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

29 February to 4 March, 2016

Lima, Peru

Compiled by:
Jeffrey C. Mangel, Alan Rees, Mariela Pajuelo,
Francisco Córdova, and Nicolas Acuña

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

March 2019

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March 2019

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

Mangel, J.C., Rees, A., Pajuelo, M., Córdova, F, Acuña, N. compilers. 2019. Proceedings of the Thirty-Sixth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NOAA NMFS-SEFSC-734: 364 p. doi: 10.25923/ng2d-c375

Technical Editor:

Lisa Belskis

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Southeast Fisheries Science Center

Sea Turtle Program

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Miami, FL 33149

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Abstract titles marked with an * at the end of the title denote an Oral Presentation.

PRESIDENT'S REPORT

36th Annual Symposium on Sea Turtle Biology and Conservation

29 February - 4 March, 2016, Lima, Peru

Joanna Alfaro-Shigueto, President, ISTS

The 36th Annual Symposium on Sea Turtle Biology and Conservation was held in the City of Lima, Peru from February 29 to March 4, 2016. This year the Symposium's theme was *Crossroads*, highlighting the need for multi-disciplinary, multi-taxa, multi-national, and multi-gender efforts in advancing marine conservation worldwide. This meeting aimed to break down barriers and boundaries between people and countries in order to achieve marine conservation through its most global flagship, the sea turtle. The structure of the symposium was similar to past symposia, with pre-symposium workshops and regional meetings, plus 3 days of symposium meetings. Overall the meeting was a success from basically every perspective; details are offered below.

A total of 685 people from 52 countries registered for the Symposium. The venue for the symposium was the Maria Angola Convention Center in the city of Lima. A total of 155 oral papers and 305 posters were presented at the symposium.

Pre-symposium Workshops & Regional Meetings: Several workshops and meetings were scheduled during the two days prior to the symposium main days. The opening was presented by Sonia Valle Rubio, representative from Cientifica del Sur University, Larry B. Crowder and Joanna Alfaro. A total of 12 workshops were held. These were: In-water capture techniques, GIS Training, Marine mammals, Elasmobranchs, Ghost Fisheries, Survey training, Temperature-dependent Sex Determination (TSD), Photo-Identification techniques, Turtle Medicine, Leatherback Turtles of the Southeast Pacific, Environmental education and Bycatch of Sea turtles in the East Pacific.

A total of five Regional meetings were held. These were: RETOMALA (Latin American), Africa, Mediterranean, East Asia, and Indian Ocean South East Asia. These meetings were successful and contributed to bring attendees early to the symposium.

Three meetings were also held: Caribbean Wider Caribbean Sea Turtle Conservation Network (WIDECAST), Freshwater Turtle and Tortoise and IUCN Marine Turtle Specialist Group (MTSG).

Key Note Speakers: Two Key Note speakers delivered 20 minute addresses. Colin James Limpus from Australia gave a comprehensive introduction of 'Marine Turtles at the Crossroads: Complex Life Histories Requiring Local, National and International Action for their Conservation'. Brendan J. Godley immediately followed, speaking to the audience about his 10 tips on being a successful sea turtle researcher.

Symposium Sessions: This symposium included traditional sessions held at previous symposia, such as Anatomy, Physiology and Health; In-Water Biology (Ecology, Telemetry, Foraging, Behavior); Nesting Biology (Ecology, Behavior, and Reproductive Success); Population Biology and Monitoring (Status, Modeling, Demography, Genetics, Nesting Trends, In-Water Trends); Fisheries and Threats; Conservation, Management and Policy; Education, Outreach and Advocacy; and Social, Economic and Cultural Studies.

There were four special sessions. The session Emerging Threats-Climate Change, Oil Spill and Plastic Pollution had oral presentations on innovative methodologies, and new conservation issues such as plastic debris, sea level rise and oil spills. The second special session was 'Turtles in Time' where studies of turtles using historical archives were presented and discussed, and Eastern Pacific Sea Turtles sessions focused in regional aspects in turtle biology and conservation.

Poster presenters had the opportunity to answer questions and give more details on their presentations during "Meet the Authors".

Social Events: The socializing component of the symposium was comprised of the Welcome Social, Live and Silent Auctions, Video Night (23 videos were projected to symposium attendees as wells as the general public), Student events, Student Awards and Farewell party. Among those events, a Speed Chatting with Experts event was held the night of the first day of the meeting, with the following lineup: Joanna Alfaro Shigueto, Bryan Wallace, Emma Harrison, Colum Muccio, Zoe Meletis, and Andrea Phillot.

The Student Committee conducted two activities. One was a workshop to discuss methods to raise funds for research using social media. The second activity was a Social Mixer, letting students meet other students as well as scientists and researchers exposing their latest investigations. Of all these events, the Live Auction and the Farewell party were probably the most popular.

Travel grants: More than 200 registrants received a travel grant, 8 from Africa, 34 from US/Canada, 10 from Caribbean, 1 from South Asia, 6 from Asia Pacific, 3 from Middle East, 95 from South America, 18 from Europe, 38 from Mexico/Central America, others). This level of travel grant awards represents about 29% of the total registered participants. Travel grants took the form of cash and room grants, for a total of about 200 persons, which was highly advantageous for the awardees.

Auctions: We were able to collect $25,000 through the live and silent auctions, breaking records set from previous symposia. This money will be used to help students to attend future meetings via travel grants.

ISTS Awards: During the symposium a series of awards were made to prominent members of our sea turtle society. Earl Possardt, Jeanne Mortimer and Dave Owens were awarded the Lifetime Achievement Award for their extensive and significant contributions to the promotion of sea turtle biology and conservation. ICAPO (Eastern Pacific Hawksbill Initiative) was awarded with Championship Award. Hipolito Lima received a Championship Award too. President's awards were given to Colin Limpus and to the Peruvian organization "Asociacion Amigos de la Naturaleza", a group of fishermen working with conservation. Debbie Sobel received the Ed Drane Award for Volunteerism. Congratulations to all the awardees.

Archie Carr Student Awards: Four students won the Archie Carr award for outstanding presentations at the symposium. Boris Tezak (Biology) and Callie Veelenturf (Conservation) won in the poster category. Karen Panlaew (Biology) and Kimberly Riskas (Conservation) won in the oral category.

Resolutions: A very important component of every symposium is the issuing of *Resolutions*, documents that allow the Society at large to pronounce itself with regard to issues pertaining to sea turtle conservation around the world. During the ISTS 36, there were no resolutions submitted nor discussed in Lima.

Board meeting: The Board meeting held during the Lima symposium was fruitful and lasted until midnight of the first day of the symposium. The Board received and discussed reports from the Nominations Committee, Student Committee, Travel Committee, Students Awards Committee, Awards Committee, as well as reports from the Program Officer and Treasurer.

Business Meeting: Very important issues were addressed during the plenary business meeting, Travel committee chair, and the Treasurer presented their reports and the attendees approved. Also, it was announced the new President-elect for symposium 2018: Yoshimasa Matsuzawa from Japan.

Frank Paladino, future President 2017, unveiled the venue where the next symposium will be held, and gave details on this. We will get together again in JW Marriot hotel & Spa in Las Vegas from 15-23 April 2017.

Society Elections: After the voting process ended in Lima, the Society will be led by President: Frank Paladino, President-elect: Yoshimasa Matsuzawa, Past President: Joanna Alfaro Shigueto, Secretary: Manjula Tiwari, and Treasurer: Terry Meyer. The new Board of Directors is comprised by Roldan Valverde (2017), Alejandro Fallabrino (2017), George Balazs (2017), Yakup Kaska (2018), Emma Harrison (2018),

Pam Plotkin (2018), Mariana Fuentes (2019), Alan Rees (2019), Andrea Phillot (2020), Laura Prosdocimi (2020), Andrews Agyekumhene (2021) and Jeanette Wyneken (2021)

The Nominations Committee added new members Kartik Shanker, Connie Ka-Yan Ng and Kate Mansfield.

EXECUTIVE, ORGANIZING, AND PROGRAM COMMITTEES

Executive Committee Role	Member
President	Joanna Alfaro Shigueto
Secretary	Manjula Tiwari
Treasurer	Terry Meyer
President Elect	Frank Paladina
Past President	Yakup Kaska

Organizing Committee Role	Member
Event Coordinator	Andrea Pásara, Nina Pardo
Auction Co-Chairs	Jennifer Homcy, Marina Zucchini, Rod Mast
Exhibitor/Vendor Chairs	Clara Ortiz, Flor Gomez
Speed Chatting Coordinators	Emma Harrison, Zoe Meletis
Nomination Committee Chair	Nancy FitzSimmons
Nomination Committee Members	Shaleyla Kelez, Edward Aruna, Milagros López-Mendilaharsu, Alberto Abreu Grobois
ISTS Awards Committee	Brad Nahill, Blair Witherington, Thushan Kaparusinghe, Michael Jensen, Andrés Estrades
Program Officer (Fundraising)	Ingrid Yañez
Registration desk	Eliana Alfaro, Elizabeth Campbell, Clara Ortiz
Student Committee	Itzel Sifuentes, Adriana Cortez
Student Judging Committee	Matthew Godfrey, Andrea Phillott
Grassroots Conservation Award Committee	Alejandro Fallabrino, Angela Formia, Jack Frazier, Colum Muccio, Manjula Tiwari, Ingrid Yañez
Volunteer Coordinator	Shaleyla Kelez
Workshops Committee	Gabriela Velez, Alan Norzaga

Program Committee Role	Member
Program Coordinator	Ana Barragan
Program Chairs	Mariela Pajuelo, Natalie Wildermann, Kelly Stewart, Justin Perrault, Mariluz Parga, Daniela Freggi, Jeanette Wyneken
Session Chairs	Clayton Pollock, Catherine McClellan, Hannah Vander Zanden, Seth Sykora-Bodie, Steve Dunbar, Tina Fahy, Patricia Zárate, Bruno Giffoni, Jeffrey Mangel, Robin LeRoux, Erik Martin, Niki Desjardin, Meg Lamont, Claudia Ceballos, Mariana Fuentes, Héctor Barrios-Garrido, Thushan Kapurusinghe, Gustave Lopez, Kelly Stewart, Bill Kendall, Marco García-Cruz, Brian Shamblin, Zoe Meletis, Aliki Panagopoulou, Emma Harrison, Irene Kinan Kelly, Matthew Godfrey, Mark Hamann, Cathi Campbell, Javier Quiñones, Bryan

	Wallace, Frank Paladino, Gabriela Vélez, Laura Prosdocimi, Suzana Guimaraes
Poster Chairs	Ximena Vélez-Zuazo, Jane Provancha, Maike Heidemeyer, Celia Cáceres, Luciana Klinge
Proceedings Compilers	Jeffrey Mangel, ALan Rees, Mariela Pajuelo, Francisco Córdova, Nicolas Acuña
Social and Entertainment	Alejandro Fallabrino, Nicolas Acuña, Kerstin Forsberg, Nelly de Paz

