up to 100 m, have leaders of up to 2 km, and traps measuring in excess of 10,000m^3 with nitial construction costs exceeding US$2 m. Pound nets with underwater traps prevent sea turtles from reaching the surface to breathe and can result in high mortality rates. We launched a three phase, multi-sector research and outreach program to a) raise awareness for the need of pound net bycatch solutions, b) develop a system for testing PEDs, and c) develop and test PED designs for turtle escape and fish retention. We engaged fishermen, fisheries managers, marine scientists, and gear manufacturers from the outset in all facets of the work in order to increase the efficacy of PED designs and to augment future PED adoption. During each workshop we assembled a model pound net trap in an aquarium viewing tank. Participants collaborated during the workshops to develop and then test several innovative categories of PEDs. In total we ran 126 turtle escape trials on 25 PED designs with fish retention trials on the most promising. During the third workshop in October 2011 we identified 4 PED designs that exhibited 100% turtle escape with 100% fish retention. Members of the public and press joined workshop participants to observe the trials from within the aquaria. The public setting yielded firsthand views of turtles that were struggling to escape from the pound net trap in order reach the surface to breathe. This resulted in extensive press coverage detailing the bycatch problem and the collaborative process of developing PEDs. Coverage appeared in prominent national Japanese media outlets including NHK TV. Public discourse focused on solutions development and treated the bycatch problem as a given. Thus the education and public awareness raised throughout this process has been as influential as the PED research itself. In addition, our multisector international team developed several PED designs that result in 100% fish retention and turtle escape under controlled conditions. The variety of successful PED designs offers practical use across a range of fishing conditions and pound net configurations. We plan to undertake commercial field trials in conjunction with fishing associations.

COLLABORATIVE RESEARCH CAPACITY-BUILIDING TO REDUCE MARINE TURTLE BYCATCH*

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Our project involves integrated components that assess the baseline fisheries practices and marine turtle interactions, through collaborative research capacity-building that induces confidence among participants, creating a vibrant network of partners working toward turtle conservation hand in hand with fisher communities and industry. Collaboration is a cornerstone objective in all aspects of this project and thus we will formalize partnerships with collaborators to implement the activities below. Partners in this project will include: NOAA National Marine Fisheries Services' Southeast Fisheries Science Center (SEFSC); national fisheries agencies; regional fisheries management organizations; Inter-American

Tropical Tuna Commission (IATTC); and the World Wildlife Fund (WWF). Further, we intend to expand partnerships with local fisheries organizations (e.g., NGOs, industry groups) to ensure we are working with credible, trusted local voices and thus further enhance our access to the fishing industry. Additional local partners will include universities and technical institutes. We will conduct a two-year project, associating two candidate countries. Activities will include: Fisheries Assessment, which will be conducted in conjunction with local, credible fisheries organizations, and employing WWF assessment methods tested in French Guiana, Suriname and Guyana. We will assess the fisheries practices, level of effort, target and bycatch species, fleet specifications, industry leadership and organizational capacity, turtle interactions, and socio- economic challenges. The primary method will be dock-side questionnaires, followed by observer data —while we will accompany partners in the creation of on board observer programs these will ultimately be implemented by local, national, or regional organizations. TED Evaluation and Transfer through Collaborative Research: Though some countries currently have successful TED programs others do not. Through collaborative research with industry, voluntary TED adoption becomes possible. This is precisely the case of French Guiana and Gabon both of which have benefited from such collaborative projects in the recent past. Components of the TED projects included building local staff capacity through peer mentoring and TED technology transfer through collaborative research activities. For the project at hand we will identify industry partners and opinion leaders for at-sea trials of TEDs, and reach out to leaders to jointly conduct TED demonstrations. At-sea scientific trials are critical to demonstrate the effectiveness of TEDs and illustrate the potential of collaborative research. Selected scientists and industry representatives from the region will participate in the trials. Collaborative Research Capacity Building Workshop: Working with local universities or technical institute partners, we will recruit fisheries scientists at universities who have applicable skills for collaborative fisheries research. A 3-day workshop in conservation engineering, research design, and collaborative research will be designed and administered in the two candidate countries. Invited scientists will participate in each workshop, a sub-set of which will participate in the at-sea-trials of the TED. Participating scientists will be enrolled in the an e- Networking social media curriculum to enable facilitated peer mentoring and faculty coaching, moderated by one of our local partners and a US-based Collaborative Fisheries Research Fellow. After a 1YR apprenticeship, we will conduct a web-based research symposium and award professional certificates in collaborative fisheries research to the class of scientists.