TRAVEL GRANT COMMITTEE AND REGIONAL MEETING ORGANIZERS

Travel Grant Committee Role	Member
Chair	Alexander Gaos
Regional Chair - Africa	Angela Formia
Regional Chair – Caribbean (English speaking)	Karen Eckert
Regional Chair - Europe	Aliki Panagopoulou
Regional Chair – Mexico and Central America, Spanish-speaking Caribbean	Emma Harrison
Regional Chair – Middle East	ALan Rees
Regional Chair – South America	Alejandro Fallabrino
Regional Chair – South Asia	Andrea Phillott
Regional Chair –Southeast Asia/Pacific	Maggie Muurmans
Regional Chair – USA and Canada	Kelly Stewart

Regional Meeting Committee Role	Member
Africa	Manjula Tiwari, Andrews Agyekumhene, Jacques Fretey, Boniventure Mchomvu, Angela Formia
Caribbean (WIDECAST)	Karen Eckert
Freshwater Turtle and Tortoise	Chuck Shaffer
IUCN Marine Turtle Specialist Group (MTSG)	Roderic B. Mast
Indian Ocean & Southeast Asia (IOSEA)	Lalith Ekanayake
Latin America Meeting (RETOMALA)	Rocío Álvarez, Juan Manuel Rodríguez, Natalie Wildermann, Juan Pablo Muñoz, Maike Heidemeyer
Mediterranean	Paolo Casale
East Asia Meeting	Yoshimasa Matsuzawa

BOARD OF DIRECTORS AND THEIR END OF TERM

Raymond Carthy	2016
Paolo Casale	2016
Aliki Panagopoulou	2016
George Balazs	2017
Alejandro Fallabrino	2017
Roldan Valverde	2017
Pam Plotkin	2018
Emma Harrison	2018
Mariana Fuentes	2019
Alan Rees	2019
Andrea Phillot	2020
Laura Prosdocimi	2020
Ray Carthy (past President 2013)	2016
Roldán Valverde (past President 2014)	2017
Yakup Kaska (past President 2015	2018

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The International Sea Turtle Society gratefully acknowledges the generous financial support from the following organizations and individuals:

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Turtle Nesting Safe

CLS-Argos
Equilibrio Azul
Loggerhead Marinelife Center
Lotek/Biotrack/Sirtrack
ProDelphinus
SWOT
The Pacuare Nature Reserve
Turtle-Trax
WWF

ISTS AWARDS

Chair: Brad Nahill
Members: Blair Witherington, Thushan Kaparusinghe, Michael Jensen, Andrés Estrades

Life Time Achievement Award
Earl Possardt
Jeanne Mortimer
Dave Owens

Champions Award
ICAPO – Eastern Pacific Hawksbill Initiative

President's Award
Colin Limpus
Asociación Amigos de la Naturaleza

Ed Drane Award for Volunteerism
Debbie Sobel

STUDENT AWARDS

There were 50 oral presentations and 68 poster presentations entered by students in the Archie Carr Student Awards. The Program Chairs worked with the Student Award Chairs to minimize conflicting student presentation times, thereby ensuring all student presentations were seen by the judges, but we encourage future Program Chairs to liaise with the Student Award Chairs early in the planning process to minimize the requirement for last minute work by all parties. The Co-Chairs will, in future years, be more proactive in ensuring new Program Chairs are familiar with scheduling requirements early in the planning process.

Lunch for the judge's meeting was graciously provided by the ISTS, and we hope the BOD will continue to provide this in future years.

Judges of the presentations in Peru were:

Alan Rees, Ana Barragan, Brian Shamblin, Emma Harrison, Marc Girondot, Mariana Fuentes, Michael Jensen, Paolo Casale, Roldan Valverde, Wendy Dow Piniak, Ximena Velez-Zuazo, Yakup Kaska, Zoe Meletis

Award amounts: Winners = US $300 each, Runners-up = US $150 each. Total for all awards = US $1,800

Student Awards for Poster and Oral Presentations at ISTS36, Lima, Peru:

Category	Prize	Student	Institution	Presentation Title
Biology Poster (n=35)	Winner	Boris Tezak	Florida Atlantic University	Can sex-specific proteins in blood be used as a reliable method to identify the sex of sea turtle hatchlings?
	Runner up	Victoria Erb	Florida Atlantic University	The role of weather and sand moisture in shaping loggerhead sea turtle (*Caretta caretta*) hatchling growth and survival
Conservation Poster (n=33)	Winner	Callie Veelenturf	Indiana University-Purdue University	Human use and potential impacts to the green sea turtle (*Chelonia mydas*) in key in-water habitat of southeast Florida
	Runner up	Philippine Chambault	University of Strassbourg	Developmental habitat and migratory pathways: Key areas for the conservation of future breeding green turtles across the Caribbean-Atlantic region
Biology Oral (n=29)	Winner	Karen Pankaew	Florida Atlantic University	Physiological effects of disorientation loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) sea turtle hatchlings
	Runner up	Brianna Myre	Texas A&M University	Ovarian dynamics in free-ranging loggerhead sea turtles
Conservation Oral (n=21)	Winner	Kimberly Riskas	James Cook University	Illegal fishing and its impacts on sea turtles in Terengganu state, Malaysia
	Runner up	Michelle Cazabon-Mannette	University of the West Indies	The economic value of sea turtles to scuba divers in Tobago

OPENING REMARKS, PLENARY AND SPECIAL SESSIONS

OPENING REMARKS
Joanna Alfaro-Shigueto, President, International Sea Turtle Society
Sonia Valle, Decana, Universidad Científica del Sur
Gabriel Quijandria, Vice-Minister, Ministerio del Ambiente del Perú
Brian Nichols, Ambassador of the United States to Perú

MARINE TURTLES AT THE CROSSROADS: COMPLEX LIFE HISTORIES REQUIRING LOCAL, NATIONAL AND INTERNATIONAL ACTION FOR THEIR CONSERVATION
Guest Speaker: Colin J. Limpus
Queensland Turtle Research Project, Queensland, Australia

TEN LESSONS I HAVE LEARNED IN (MARINE TURTLE) CONSERVATION SCIENCE
Guest Speaker: Brendan J. Godley
Centre for Ecology and Conservation, College of Life and Environmental Sciences, University of Exeter, Cornwall Campus, Penryn, UK

ASO NETWORK
Chair: Laura Prodoscimi, Suzana Guinarães, and Gabriela Velez-Rubio

EASTERN PACIFIC SEA TURTLE
Chair: Bryan Wallace, Javier Quiñones, and Frank Paladino

EMERGING THREATS – CLIMATE CHANGE, OIL SPILL AND PLASTIC POLLUTION
Chair: Cathi Campbell, Matthew Godfrey, and Mark Hamann

TURTLES IN TIME
Chair: Jack Frazier

SPECIAL FEATURES

SPEED CHATTING WITH THE EXPERTS
Chairs: Emma Harrison and Zoe Meletis
Panel: Joanna Alfaro Shigueto, Bryan Wallace, Emma Harrison, Colum Muccio, Zoe Meletis, Andrea Phillot

FILM NIGHT
Chairs: Jorge Azócar, Bruno Monteferri, Florencia David

WORKSHOPS

TERRAPIN, TORTOISE AND FRESHWATER TURTLE MEETING
Organizer: Chuck Schaffer

MARINE TURTLE BYCATCH REDUCTION AND CONSERVATION: UNDERSTANDING AND DEVELOPING COLLABORATIVE RESEARCH CAPACITIES AMONG MARINE TURTLES CONSERVATIONISTS
Organizer: Tony Michel Nalovic

GIS WORKSHOP
Organizers: Andrew DiMatteo

EASTERN PACIFIC LEATHERBACKS WORKSHOP
Organizer: Velkiss Gadea & Bryan Wallace

PHOTO ID WORKSHOP
Organizer: Stephen G. Dunbar
Assistants: Jillian Hudgins & Claire Jean

MARINE MAMMAL WORKSHOPS
Organizers: Fernando Félix

SCIENTIFIC AND INTERNATIONAL CAPTURE OF SEA TURTLES WORKSHOP
Organizers: Daniel González-Paredes
Co-organizers: Ximena Velez-Zuazo & Luciana Kingle

SOUTH PACIFIC CARETTA (CMS) WORKSHOP
Organizers: Colin Limpus

6TH MEDICINE WORSHOP DURING THE 36TH ISTS SYMPOSIUM: CROSS ROADS …AND EXPERTISE!
Organizers: Daniela Freggi, Mariluz Parga & Antonio Di Bello

SOCIAL SCIENCE: SO YOU THINK YOU CAN SURVEY? WORKSHOP
Organizers: Zoe Meletis & Aliki Panagopoulou

ENVIRONMENTAL EDUCATION WORKSHOP
Organizers: Paula Salinas, Nelly de Paz & Gabriela Vélez-Rubio

TSD WORKSHOP
Organizers: Marc Girondot

SHARKS WORKSHOP
Organizers: Sebastián Hernández & Randall Arauz

GHOST GEAR WORKSHOP
Organizers: Martin Stelfox

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Anatomy, Physiology and Health

SEX RATIO OF GREEN TURTLE FORAGING GROUNDS IN THE PACIFIC: ESTABLISHING BASELINES FOR CLIMATE CHANGE RESEARCH*

Camryn D. Allen[1], Ian P. Bell[2], and Jeffrey A. Seminoff[1]

[1] *Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, La Jolla, CA, USA*
[2] *Marine Turtle Conservation, Threatened Species Unit, Department of Environment and Heritage Protection, Garbutt, Queensland, Australia*

In order to conserve endangered sea turtles, sex ratio and sex-specific survival rate data in foraging sites have been underscored as key information that is currently lacking. Sea turtles do not have sex chromosomes; instead, sex is determined by incubation temperature of the egg during embryonic development (warmer temperatures produce females). This strategy, known as temperature-dependent sex determination, is sensitive to changing climate temperatures, potentially leading to large changes in population demography. Physical sex differences are not perceivable until sexual maturity, making visual identification of immature turtle sex impossible. The two main techniques employed to determine sea turtle sex are laparoscopy or testosterone quantification. Laparoscopy is the ideal method for unequivocal sex determination, but requires invasive surgery. The collection of blood for testosterone measurement is less invasive and, therefore, more commonly used. Despite its potential, measuring testosterone (male turtles have distinctively higher testosterone concentrations) to determine sex has been applied at surprisingly few sea turtle foraging locations. Sex ratios were determined via a previously validated ELISA testosterone assay and laparoscopy (Australian foraging ground) at 3 green foraging locations [San Diego Bay, CA, USA; Long Beach, CA, USA; Howicks Group of Islands, northern Great Barrier Reef (nGBR), Australia]. All foraging aggregations were female biased with a greater bias towards females in the immature stage class. For example, the nGBR green turtle foraging aggregation sex ratio was 3.3F:1.0M among all immature turtles. Comparison of the results of the present study to previous studies of sex ratios of immature green turtles at foraging grounds worldwide found nearly no bias (Hawaii: 1.0F:0.96M and Bahamas: 1.4F:1.0M) or moderately to heavily female-biased populations (Malaysia: 4.0F:1.0M and Australia: 4.2F:1.0M). Additional sex ratio studies are being conducted worldwide for all species (except flatbacks) including 3 Kemp's ridley, 2 loggerhead, 2 leatherback, 1 olive ridley, 1 hawksbill, and 1 additional green foraging ground/s. Sex ratio data for foraging locations provides important baseline information for investigating the potential effects of climate change and consequential feminization of sea turtle populations.

PRELIMINARY RESULTS: COMPARATIVE ANALYSIS OF CONGENITAL MALFORMATION RATES BETWEEN TWO OLIVE RIDLEY NESTING COLONIES FROM MEXICAN PACIFIC

Annelisse Bárcenas-Ibarra[1], Michelle Elizabeth Dorantes-Palacios[1], Miguel Ángel Coyote-Tabaco[2], and Santiago Rabal Martínez[1]

[1] *Asociación Sudcaliforniana de Protección al Medio Ambiente y a la Tortuga Marina de Los Cabos, A.C., Mexico*
[2] *Universidad Autónoma Metropolitana, Mexico*

Any alteration during early development, caused by either genetic or environmental factors, can drastically affect embryonic processes or generate congenital malformations. Congenital malformations in sea turtles are relatively rare, and may indicate negative changes in their biology. While studies focusing on the conservation and protection of sea turtles have risen in recent years, only a few address malformations. Congenital malformation frequency for embryos and hatchlings of sea turtles ranges from 0.2% to 2%. A recent study of congenital malformation rates of three sea turtle species breeding on Mexican beaches has shown that the highest malformation frequency rates are occurring in the olive ridley (*Lepidochelys olivacea*). However, these results may be strongly affected by management strategies. Here we present preliminary results from detailed qualitative and quantitative analyses of congenital malformations based on external anatomy observations in hatcheries from two olive ridley nesting beaches on the north-western Mexican coast. We examined 123 olive ridley nests on the beaches of El Verde and San Cristobal during the 2012 and 2015 nesting seasons, respectively. At El Verde Beach, olive ridley eggs were transferred to a hatchery and incubated in temperature controlled rooms using styrofoam boxes. While nests from San Cristobal Beach were incubated in an open-air hatchery. Data recorded for each nest included: number of eggs, hatchlings (alive and dead), and eggs with or without embryonic development. Hatching and mortality levels were compared for nests with and without congenital malformations. Malformation frequency was evaluated with indices of (i) prevalence, as the proportion of eggs and nests with at least one malformation, and (ii) severity, as the number of malformations per organism and nest. Overall, El Verde Beach showed significantly higher mortality (including dead hatchlings inside the nest, eggs with obvious embryonic development, and eggs without obvious embryonic development) rates and lower hatching success than those observed at San Cristobal Beach. In both beaches, mortality in nests containing malformed organisms was significantly higher than in nests without malformations and therefore hatching success was significantly lower in nests with congenital malformations than those without. Comparison between beaches showed that mortality and hatching levels were significantly higher and lower, respectively, in nests with congenital malformations for El Verde Beach than from San Cristobal Beach. Prevalence was significantly higher in nests from El Verde Beach than those from San Cristobal Beach. No significant differences in severity were observed between beaches. Olive ridley nests from El Verde Beach seem more prone to the occurrence of congenital malformations than those from San Cristobal Beach. These differences could suggest an effect from intrinsic incubation factors in these nests, perhaps associated with the nesting female's health condition at each nesting beach. Whether the observed malformation levels are normal or represent a health problem cannot be currently determined without long-term assessments.

IMPORTANCE OF EPIBIONT REGISTRY COUPLED WITH THE MINIMUM CURVED CARAPACE LENGTH (CCLMIN) MEASUREMENT

Beatriz Brito-Carrasco[1], Raúl García Varela[1], Daniela Rojas-Cañizales[1], Jennifer Gooch[1], and Emma Harrison[2]

[1] *Sea Turtle Conservancy, Tortuguero, Costa Rica*
[2] *Sea Turtle Conservancy, San Jose, Costa Rica*

Since 1959, the Sea Turtle Conservancy (STC) has been working at Tortuguero. This beach is located on the north Caribbean coast of Costa Rica, and is the most important nesting site for green turtles (*Chelonia mydas*) in the Western Hemisphere. A long-term monitoring program of this nesting population has been conducted since the 1950s. Activities conducted during encounters with nesting females include; flipper tagging, collection of standard biometric data and an evaluation of the external physical condition of the turtle, which are all important aspects of the research program. The main objective of this study is to assess the prevalence of carapace epibionts (particularly barnacles) and their potential effect on the accuracy of the Curved Carapace Length Minimum (CCLmin) measurement of green turtles. The data were collected during the 2015 Green Turtle Program, which STC conducts from June to October. CCLmin was measured using a flexible tape measure, from the anterior point at midline (nuchal scute), where the carapace meets the skin, to the posterior notch at midline between the supracaudals. The CCLmin measurement is taken three times, to the nearest mm, by the same observer. Following the application of tags and the collection of carapace measurements, an external body check was performed to record any injuries, deformities or other physical anomalies. The presence of any barnacles on the carapace was registered, differentiating between those located along the midline of the carapace ("Barnacles affecting CCLmin") and those in other parts of the carapace ("Barnacles not affecting CCLmin"). Data from the turtles that were measured for CCLmin in 2015 were included in the study (n=1419), using only the first set of data for turtles encountered more than once and eliminating those individuals with unconfirmed identification. An initial analysis determined that 24% of turtles had barnacles present on their carapace. For those individuals with epibionts present, we calculated that 37% had barnacles along the midline, affecting the CCLmin measurement. When all individuals were included, with and without barnacles, we calculated that 9% of the turtles assessed in 2015 had barnacles along the midline that affected the measurement of the CCLmin. Other anomalies affecting CCLmin were notches, growths and deformities in the carapace, which combined affected 0.6% of all measurements taken. The presence of epibionts or carapace deformities can affect the accuracy of the CCLmin measurements, and the presence of barnacles was the most common cause for CCLmin imprecision in this study and may be a common cause for imprecision in CCLmin at other projects. This measurement is the most commonly used in sea turtle research programs worldwide and allows the comparison of measurements of individual turtles over the years (to assess growth rates) and also between different populations of the same species. The presence of barnacles might have been the cause of anomalous findings, such as turtles that appear to have grown significantly or even shrunk in length between successive encounters, and populations with high indices of barnacles might be susceptible to a greater impact as a result. Therefore, the importance of recording the presence of all carapace epibionts at the moment when morphometric measures are taken should be emphasized and be encouraged as a standard component of the data collection process. Also, further studies of the level of impact that barnacles have on the CCLmin measurement should be conducted.

A MORPHOMETRIC COMPARISON OF TWO SPECIES OF SYMPATRICALLY OCCURRING IMMATURE MARINE TURTLES INDICATES DIFFERENT EARLY EVOLUTIONARY STRATEGIES

Christina Marie Coppenrath[1], Yolanda M. Leon[2], and Michael Salmon[1]

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As hatchlings and post-hatchlings, marine turtles are vulnerable to a wide variety of marine, terrestrial and aerial predators. Throughout their early stages of growth, different sea turtle species display a variety of strategies to reduce their predation risk. In some species, small post-hatchlings hide from potential predators by associating with Sargassum and other flotsam that accumulates on the ocean surface. Some small turtles are also counter-shaded, which may make them more difficult to detect by predators from both above and below. In addition to these strategies, changes in shape and the development of defensive structures (spines, serrations) may also make small turtles more difficult or dangerous to handle by their predators. We compared and contrasted differences in the growth and defensive morphology shown by immature hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) sea turtles, occurring sympatrically in a foraging habitat in the southwestern Dominican Republic. We documented three major differences between the species. (i) At a given straight carapace length (SCL), green turtles were proportionally wider in carapace width (SCW) than hawksbills. (ii) At a given SCL, green turtle body depth exceeded the body depth measurements made on hawksbills. (iii) At a given SCL, hawksbill turtles possessed sharp, posteriorly-oriented spines on the edge of their marginal scutes. Those spines are absent in green turtles. These differences in growth pattern and resultant carapace morphology suggest that the two tribes of marine turtles (Carettini, represented by the hawksbill; Chelonini, by the green turtle) have, since their separation ~ 30 MYA, evolved different behavioral and morphological strategies to reduce the impact of their predators.

HEAVY METALS AND OXIDATIVE STRESS BIOMARKERS IN OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) TURTLES FROM "LA ESCOBILLA" BEACH, OAXACA, MEXICO*

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The IUCN Red List classifies olive ridley turtles (*Lepidochelys olivacea*) as "vulnerable". In Mexico, all marine turtles are considered endangered species within the regulation norm NOM-ECOL-059-2010 and have been made a priority for conservation. One of the main threats that have led turtles to this point is pollution; among them, trace elements, especially cadmium (Cd), lead (Pb), arsenic (As) and selenium (Se), are the most studied due to their high risk of toxicity. These elements are widespread in the aquatic environment as a result of industry, mining and discharges of wastewater. Olive ridleys from "La Escobilla" (one of the most important beaches in the world for its "arribada" events) have been previously reported with the highest Cd concentrations worldwide for all sea turtle species. Oxidative stress refers to the imbalance between the production of reactive oxygen species (ROS) and the antioxidant defenses in the organisms. These ROS are oxygen-derived molecules with strong oxidative properties. It has been demonstrated in in-vivo and in-vitro works that ROS have the potential for damaging proteins, lipids and nucleic acids, causing tissue damage, metabolic dysfunction and apoptosis cell death. Due to the relationship between molecular indicators of oxidative stress and environmental xenobiotics (e.g. heavy metals), the use of these indicators, such as superoxide dismutase (SOD) and catalase (CAT), are considered an important tool as biomarkers of pollution exposure. On the other hand, metallothioneins (MT) are among the most important proteins in protecting cells against heavy metal toxicity (especially Cd, Cu and Zn), and therefore serve an important role in protecting the cell from free radical mediated injury and reducing oxidative stress. In wildlife, establishing contaminant concentrations is usually done through biomonitoring. However, to assess the risk that pollutants can actually pose to individuals, it is imperative to plan ahead and attempt to set up different biomarkers (either of exposition, effect or susceptibility) in order to establish whether or not a particular pollutant could be a threat to the health of specific species. In order to explore this further, we first needed to establish whether oxidative stress biomarkers and MT are useful tools in olive ridley turtles as well as in other species. Due to the lack of information existing about SOD, CAT and MT in *L. olivacea* related to heavy metals, the aims of this work were (1) partial sequence of the genes of SOD, CAT and MT from *L. olivacea*, (2) assess gene expression of these biomarkers in liver and kidney by real-time PCR, (3) measure SOD and CAT enzyme activity in the same organs, (4)

assess heavy metal concentrations, and (5) explore if there exists any correlation between gene expression, enzyme activity and heavy metal concentrations.