SUSTAINING IMPERILED FISHERIES AND TURTLES: A PORTFOLIO OF VOLUNTARY BYCATCH SOLUTIONS AT BCS MEXICO*

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Global assessments have revealed bycatch hotspots where intense, small-scale fisheries overlap with sea turtle and other megafauna habitats. Reducing bycatch in small-scale fisheries presents a daunting challenge, but high bycatch rates can actually provide unexpected conservation leverage; changing the practices of a relatively few fishers with high bycatch rates can disproportionally spare many turtles. Despite strong international and national protection of sea turtles, enforcement is often lacking, especially in developing nations. For these reasons innovative conservation approaches are required for reducing

bycatch in small-scale fisheries globally. We initiated Proyecto Caguama (Operation Loggerhead) in 2003 to assess and reduce bycatch of endangered loggerhead turtles in small-scale fisheries at Mexico's Baja California peninsula. Because management of these fisheries was weak, we forged innovative partnerships with local fishers and their families to develop a portfolio of voluntary bycatch solutions that maintain or augment fisheries sustainability and fisher wellbeing. In Phase 1, we initiated a long-term, participatory bycatch assessment program through on-board observers and shoreline surveys and documented among the highest bycatch rates of sea turtles documented globally (29 loggerheads/1,000 hooks and 1.0 loggerhead/km of net in local bottom set longline and gillnet fisheries, respectively). These rates resulted in thousands of loggerheads killed each year, representing a major obstacle to recovery of the endangered North Pacific loggerhead population. In Phase 2, we developed and tested bycatch mitigation solutions including a) buoyless gillnets that consistently reduce loggerhead bycatch by 60% while maintaining target catch, b) substitution of zero-bycatch hook for gillnet fishing, and c) voluntary retiring of bottom-set longline gear from the loggerhead hotspot. Currently we are working on Phase 3, the implementation of market-based bycatch mitigation solutions through which local fishermen are trained and equipped to increase catch selectivity and quality coupled with cultivation of preferential markets for high quality, bycatch-free fish in order to augment fisheries sustainability. Here we report the success of our long-term portfolio approach to bycatch mitigation. Our local fisher partners are increasing the sustainability and profitability of their target fishing and have dramatically reduced their bycatch rates in bottom-set longlines and gillnets, sparing thousands of juvenile loggerheads each year since 2007. This success is reflected in 60-80% decreases in annual loggerhead strandings at the index shoreline of Playa San Lázaro BCS. Our integrated methodology has applicability in other bycatch hotspots, particularly in the context of weak fisheries management. We conclude by discussing the limitations of voluntary bycatch reduction programs and highlight the potential for integration with management authorities.

COMPARISON OF THE HOOKING LOCATION IN SEA TURTLES IN CIRCLE HOOKS AND HOOKS TYPE "J" IN THE ARTISANAL LONGLINE FISHERIES IN THE EASTERN PACIFIC OCEAN*