BIOCHEMICAL PARAMETERS AND INORGANIC ELEMENTS IN *LEPIDOCHELYS OLIVACEA* FROM "LA ESCOBILLA BEACH, OAXACA, MEXICO

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Serum biochemistry is commonly used as a diagnostic technique to assess health in wild and domestic animals. These parameters vary depending on species, gender, age, diet, pathological processes and analysis techniques. Due to all these variations, it is not easy to establish normal parameters for marine turtles and it is recommended to have a database by species and by population. This database would then provide indications of health, diseases, nutrition and even habitat quality. This information would help to make a better assessment on the health of different populations and also to serve as an important tool to diagnose and provide veterinary care of rescued animals. Among the different causes that can alter the health of marine turtles, as with other species, are pollutants. Among the most studied pollutants, due to their toxicity, are heavy metals. These elements are natural components of the earth's crust, but their multiple anthropogenic use in industrial, domestic, medical, agricultural, mining and electronic applications have led to their wide distribution in the environment. Due to their toxicity risks, cadmium, lead, arsenic and chromium are among the most studied metals. There is little existing information for olive ridley turtles from "La Escobilla" (one of the most important beaches in the world for this species) on this subject. The aims of this work were: to establish biochemical parameters that could be affected by pollutants in turtles (n=100); to assess heavy metal concentration in whole blood of the same individuals, and to make correlations between biochemical parameters and heavy metals.

IDENTIFICATION OF A NOVEL INTERMEDIATE HOST TRANSMITTING BLOOD FLUKES (SPIRORCHIIDAE) IN CAPTIVE SEA TURTLES*

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Blood flukes are considered one of the most severe causes of natural pathology in sea turtles. Marine spirorchiid trematodes have been reported as a cause of many strandings and death in turtles but no complete life cycle description has been reported until now. Diversity of habitats utilized by marine turtles and the vast number of possible intermediate hosts within those environments have presumably made elucidation of these life cycles difficult. Gastropods have been postulated as the most likely intermediate hosts; all known spirorchiid life cycles of freshwater turtles infect gastropods. We report for the first time a vermetid gastropod as an intermediate host in the life cycle of a marine spirorchiid. A complete life cycle has been verified in a group of loggerhead sea turtles (*Caretta caretta*) from a head-starting program suffering from spirorchidiasis in a Rehabilitation Center at the Oceanogràfic in Valencia, Spain. A spirorchiid infection was detected by histopathology in a group of loggerhead sea turtle neonates (5 months old) after a mortality outbreak. Spirorchiid eggs were also found in parasitological fecal exams from live individuals as well as from tank bottom aspiration. Four snail species were detected in the rehabilitation facilities, three of them microscopic and located in base of the tank and a fourth macroscopically detectable inside the pipes of the life support system. Several specimens of all four-snail species were monitored for cercariae emergence and micro-dissection was performed seeking trematode infection. A high prevalence (90%; 45/50) of infected snails was found in just one species, a vermetid. Infections comprised sporocysts and characteristic ocellate furcocercous cercariae. Comparison of 28S rDNA sequences suggests that the spirorchiid is a species of Amphiorchis. This finding represents important progress in the understanding of natural disease in marine turtles, including host-parasite interaction and epidemiology, and will inform future control of spirorchiidiasis in turtle rescue centers. In addition, this is the first report of spirorchiid infection in sea turtles from the Mediterranean Sea.

PHYTOTOXINS ASSOCIATED WITH MORTALITY IN SUBADULT BLACK TURTLES (*CHELONIA MYDAS AGASSIZII*) IN MICHOACAN, MEXICO

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The sources of mortality in most sea turtle species have been evaluated in nesting beaches and in some areas of supply, however, the sources of natural mortality in the marine environment are not well known because of logistical challenges. Harmful algae are a threat to human health as well as for marine turtles

particularly in the tropical zone of the planet. A harmful algal bloom (HAB) is a massive increase in the number of phytoplankton cells; these blooms can result in depletion of oxygen or nutrients from the water that are essential for others species, and thus affect aquatic biota. They can also cause physical harm to other organisms (blockage of gills) and/or cause poisoning through the production of chemical substances (toxins), altering physiology. There have been reports of turtle mortalities associated with harmful algal blooms from the mid-twentieth century in the Indian Ocean (Sri Lanka). There the poisoning and death of people is documented associated with consumption of turtle meat (termed Chelonitoxication). Over the months of November and October 2010 an unusual stranding event of black turtles (*Chelonia agassizii*) was reported at the main nesting sites of the Coast of Michoacán. Visits were made to the waters and nesting beaches to identify the location of these individuals and to collect water and salps samples. A total of 376 individuals, dominated by breeding adults, were recorded. The signs that the sick individuals presented coincided with the symptoms associated with neurotoxin poisoning produced by phytoplankton during harmful algal blooms. In tested blood we identified saxitoxin and neosaxitoxin present 0.32 ug STX / STX 100 g 1.22 g / 100 g STX 0.08 ng / ml to 0.17 ng STX / ml, lower than those levels reported in other studies, however, saxitoxin levels are greater than the minimum lethal dose to human of 0.5 mg. In the water samples and in stomach contents of black turtles, we found *Salpa maxima* (Thaliacea), which form large chains, and some toxic dinoflagellate identified as *Pyrodinium bahamense* and *Alexandrium* sp. These dinoflagellates produce two neurotoxins: saxitoxin and neosaxitoxin. The main cause of the mass mortality of black turtles off the coast of Michoacan was caused by ingestion of salps that filter water accumulated in significant amounts of phytotoxin that accumulates in the pellets of excrement inside the bodies of salps.

THE USE OF ESOPHAGOSTOMY TUBE IN THE REHABILITATION OF SEA TURTLES IN CRITIC CONDITIONS: EXPERIENCES ON 75 LOGGERHEADS (*CARETTA CARETTA*) IN SOUTH ITALY*

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From 2011 to 2015, in 75 loggerhead turtles with anorexia or severely debilitated conditions by trauma or hook and line ingestion, an esophagostomy tube was set up to provide a controlled feeding during the recovery period. The anesthetic protocol has always been chosen based on the patient's general condition. Depending on the size of the turtle, we used Levin tubes with a caliber of 4 to 8 mm and a length of 125 cm; for turtles of more than 40 kg we used clear 10-12 mm PVC non-toxic tubes. It is important in advance to mark on the tube the distance from the surgical breach to the external projection of the stomach on the plastron in order to understand the exact length of the tube to insert in the patient. Compared to the previously described procedure by the same authors, we have made some substantial changes to the technique for inserting the tube. In fact, the tube was inserted through the incision of the esophagus, taking care to exteriorize the organ by two or three sutures so as to distend the intracoelomatic portion of the esophagus and to facilitate the progression of the probe. To prevent the folding of the tube within the esophagus or to make it easier to overcome the esophagogastric sphincter, a PVC rigid stylet can be inserted in the tube. Once assured to have reached the stomach, the tube was attached to the wall of the esophagus with interrupted horizontal mattress sutures. The tube was further secured to the skin with finger sutures

using large caliber non-absorbable monofilament material. The proximal end of the tube was rotated dorsally on the shell and fixed to the body of the animal with a self-adhesive elastic bandage and well closed by a stopper or syringe of appropriate caliber. The animals were fed daily with highly energetic fish meal used in aquaculture, in increasing quantities from 1 to 5 percent of body weight. The consistency of the food in the liquid solution has allowed an easy administration without stress for the patients that during the procedure could remain in their tanks. In addition, the high level of energetic contents of this type of food had a positive effect on recovery time. This procedure has improved recovery of 92% of treated subjects that in a time ranging from 3 to 8 weeks have resumed the spontaneous feeding and a consequent rapid increase of weight, supporting a faster recovery of health conditions.

EPIBIONT DIVERSITY IN *LEPIDOCHELYS OLIVACEA* FEMALES ON TWO BEACHES OF THE MEXICAN TROPICAL PACIFIC

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Large marine vertebrates such as whales and sea turtles host a variety of organisms, called epibionts, including barnacles, crustaceans, molluscs, algae and even some vertebrates such as remoras, generating true ecosystems that travel through the ocean. For turtles, these organisms adhere and colonize both hard surfaces (head and shell), and soft surfaces, mainly in the neck, adjusting to live on another living being, developing a process called epibiosis. From the ecological point of view, the principal relationship established between turtles and epibionts is the use of turtle body surface, both skin and shell, as a substrate for larval settlement and as a means of obtaining food and dispersion. Several studies have used the epibionts as a tool to understand the ecology of their hosts, their migration routes, or as biogeographic indicators. Also, epibionts may indicate specific environmental conditions in which the turtles are developed during some stage of life. In recent years, Mexico has developed much research on the biology and ecology of sea turtles, but epibiosis has been poorly documented. This study analyzes the diversity and distribution of epibionts between two populations of *L. olivacea* females which nest on beaches in the state of Jalisco and Guerrero, in the Mexican Tropical Pacific. In the state of Jalisco, collections were made at Playon de Mismaloya Marine Sanctuary during the seasons 2004, 2006 and 2007; while in Guerrero, collections were made at Playa Ventura in the seasons 2014 and 2015. Epibionts were directly detached from the turtle's hard parts (shell and plastron) also skin and scales (flippers, neck, cloaca) of nesting females. *L. olivacea* females sampled in Jalisco and Guerrero totaled 446; only 261 had epibionts, representing 58.5%. Fourteen taxa of epibionts were identified, which were included five major groups: cnidarians, annelids, arthropods, chordates, and algae. The most abundant was the amphipod *Podocerus chelonophilus*, followed by barnacles *Lepas hillii* and *Conchoderma virgatum*, the cirripeds *Stomatolepas elegans* and leeches *Ozobranchus branchiatus*. On turtles that nested in Guerrero were hosted 3 epibionts, 2 crustaceans and filamentous algae, which were not found in turtles that nested in Jalisco. These included: *Balaenophilus* sp., *Elasmopus rapax* and filamentous algae in the Rodophyta. Females which nested in

Jalisco had 5 epibionts which were not found in Guerrero´s females: jellyfish, Balanus, barnacles, crabs and fish. Regarding distribution of epibionts on the bodies of females (hard and soft parts), *Ch. testudinaria* dominated the shell while *O. branchiatus* dominated over the neck and flippers of *L. olivacea* females.

GENOMIC VARIATION OF CHELONID FIBROPAPILLOMATOSIS-ASSOCIATED HERPESVIRUS CFPHV AMONG THREE DIFFERENT FLORIDA SEA TURTLE SPECIES*

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Fibropapillomatosis (FP), a debilitating neoplastic disease of panzootic proportions, is a significant threat to endangered and threatened sea turtle populations. The disease manifests as tumors that can reduce vision, limit feeding ability, decrease capacity for predator avoidance, and interfere with the buoyancy and hydrodynamics of sea turtles, contributing to stranding and mortality events. The etiological agent is most likely the chelonid fibropapillomatosis-associated herpesvirus (CFPHV); however, numerous attempts to culture this virus have failed, hindering efforts to better understand its role in FP. Further complicating the investigation of FP is the ability of herpesviruses to become dormant, or latent, within the host, creating lifelong infections. Sequence analysis of the CFPHV genome provides another opportunity to elucidate the molecular mechanisms of pathogenesis. Currently, the only CFPHV genome available was sequenced from the glottis tumor of a Hawaiian green sea turtle using the BAC clone system. Previous phylogenetic analyses have revealed the existence of CFPHV variants whose sequences cluster by geographic locations. This is concordant with the distinct ways that FP manifests in different locations and species. To gain further insight into the geographic and species-specific genomic variants of CFPHV, this study sequenced the CFPHV genome from green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), and loggerhead (*Caretta caretta*) sea turtles from Florida. Using the Hawaiian green sea turtle CFPHV genome as a scaffold, long range polymerase chain reaction (LR-PCR) combined with next generation sequencing (Illumina MiSeq) of amplicons was used to sequence CFPHV from the tumors of three Florida sea turtle species. The sequenced amplicons were then assembled and compared to the Hawaiian genome as a scaffold to identify conserved and variable regions. Initial results indicate significant nucleotide variations between the different species. The newly sequenced genomes will be used to create an updated phylogeny comparing CFPHV across multiple locations and species, providing insight into the role genetics plays in the manifestation of FP. Additionally, the identification of CFPHV oncogenes, and genes that are involved in modulating latency may have important implications for management and treatment of FP.

SEXUAL DIMORPHISM IN *LEPIDOCHELYS OLIVACEA**

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There are several hypotheses for the evolution of sexual dimorphisms, especially in size. Darwin hypothesized that selection for higher fecundity would lead to larger females. Another hypothesis is that sexual selection and male-male competition would result in larger males. Lastly, ecologists have proposed that sexual size dimorphism could have evolved to permit possible niche divergence resulting in different diets between males and females to avoid food competition. Sexual dimorphism in sea turtles has been scarcely explored in-depth in the past. Previous studies in green, hawksbill, and loggerhead turtles have concluded that sexually mature males are in general significantly smaller in size than females with respect to shell dimensions. Two previous morphometric studies on mature male and female olive ridley turtles came to contradicting conclusions concerning morphological differences between females and males. Pritchard (1969) did not see a difference in size between breeding males and females, but did not analyze traits statistically and did not analyze any traits other than shell dimension. Frazier (1983) concluded that males are longer, but females are more voluminous, but his study had limited male sample size (n=18). Additionally, barely any study has measured morphological traits other than shell dimensions to determine divergences in morphology based on sex. The present study compared 16 morphometric traits of 149 (males n=76, females n=73) breeding *Lepidochelys olivacea* from Costa Rica's Pacific coast. Morphometric traits measured were: curved carapace length, curved carapace width, plastron length, shell circumference, tip to plastron tail length, tip to vent tail length, length of both front and rear flippers, length of both front and rear claws, head width, and weight. The morphological traits were analyzed using a principal components analysis to correct for differences due to allometry and an ANOVA to statistically determine differences in size and shape between the sexes. The results were interpreted in light of the trait functions in the differing reproductive behaviors of males and females. Traits related to shell dimension and general body form showed no significant difference in size, but there was a difference in shape, which was mainly due to a significantly shorter plastron in males and higher mass in females. The first might have evolved to aid males mounting the female and the latter could have evolved to increase the space for eggs and results in higher fecundity in females. Traits related to body appendages showed a significant difference in size, with males having longer appendices, but not in shape. The tail and claws were significantly longer in males than in females; the long male tail relates to mounting by positioning the penis close to her cloaca once mounted and may deter dislodgement by other courting males. The only appendages that were significantly longer in females than in males were the rear flippers, which females use to excavate egg chambers. The front flippers in males and females did not differ in size or shape, which could be explained by a strong functional constraint on this specific trait because the front flippers are the most important component for locomotion in sea turtles.

ASSESSING THE TOXIC EFFECTS OF ORGANIC AND INORGANIC CONTAMINANTS IN MARINE TURTLES USING CELL-BASED TOXICITY ASSAYS*

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The long-lived nature of marine turtles and their widespread use of coastal foraging grounds can result in high exposure to organic and inorganic contaminants from urban, industrial and agricultural sources. In fact, organic and inorganic contaminants have been identified in all species of marine turtles worldwide, making these animals important indicators of pollution in marine systems. However, very little is known about the impacts of these contaminants on marine turtle health. To date, the effects of relatively few contaminants have been investigated for a small number of toxicological endpoints, driven largely by the logistical and ethical constraints of conducting direct exposure experiments on these large, protected animals. Due to the seemingly infinite number of contaminants that could be accumulating in marine turtles, it is important to further investigate the toxic effects of a larger number of contaminants for a wider variety of endpoints. This will provide valuable information for identifying marine turtle populations at risk. Recently, in vitro (or cell-based) exposure experiments using cell lines established from turtle tissue have been proposed as an ethical, reproducible, cost-effective method to identify effects of environmental contaminants in threatened species of marine turtles. Using marine turtle primary skin fibroblast cell lines, this study investigated the toxicity of organic and inorganic compounds that are known to accumulate in marine turtles. A number of toxicological endpoints were assessed, such as cytotoxicity and oxidative stress, providing great advances in our understanding of the effects of environmental contaminants on marine turtle health. This will allow more robust and meaningful risk assessments to be conducted for marine turtles, assisting conservation and management strategies worldwide. Our results also support the use of marine turtle cell cultures as an ethical and reliable method for investigating toxicological effects of environmental contaminants.

FUNCTIONAL MORPHOLOGY OF TWO SPECIES OF SEA TURTLES

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Functional morphology is the study of the relationship between anatomical and ecological diversity in terms of biomechanical ability. One of the main functions of any organism is feeding; this process requires the anatomical and functional integration of several components and the analysis of the feeding system using morphometric and biomechanical approaches improves our understanding of how the diversification of craniomandibular morphology is linked to ecological divergence in feeding performance. Within the performance, bite force is an important measure that is related to a variety of ecological challenges. One of

the highlights of the feeding function in sea turtles, as a group, is its highly diversified feeding habits. By assessing the functional morphology of sea turtles, we can analyze the link between cranial shape changes, dietary variations and bite force. Here we applied a combination of three techniques: linear morphometrics, geometric morphometrics and biomechanical models, to test the craniomandibular morphology and patterns of trophic diversity from a functional point of view in two sea turtle species. We describe the sea turtle craniomandibular shape diversity as a way to link morphology to ecology via biomechanics. Taking into account that the west coast of the Baja California Peninsula has been considered one of the main feeding areas for several sea turtle species, we make comparisons between *Caretta caretta* and *Chelonia mydas*, which feed in this area mainly during their juvenile stage. During this period, these species are omnivorous feeders, which gradually changes as they grow. When they reach adulthood, they adopt completely different feeding habits: *C. caretta* develops carnivorous habits and specializes on hard preys such as corals and molluscs. *C. mydas*, however, develops herbivorous habits. There is a relatively extensive knowledge of food components for these organisms. However, to date few studies have analyzed variations in craniomandibular shape in sea turtles, that take into account that the sources of variation could be inter- and intra-specific. Considering the above, the main objective of this study was to assess if there is a correspondence between morphological features of the craniomandibular system of two sea turtle species with completely different trophic modes during adulthood: crushing vs. browsing. To achieve this objective, we 1. Performed dissections on the heads of specimens, 2. Collected linear measures of specific anatomical structures, 3. Collected functionally important anatomical landmarks to sea turtles relative to feeding from digital images, 3. Quantified the shape diversity of the two species using geometric morphometric techniques and 4. Used a computer model to predict the biomechanical performance and the bite force of the craniomandibular system of sea turtles, based on the relative positions of these landmarks.

ECG IN *CARETTA CARETTA*: PRELIMINARY PARAMETERS UNDER STANDARD CONDITIONS, SEDATION AND ANESTHESIA

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Clinical and surgical procedures on sea turtles require species-specific parameters for monitoring during anesthesia. The aim of this study was to evaluate the electrocardiogram (ECG) of loggerheads (*Caretta caretta*) in standard conditions and under the effect of common anesthetic drugs, such as medetomidine, propofol and isoflurane. The electrical heart activity was recorded in lead II. All the subjects were divided into groups according the administered drug. The ECG in standard conditions showed a mean heart rate of 26 bpm, mean P wave duration of 0.2 sec and mean P wave amplitude of 1.73 mV. The Q wave has never been observed. The R wave was often notched and showed a mean duration of 0.2 sec and a mean amplitude of 2.7 mV. The R wave was commonly followed by a negative deflection compatible with a S wave. The T wave was recorded upright, inverted and biphasic. Acquired data are useful to set the reference range for the ECG of loggerheads. After the administration of medetomidine, a constant and remarkable bradycardia was registered, followed by elongation of the QT interval. Following the administration of propofol, the heart rate increased only if the subject was under the effect of medetomidine, while for non-premedicated subjects no alteration was recorded. The administration of isofluorane showed no significant change in

heart rate and ECG. These results suggest interesting considerations that need further investigations on the electrical activity of the heart in sea turtles.