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Since 2004 fishing sectors, governments and non-governmental organization have implemented joint efforts to reduce marine turtle bycatch in pelagic longline operations across the eastern Pacific Ocean (EPO). Commercial fishing trips voluntarily carrying experiments to compare the effectiveness of circle hooks and J hooks in nine eastern Pacific countries from Mexico to Peru. Differences in hooking location in sea turtles were analyzed in 2,295 fishing trips, with a total of 10,386 sets, in 578 vessels, with a sample of almost 4 million hooks. All this information has been collected by 238 onboard observers voluntarily accepted by fishers. The analysis was performed for all countries that participated in the experiments separated by longline operating depth (surface or bottom longline), target species, size of sea turtles, among other variables. In total, 5,358 sea turtles were registered with a total of 16 different locations of hookings grouped into the categories of swallowed, external, tongue, upper jaw and lower jaw. Analyses were performanced only for olive ridley (*Lepidochelys olivacea*) which is the most abundant bycaught sea turtle species. Results showed a significant reduction in the number of "serious" or severe hooking (i.e., internal hookings or hooks swallowed) in circle hooks in comparison with J hooks. While J hooks showed a higher proportion of internal hookings, circle hooks showed a higher proportion of hookings both externals and in the lower jaw. The reduction of internal hookings were observed in all tested sizes of hooks and throughout the rage of sizes of olived ridely analyzed. The proportion of J hooks swallowed was higher in the Mahi-mahi fishery in comparison with Tuna-Billfish-Shark (TBS) fishery. It is important to consider the effectiveness of circle hooks in relation to hooking location on sea turtles, along with best practices of handling and releasing, as a measure to reduce serious injuries and improve post-release survival.

USE OF TWO TYPE OF HOOKS TO DETERMINE SEA TURTLE'S HOOKING PROPORTIONS IN LONGLINE PELAGIC FISHERIES IN COSTA RICA, PACIFIC OCEAN

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Through hook exchange, the sea turtle bycatch reduction programme has tested circle hooks of different sizes, shapes and materials in the tropical Eastern Pacific region. In Costa Rica, the program started in 2005. By implementing an observer's program, it has been possible to test different arrangements of J vs C16 and C18 hooks in experimental fishing longlines working off Pacific coast of Costa Rica. Observers were accepted after voluntary enrollment and assigned to long line fishing boats targeting tunas (*Thunnus albacares*), mahi-mahi (*Coryphaena hippurus*) and pelagic sharks. From 2005 to 2011, were tested 1161759 hooks aboard of 69 vessels in 276 Trips in which were made 2,543 sets. The data shows that these circle hooks result in a lower rate of "serious" hooks (hooks that are swallowed or embedded in the upper jaw or glottis). It is recommended to use at least circle hooks 16/0 to reduce proportions of internal hooking of sea turtles in Costarican long -line fishery. Training courses in good practices for handling hooked or entangled turtles should be implemented as part of courses specified by fishermen regulation, de-hookers, turtle mouth openers, dipnets and hook and line cutters must be onboard of any longliner vessel.

NET ILLUMINATION AS A METHOD TO REDUCE SEA TURTLE BYCATCH IN GILLNET FISHERIES*

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Coastal gillnet fisheries are found throughout the world and are often problematic because of their non-selective impacts. Gillnet fisheries have been associated with significant sea turtle bycatch rates. For example, the coastal gillnet fishery based in Lopez Mateo, Baja California, MX interacts with up to 800 loggerhead turtles (*Caretta caretta*) per year, while gillnet fisheries off the coast of Northern Peru catches over 300 green sea turtles (*Chelonia mydas*) per year. Behavioral and physiological studies show that visual cues play important roles in sea turtle foraging and orientation. This has led us to examine visual based strategies as ways to reduce sea turtle interactions with gillnet fisheries. While using visual cues to alert non-target species has been examined in a variety of other fishery settings, utilizing visual alerts to deter sea turtles from gillnets is a novel approach. We have examined the use of illuminate nets that reduce green sea turtle interaction rates by 40-60%. When adapted to commercial bottomset gillnet fisheries, these illuminated nets do not significantly alert the catch rates of target species or value of catch. Experiments with illuminated nets

were conducted in Baja California, but can be adapted in any coastal gillnet fishery. Current projects to explore the use of illuminated nets include field trials in Northern Peru and Southern Brazil. In addition, we have begun testing the use of ultra-violet (UV) lightsticks to illuminate gillnets. Many pelagic and coastal fish species have eye structures that prevent UV vision, while behavioral and anatomical studies indicate that sea turtles are sensitive to UV light. This suggests that the UV spectrum may selectively alert sea turtles. Preliminary results suggest that UV illuminated nets reduce sea turtle interactions by 50% without reducing total target catch rates on bottom-set gillnets. Interestingly, halibut catch rates in UV illuminated nets increased. California halibut (*Paralichthys californicus*) are the primary target fish species and hold the most value per kilo.

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