EVIDENCE OF NEURAL TROPISM BY CHELONID HERPESVIRUS-5 IN *CHELONIA MYDAS*

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There are important consequences regarding the ability of the herpesvirus to establish latent infections: the host becomes a vessel for the virus, often for an extended period or for life. The virus can be reactivated at certain times, particularly under conditions of stress or immunity reduction, and the carrier then begins to eliminate the agent. There are also cases in which the agent may develop severe clinical situations on the tissues establishing its latency, particularly in the nervous tissue. Some nerve syndromes are related to the herpesvirus: viral ganglioneuritis in abalone (*Haliotis laevigata*, *H. rubra* and *H. diversicolor supertexta*) caused by AbHV (abalone herpesvirus); encephalitis in horses, caused by EHV (equid herpesvirus); inflammation in nerve tissues, including the brain, by infection with Varicella-zoster virus (HHV-3) in humans. The relationship between HSV-1 and Alzheimer's disease has recently been demonstrated in humans, demonstrating the importance of understanding the biology of herpesvirus in the nerve tissue. In this study six juvenile animals (CCC between 30 and 50 cm) that died in Espirito Santo were necropsied, and brain, skin and tumors samples were collected for detection of the CFPHV. The results showed the agent's presence in the brains of the 5 animals. The presence of the virus was also detected in tumors on 3 of them with fibropapillomatosis. One of the animals presented nervous symptoms, with low blink reflex. DNA polymerase sequences of CFPHV obtained from the analysis of the electropherogram suggest that 5 of these animals could present multiple infections by more than one viral variant. In one animal, it was possible to detect a single variant in the brain, skin, and tumor, and the sequence of 483 bp obtained in this analysis revealed a new variant on the Brazilian coast with high identity with variants detected in Puerto Rico and Gulf of Guinea. These findings suggest that the virus establishes latent infections in the brain of *Chelonia mydas* and that this species can carry the agent over long distances. The haplotype green turtles CM-A5, CM-A8 and CM-A10 were identified, also demonstrating that CFPHV can infect animals from different reproductive areas. Acknowledgments: The authors wish to thank the Tamar/ICMBio. This study received financial support from the Foundation for Research Support of the State of São Paulo (Fundação de Amparo à Pesquisa do Estado de São Paulo – FAPESP; Process 2012/14319-6) and the Coordination

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FATAL CITROBACTER SEPTICEMIA IN A JUVENILE GREEN TURTLE (*CHELONIA MYDAS*): A CASE REPORT

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Infections in sea turtles are almost always the result of immunosuppression and are often associated with captivity-stress. Gram-negative bacteria are the most common bacterial pathogens among sea turtles, which is not surprising since gram-negative bacteria are common isolates in healthy reptiles. This report describes the post mortem lesions in a juvenile green turtle (*Chelonia mydas*) that died during rehabilitation due to a severe celomitis. On November 12th, 2014, a juvenile green turtle was rescued by Projeto Tamar (Brazilian sea turtle conservation program) after stranding on Jurerê beach, Florianópolis, Santa Catarina State, Brazil. On admission, the animal measured 60 cm curved carapace length, 52.5 cm curved carapace width, and weighed 14.92 kg. The turtle exhibited signs of cachexia, dehydration, lethargy, anaemia (PCV 12%), positive buoyancy and it was covered with leeches and barnacles. The initial treatment consisted of ceftazidime (20 mg/kg IV), clindamycin (5 mg/kg IV), injectable vitamin supplement and intravenous fluids. Death occurred three days after initial supportive care and a complete necropsy, following a standardized protocol, was performed on the turtle, revealing a severe generalized celomitis, with multiple cystic structures and bulky caseous masses of different sizes, throughout the serous tissues of the coelomic cavity and following organs: liver, lungs, stomach, large and small intestines, ovaries, oviduct and urinary bladder. On cut the cystic structures had a typical onion appearance, with a fibrous layer lining it and multiple concentric laminated layers in its interior. Tissue samples were collected and fixed in 10% neutral formalin solution and sent to the Laboratory of Animal Pathology, in northern Rio de Janeiro State University Darcy Ribeiro (UENF). Swabs were taken from the contents of the cysts / masses and sent to a private laboratory, in Florianópolis, named Citovet©. The histological analysis revealed an inflammatory response characterized by a dense eosinophilic exudate, containing large numbers of heterophils. The cystic structures had a fibrous layer lining it and multiple concentric laminated layers of keratin in its interior. On the other hand, the caseous masses (abscesses) also had a fibrous layer lining it, but a solid material of cheeselike consistency in its interior. Bacterial colonies were seen as thin basophilic granules within the abscesses and cysts. Two species of bacteria were isolated from the swabs: *Citrobacter freundii* and *Citrobacter amalonaticus*. Our results indicate that the turtle died from acute septicemia associated with *C. freundii* and *C. amalonaticus*. No evidence of clinically relevant infection by any other pathogens was found in the present case. Unfortunately, the source of infection remains unknown. Although we cannot

positively determine whether these bacteria were primary pathogenic agents or secondary invaders, it seems likely that they are capable of producing disease in sea turtles.

HISTOPATHOLOGICAL SURVEY OF LATE STAGE EMBRYONAL MORTALITY IN LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*) IN ST KITTS, WEST INDIES

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Critically endangered leatherback sea turtles (*Dermochelys coriacea*) have a low global hatch success of 50%, hence, protection of eggs and successful hatching are critical for population recovery. The aim of our research is to identify factors associated with embryonic death. In St. Kitts, hatch success typically averages from 5-10%. The Caribbean, as a whole, has a 49.14% success rate, based on studies conducted in Tobago, Costa Rica, and St. Croix, indicating St Kitts' success well below average. Determination of embryonic development was categorized by either early or late stage development. Early stage was denoted as any stage of development from an eyespot to a dead embryo smaller than the yolk sac, whereas late stage development was noted as larger than the yolk sac. Our studies showed that there was 5.8% early stage death, and 6.2% late stage death. In 2015, postmortem examinations were performed on twenty-five late stage embryos collected from 10 nests, representative of the two main nesting beaches in St Kitts. Occasionally embryos were observed to have miliary white nodular foci in the lungs. Otherwise, no gross abnormalities were observed. Histopathological evaluation revealed pneumonia affecting the majority of late stage embryos across both beaches. Pneumonia ranged from mild to severe, was predominately heterophilic, although there were cases with heterophilic granulomas, and the pattern varied from embolic to interstitial to bronchopneumonia. A minority of cases contained intralesional bacteria. Aerobic and anaerobic cultures failed to identify a predominant isolate. Factors predisposing to fetal bacterial pneumonia could include maternal flora, putrefaction of the nest environment, abnormal development of the fetal immune system, immunosuppression due to pollutant exposure, and primary viral infection. Further study is warranted to determine the impact of pneumonia on hatch success in Leatherbacks in the wider Caribbean region.

NOVEL APPROACHES TO DETERMINE IF EXPOSURE TO COASTAL POLLUTANTS ARE ADVERSELY AFFECTING GREEN TURTLE HEALTH AND ITS POPULATIONS OF THE GREAT – PRELIMINARY FINDINGS*

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The current condition and outlook of the Great Barrier Reef (GBR) in Queensland, Australia is poor. With the threat of its World Heritage status being downgraded to 'in danger', coastal development and poor water quality continues to be recognised as the biggest threat to the GBR. Since 2010, unexplained mass stranding mortalities, high incidence of disease and poor health has been observed in green sea turtles (*Chelonia mydas*) from several GBR locations. Although suspected causes include poor water quality and pollutants, the toxicological and causal link between a wide range of coastal pollutants from land and marine based sources and the health of marine wildlife is poorly understood. As proposed, sentinel indicators of environmental health and internationally endangered green turtles are ideal models to determine the effect of exposure to complex chemical mixtures on their health, survival and biological function. Displaying strong site fidelity and a low trophic status, chemical exposure and health of subadult green turtles is expected to closely reflect the suite of chemicals present in local sediment, seagrass and water. The aim of the four-year Rivers to Reef to Turtles epidemiological project is to investigate associations between coastal pollutants and turtle health. In the first year, the study characterized the chemical exposure of external (water, sediment and seagrass) and internal (turtle blood and scute) samples, and evaluated green turtle health in three northern GBR sites: Upstart Bay (agriculturally influenced; 2012 mass stranding), Cleveland Bay (industrial/urbanised) and Howick Group of Islands (control; where pollutant input is low or absent). A total of 1131 turtles were caught and assessed at the three sites for demographic, body mass index, and general health information with a subset evaluated for clinical pathology in comparison to established hematology and blood biochemistry reference ranges. As opposed to targeting a small set of selected pollutants, subadult blood and scute samples were analyzed using a novel approach that combines in vitro cell based bioassays and a range of organic chemical and trace element analytical screening methods to evaluate chemical exposure. Sediment, seagrass and water samples were also analyzed using both non-target organic chemical and targeted trace element analysis. Preliminary results show significant differences in: (1) chemical mixture profiles in the water, sediment, green turtle blood and scutes at each site; and (2) the clinical health status of the three turtle populations. Initial results also indicate the possible presence of

metabolites that relate to oxidative stress, consistent with elevated white cell counts detected in both the agricultural and urbanised sites. Further investigation is needed to examine possible links between chemical exposure and systemic stress related responses. To address this, future research will focus on determining the toxicokinetic distribution and toxicodynamic effect of pollutants. This project will contribute to the establishment of baselines for pollutant exposure in green turtles, and in the long term, establish novel and cost-effective bio-monitoring tools and approaches that can be used to look at cause and effect of coastal pollutants on the health of marine turtles and their inshore habitats.

ORIENTATION AND BEHAVIORAL RESPONSES OF HATCHLING LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) TO ENVIRONMENTAL ACOUSTIC CUES

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Although the visual and geologic orientation cues utilized by sea turtle hatchlings during seafinding, when they move from the nest to the sea after hatching, have been well studied, the potential for auditory stimuli to act as an orientation cue has not been well explored. Over the past several decades our knowledge of the auditory capacity of sea turtles has increased greatly, yet little is known about the biological significance of this sensory ability. To investigate whether hatchlings can use ocean sounds during seafinding, we measured the behavioral responses of hatchling loggerhead sea turtles (*Caretta caretta*) collected from nesting beaches in North Carolina to the presence of beach wave sound recorded on a nesting beach during the summer of 2015. The highest sound energy of beach waves occurs <1000 Hz, which overlaps with the most sensitive hearing range of loggerhead hatchlings (range of frequency detection: 50-1600 Hz, maximum sensitivity: 50-400 Hz). In our experiment, we placed turtles in a V-maze that isolated them from visual, vibratory, and chemical cues. One end of the V held a speaker producing beach wave sounds recorded from nesting beaches, while the other end held sound-reducing foam. To minimize sound reflections from the sound side of the maze, we encased the V-maze in sound-reducing foam. Turtles were inserted into the middle of the V and given 5 minutes to crawl toward or away from the sound. To reduce biase we alternated the sound and no sound side of the maze between trails, and to ensure hatchlings did not exhibit preference for one side of the maze we conducted control trials in which the speaker was present, but no sound was played during the trial. We examined the phonotaxic behaviors of the hatchlings at two sound pressure levels (70 dB re: 20μPa and 67 dB re: 20μPa measured at the hatchling start location). In the presence of the higher sound pressure level, hatchlings exhibited no phonotaxic response; yet, at the reduced sound pressure level hatchlings exhibited a negative phonotaxic response. In control trials, hatchlings oriented to the two sides of the V-maze equally, suggesting the hatchlings in the lower volume treatment group were responding negatively to the sound. These results indicate the need for further auditory orientation experiments to better understand hatchling behavioral responses to environmental acoustic cues and to address possible impacts of anthropogenic beach sounds that have the potential to disorient hatchlings during seafinding.

LEARNING WITH LOGGERHEADS: EFFECTIVE TRAINING TOOLS AND TECHNIQUES FOR HUSBANDRY AND SCIENTIFIC INVESTIGATIONS

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Since the early 20th century, chelonian learning and sensory capabilities have been investigated using an array of training methods. Punishment-directed classical conditioning approaches have been replaced largely by operant conditioning designs, whereby food rewards are used to reinforce correct responses in lieu of the delivery of electric shock in aversive conditioning experiments. Operant conditioning is a highly effective and adaptable paradigm for exploring the sensory modalities of soniferous (sound-producing) and non-soniferous aquatic species including fishes, turtles and, to a greater extent, marine mammals in which detection and discrimination capabilities of acoustic, chemical, and visual stimuli are tested. As the "gold standard" of audiometric test methods, behavioral studies typically yield lower auditory sensitivity thresholds than electrophysiological tests, albeit the former are more time-intensive. To better equip the researcher interested in training sea turtles, I present challenges and solutions encountered during a published hearing capability study. In addition to sensory threshold studies, the guidance provided could be applied to husbandry-related exercises, health assessments, and learning capacity studies. Design considerations, behavioral markers, methods for expediting data acquisition, and how to maintain a productive motivation level are outlined. Described experimental design details include: apparatus geometry, trade-offs, number and shape of manipulanda, and simplicity of the training procedure. Response bias reduction methods, reinforcement contingencies, apparatus association techniques, training tool selection, and reward delivery are also discussed. For sensory threshold study design, I discuss stimulus (signal) type, stimulus presentation format, and primary stimulus uniformity controls. I subjected captive-reared post-hatchling (19.0-32.2 cm, straight carapace length (SCL)) and juvenile (44.1-62.0 cm, SCL) loggerhead sea turtles (*Caretta caretta*), representing three year classes to a unique two-response forced-choice operant conditioning framework at the NOAA Fisheries Galveston Laboratory Sea Turtle Facility (Texas, USA). Forty-three animals participated in the reward-mediated training exercises for underwater audiometric testing. Over the 3-year study, refinements were necessary to account for differences in body size, to streamline procedural chain, and to reduce data acquisition duration. Training involved several progressive stages. The training effort necessary for the test subjects to master the procedure varied with individual, year class, and procedure complexity, varying from a few days to several months. Remedial training and re-engagement exercises functioned to "reset" and refocus the animal. Downturns in performance frequently correlated with inclement climatic conditions and transitory phases. Several key elements were required to facilitate sea turtle training including age- and species-appropriate food reinforcement, reward delivery timing, secondary reinforcement, and response apparatus designs conducive with natural behaviors of the species. I explain how to identify and eradicate design biases and recommend assessment tools for monitoring and evaluating animal performance. Altogether, this guidance will enable researchers to budget accordingly, establish contingency plans, and maximize available resources while effectively training sea turtles.

POTENTIAL ADVERSE EFFECTS OF METALS ON CLINICAL PARAMETERS OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) FROM BAJA CALIFORNIA SUR, MEXICO

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Blood has been successfully used as a tissue to measure contaminants, like heavy metals and metalloids, due to the vital functions performed by blood cells and their susceptibility to intoxication. Within blood, processes of absorption, accumulation and circulation of heavy metals can be correlated to their bioavailability and potential toxicity. This study aims to (1) determine the hematological and biochemical reference intervals (RIs) in blood of the loggerhead sea turtle, *Caretta caretta*, population from Baja California Sur (BCS), Mexico, and (2) compare the heavy metal concentrations in blood of these sea turtles to evaluate the potential effects of these contaminants on clinical parameters. We found several associations with the objectives, contributing to our understanding of loggerhead sea turtle health in this region. In July and August of 2008, blood samples from 22 loggerhead sea turtles were collected from the Vizcaino Peninsula (27°50N/115°05W) to Bahía Magdalena (24°30N/112°00W). Heavy metal concentrations (based on wet weight), packed cell volume (PCV), plasma total protein and blood plasma parameters were measured. The mean of packed cell volumes was 34.76% (4.58), with a reference interval of 25‑44%. Heterophils were the most numerous leukocytes found, followed by lymphocytes. No basophils or hemoparasites were detected in any of the 22 turtles sampled. For lactate dehydrogenase (LDH) and uric acid, only 16 turtles and one turtle could be analyzed respectively. Heterophil and lymphocyte percentages and alanine phosphatase enzymatic value were significantly correlated with body size (SCL) and body weight. Lymphocyte percentage and alanine phosphatase enzymatic values showed a positive correlation with body size and body weight, whereas heterophil percentage had a negative correlation with body size and weight. In this study, a number of significant correlations between the element levels and the clinical parameters were found: ALP vs Cd ($R^2=0.874$), As ($R^2=0.656$), and Mn ($R^2=0.834$), and Ni vs LDH, and a correlation between Cd vs Cu. In conclusion, the use of blood has been shown to be an excellent tissue for estimating concentrations of metals. Furthermore, a possible immune response has been observed in this and previous studies. potentially as a results of metal contamination. Our results show that high levels of toxic metals such as Cd and As in turtles could represent a risk to population health and we suggest that blood analysis of contaminants and toxicological responses be included in sea turtle conservation and management plans.

FIBROPAPILLOMA DISEASE IN AUSTRALIAN MARINE TURTLES*

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Fibropapillomatosis (FP) preexisted with marine turtles in the SW Pacific before turtle research spread through the region in 1960s and 1970s. The first Australian record of FP epidemic with foraging green turtles occurred in 1974-1975 at Airlie Beach. Veterinary and genetic studies during 1972-1998 concluded that FP tumours sampled from foraging loggerhead and green turtles in Moreton Bay were similar to the tumours that have been observed on Hawaiian green turtles. There was a high degree of relatedness among herpesvirus sequences from Australia, Barbados, and Pacific Mexico with those previously identified from all turtle species. FP tumours have been encountered on foraging green turtles at numerous sites throughout the eastern Indian Ocean and SW Pacific. FP has been recorded on foraging loggerhead turtles at numerous Australian sites from eastern Indian Ocean to SW Pacific but at lower frequency than with green turtles. Numerous foraging hawksbill turtle populations have been examined in the eastern Indian Ocean and SW Pacific, with FP only recorded at very low frequency in Moreton Bay. Mark-recapture studies, led by the same researchers, of green turtles dominated by the sGBR genetic stock have been conducted at multiple foraging study sites in central and southern Queensland using standard turtle rodeo and beach jumping capture and titanium flipper tags. The frequency of FP tumored turtles has remained relatively similar within each study site but markedly different among study sites across decades of monitoring. A qualitative generalization from examination of FP frequency at all study sites in eastern Queensland, is that FP tumor frequency is highest in coastal embayments with reduced water quality associated with altered catchments and lower in coastal embayments with relatively unaltered catchments. FP tumored turtle frequency is trivial at coral reefs offshore from the mainland coast. FP tumors occur with all age classes except for turtles that have very recently recruited from open ocean pelagic foraging to benthic foraging in coastal waters. It is concluded that turtles are infected with FP after recruitment to residency in coastal foraging areas. A CMR analysis of green turtles from sGBR stock of all age classes from recently recruited juveniles to large adults of both sexes, foraging in Moreton Bay during 1990-2014 concluded: prevalence was variable across decades with juvenile prevalence increasing from ~2% in early 1990s, reaching a peak of ~20% in mid 2000s and declining to ~10% by 2014 while prevalence with large immature turtles and adults declined from ~14% in early 1990s to near zero in 2014; apparent survival probability was age class and disease-state dependent with high apparent survival probability across all age classes for turtles not presenting with FP tumors (adults had highest survival probability); turtles presenting with FP tumors had lower apparent survival probabilities by ~0.07; prevalence was age class dependent with higher prevalence among juveniles, recovery rate following being recorded with FP tumors was not age class dependent and good recovery occurred across all age classes; this population with the highest frequency of FP in Queensland has increased robustly across 25 years of CMR study with an approximate tripling of the foraging population. There has been a comparable increase in annual size of nesting populations at index beaches for this sGBR genetic stock over 5 decades.

ANATOMY AND FUNCTION OF THE PULMONARY ARTERY SPHINCTER IN *CARETTA CARETTA*

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Previous studies have shown that bycaught loggerhead turtles (*Caretta caretta*) may experience decompression sickness that result in severe trauma and/or death. The current work investigated the pulmonary vascular system in loggerhead turtles to determine the anatomical and functional characteristics of the arteries, the pulmonary artery sphincter, and the lung parenchyma. Pulmonary arteries and lungs were excised in 5 turtles that were euthanized due to severe trauma associated with fisheries interactions. Histologically the tunica intima of the sphincter had a rougher surface and thicker wall as compared with the pulmonary artery. The tunica media of the sphincter was made up of a thick layer of smooth muscle cells and elastic tissue. The presence of muscarinic and adrenergic receptors was confirmed using immunohistochemistry and western blots. The pulmonary artery and sphincter were cut in cylindrical segments of 3 to 5mm thickness. Each ring was mounted on stirrups made of stainless steel wire and submerged in a temperature controlled organ bath. One stirrup was fixed at the bottom and the other attached to a force transducer, which allowed the force of contraction to be measured. The vessel ring was exposed to acetylcholine, serotonin or epinephrine to determine the neural responses. The sphincter contracted forcefully in response to acetylcholine (parasympathetic response) and also to serotonin, but epinephrine (sympathetic tone) caused relaxation. Epinephrine also induced relaxation even under the effect of acetylcholine. The remainder of the pulmonary artery responded similarly to the sphincter area but less forcefully during contraction and relaxed less when exposed to epinephrine. We also tried organ bath on systemic arteries from *Caretta caretta* and on the pulmonary artery from Trachemys Scripta and a mild contraction was observed on those arteries as opposed to the response of the sphincter of the pulmonary artery of the former. In addition, the pulmonary parenchyma contains an unusual amount of smooth muscle that contracts in response to acetylcholine but also in response to epinephrine. We believe that these mechanisms provide a possible explanation to the observed DCS in turtles. Our hypothesis is that while normal dives the turtles contract the lung and sphincter during a dive (under parasympathetic response) which minimizes uptake of N2 and risk of DCS. Parasympathetic response also decreases heart rate and perfusion. During a stressful event, like being caught in a trawler or a net, the sympathetic response opens the sphincter resulting and increases lung perfusion, which may increase the risk of DCS. The present study contributes to the functional and anatomic characterisation of this structure described in apnea diving species, and gives new information about the pathophysiology of DCS in sea turtles. This knowledge may help mitigate DCS risk in turtles.

GENETIC CHARACTERIZATION OF BLOOD PARASITES ON THREE SEA TURTLE NESTING SITES IN THE GALAPAGOS ISLAND

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Understanding of blood parasites of the Galapagos green sea turtle (*Chelonia mydas*) has been based on similar parasites in birds. Currently, the analysis of gene sequences, especially that of the mitochondrial gene cytochrome b, offers a new tool to review the specificity, situation and phylogeny of blood parasites. In this context, the present study was conducted using standed examination of blood films and the Nested-PCR technique for detection of Haemoproteus, a parasite of the Galapagos green sea turtle (*C. mydas*). Universal primers were used that were specific to a conserved region of the mitochondrial cytochrome b gene. A 524 bp long band was amplified from DNA extracted from whole blood of green sea turtles from three important nesting sites: Las Bachas (Santa Cruz Island), Quinta Playa and Bahía Barahona (Isabela Island). The molecular method was superior in the detection of this group of parasites (21.3% infected individuals) as compared to the traditional microscopic technique (16.91% infected individuals). Sequence analysis showed that the blood parasites occurred in relation with 94% with *Haemoproteus ptyodactylii*, previously identified in geckos, 93% with *Plasmodium* sp., and 92% with *Haemoproteus* sp., reported in birds. Phylogenetic analysis showed that the sequences are grouped in a single clade related to *Haemoproteus ptyodactylii* and *Haemoproteus kopki*. This finding is relevant because it could imply that it is a divergent molecular group that would deserve extensive studies to clearly determine the diversity of species of Haemoproteus in green sea turtles. Furthermore, epidemiological studies are needed to identify the possible effects of infection with Haemoproteus on wild populations of green sea turtles and to determine the parasitic loads in healthy and diseased individuals. Acknowledgments: We wish to thank Galapagos National Park, Charles Darwin Foundation, Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesquería and World Wildlife Fund, which contributed in some way to our participation in the symposium through travel grants.

THE MICROBIOMES OF SEA TURTLE NESTING BEACHES AND HOW THEY CAN IMPACT INCUBATION*

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This study investigates how the totality of microbial species and their collective genetic material characterize a nesting beach and the potential they have to impact sea turtle egg incubation. Microbiomial research is a relatively new field that studies the species that inhabit a particular environment. This project investigated the microbiomes in the sand of several sea turtle nesting beaches in Florida to identify what species were present and their ecological role. This is a very unique approach to bacterial identification and differs from previous studies because it did not culture bacteria in the lab. Variable environmental

conditions (temperature, salinity, gas concentrations etc.) cannot be accurately replicated in the lab and thus data from previous studies are biased. Our methods took a new approach of looking for whole genomes using Next Generation Sequencing. Sand was collected from sea turtle nesting beaches in locations that differed in the amount of human utilization, pollution, historical hatching success, and sand characteristics. Samples were collected throughout the nesting season, at different depths, and after unique meteorological conditions, such as heavy storms. Bacteria were isolated from the sand samples, DNA extracted, PCR using 16s rRNA primers, and sequenced. Next Generation Sequencing provided a very lengthy list of bacterial genera present in the sand sample, including inviable or fastidious organisms. Our data show that sea turtle beach sand microbiomes are very diverse and differ tremendously within and between beaches. We documented resident species as well as ecological succession of different genera. Of particular interest was the presence of pathological species, such as *Vibrio*. Although we sampled sand from nests with high and low hatching success, we can only speculate on the correlation between the presence of individual species and their impact on egg incubation. In order to decipher the ecological impact each microbiome has on sea turtle egg clutches, a true experiment needs to be done.

PREVALENCE OF GREEN TURTLE FIBROPAPILLOMATOSIS IN THE NORTHEAST MEXICAN CARIBBEAN

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Fibropapilloma (FP) is a worldwide epizootic threat to the survival of sea turtles, documented for the first time in green turtles (*Chelonia mydas*). The etiology and pathogenesis of FP remains unknown; it is a multifactorial neoplastic chronic disease associated to herperviruses whose prevalence has been related to ambient degradation. The etiological association of herperviruses as principal agent of FP has not been proved. An important population, comprised by males, females and immature green turtles, inhabiting the coast of Quintana Roo is found foraging in extensive seagrass beds located in the Northern region of the Mexican Caribbean. During 2004, 2007 and 2008, 63 juveniles, 42 females and 24 males, were captured in the Northeast of Cancún, between Isla Contoy and the shoreline, in order to determine the prevalence of FP and to describe tumors by histpopathological techniques. Annual prevalence was of 15% (2004), 21% (2007) y 27% (2008), with an annual percentage change of 6%. Ratio of tumors was 1.8:1 (2008:2004); an annual difference of 5% was found between the fraction of individuals with tumors >10 cm in 2008 in relation to 2004. There were no significant differences in the number of tumors between age classes; no significant relationship between curve carapace length (CCL) and number of tumors observed was found. Juveniles presented an increase in number of tumors in the body across years, with an increase of >140% in 2008 relative to 2004. By using the GLM for repeated measures, we found significant differences in the number of tumors relative to anatomic region (p=0.005). The anterior region presented more tumors (mean ± error standard, 5.63 ± 1.40 tumors) than the posterior region (2.77 ± 0.86 tumors), with a mean difference of 2.86 ± 0.92, p=0.005. There was no significant interaction between anatomic region and year $(F(2,23)=0.31, p=0.74)$ or sex $(F(2,23)=0.12, p=0.88)$. Tumors were classified as fibromas or fibropapillomas, and histopathology revealed the epidermis with hyperplasia, moderate multifocal

hyperkeratosis and keratinocytes with vacuolar degeneration. In the dermis, aggregate collagen with perivascular lymphocytes, plasma cells and melanomacrophagues were observed. An increase in FP prevalence in this population, which could be associated to habitat degradation for more than four decades, is suggested. Determination of oxidative stress state is recommended, since cumulative production of ROS/RNS through endogenous (e.g. activated immune system) or exogenous factors (e.g. xenobiotics) are involved in the pathophysiology of several diseases and carcinogenesis processes.

OVARIAN DYNAMICS IN FREE-RANGING LOGGERHEAD SEA TURTLES*

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Vitellogenin (VTG) is an egg yolk-precursor protein that serves as a nutrient source for developing embryos in oviparous vertebrates. The hormonal control of this protein has been studied in a variety of taxa, but details about the dynamics of this protein remain to be elucidated in sea turtle species. VTG production is induced by estradiol-17ß (E2), and testosterone (T) is also thought to have a regulatory role, though its function in sea turtles is currently unknown. To investigate the dynamics of VTG in a multi-clutch species under natural conditions, 38 adult (SCL > 80 cm) loggerhead females entrained in the Florida Power and Light St. Lucie Nuclear Plant intake canal in Hutchinson Island, FL were sampled from May-August of 2014. Blood samples were taken to measure T, E2, and VTG using enzyme-linked immunosorbent assays (ELISAs). Ultrasound images of the gonads were used to determine ovarian status and to measure ovarian follicle and oviductal egg size. Results showed that mean VTG concentration increased from May (8.27 mg/ml) to June (15.37 mg/ml) and declined into July and August (9.44 mg/ml); this decline corresponded with the end of the nesting season. Mean E2 (718.02 pg/ml in May to 95.89 pg/ml in July-August) and mean T (2,008.35 pg/ml in May to 1,221.24 pg/ml in July-August) declined over the summer months, and mean concentration for both steroids was significantly higher in reproductively active females than means of reproductively inactive females, though overlapping concentrations of the steroids occurred between the active and inactive groups. However, VTG concentration was high in reproductively active turtles and undetectable in reproductively inactive turtles. We conclude that the addition of VTG measurement in conjunction with the gonadal steroids provides a more accurate and easily-interpretable way to predict reproductive status of adult loggerhead females. Additionally, gonadal steroid and vitellogenin concentration in our study corresponded only with late nesting animals, indicating that early season females do not become entrained in the intake canal of the power plant.

PHYSIOLOGICAL EFFECTS OF DISORIENTATION LOGGERHEAD (*CARETTA CARETTA*) AND GREEN (*CHELONIA MYDAS*) SEA TURTLE HATCHLINGS*

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The first 24 hours after hatching are incredibly dangerous due to high predation rates and important for sea turtle survival. In Florida, between the months of June and October, loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) sea turtle hatchlings emerge at night from their nests on ocean beaches. From the nest they locate the sea by orienting away from the dark, dune vegetation and crawling toward the brighter, lower oceanic horizon. However, hatchlings can be misoriented landward by strong, localized artificial sources of light or disoriented by diffuse skyglow from urban areas, causing them to wander the beach without direction. Even in cases where mis-/disoriented animals reach the ocean, the increased distances hatchlings crawl could consume valuable energy and the exhausted animals may be less likely to survive. This study utilized laboratory simulations of extended crawl distances to investigate the energy cost to sea turtle hatchlings incurred during such misorientation and disorientation events. Oxygen consumption, blood glucose levels, and lactic acid concentrations were measured as well as crawl behavior and swim performance following crawl trials. This research provides managers with physiological data to determine the best practices for sea turtle conservation and adds to the current biological knowledge of these animals.

EXERTIONAL MYOPATHY DOCUMENTED IN A JUVENILE GREEN SEA TURTLE FOUND ENTANGLED IN A LARGE MESH GILLNET

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A juvenile female green sea turtle was found alive but entangled in a large mesh gillnet in Pamlico Sound, NC, and appeared lethargic when retrieved from the net. It was transferred to veterinary care for assessment. Blood gas analysis revealed severe metabolic acidosis and hyperlactatemia. Plasma biochemistry analysis showed elevated aspartate aminotransferase and creatine kinase, marked hypercalcemia, hyperphosphatemia, and hyperkalemia. Death occurred within 24 hours of capture, despite treatment with intravenous and subcutaneous fluids and sodium bicarbonate. Necropsy revealed multifocal to diffuse pallor of the superficial and deep pectoral muscles. Mild, multifocal, and acute myofiber necrosis was identified by histopathological examination. While histological changes in the examined muscle were modest, the acid-base, mineral, and electrolyte abnormalities were sufficiently severe to contribute to this animal's mortality. Exertional myopathy in reptiles has not been well characterized. Sea turtle mortality resulting from forced submergence has been attributed to blood gas derangements and seawater aspiration; however, exertional myopathy may also be an important contributing factor. If possible, sea turtles subjected to

incidental capture and entanglement that exhibit weakness or dull mentation should be clinically evaluated prior to release to minimize the risk of delayed mortality. Treatment with appropriate fluid therapy and supportive care may mitigate the effects of exertional myopathy in some cases.

IS THERE AN ONTOGENETIC CHANGE IN JUVENILE GREEN TURTLE (*CHELONIA MYDAS*) MICROBIAL COMMUNITY STRUCTURE AS THEY MOVE FROM PELAGIC HABITATS TO INSHORE RESIDENT AREAS?

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The diverse community of microorganisms throughout the bodies of animals has become increasingly regarded as a system responsible for supporting vital functions, such as digestion, amino acid production, and immune response. Although the putative roles of these systems within sea turtles have been discussed, there is limited understanding of the structure of these microbial communities and of effects they can have on the health of an animal. Green turtles (*Chelonia mydas*) provide an interesting model of change in these microbial communities because the turtles take part in a pronounced shift between a surface-pelagic distribution and omnivorous diet, and a shallow coastal distribution and herbivorous diet. We have been investigating the structure of microflora within green turtles before and after this ontogenetic shift. Following their post-hatching migration to offshore habitat, young green turtles eat a largely omnivorous diet while living among pelagic Sargassum patches. However, they soon recruit to neritic environments where the turtles gradually increase the vegetation in their diet to become primarily herbivorous. This project characterized the microbial communities of juvenile green turtles before and after the recruitment to neritic waters. We captured green turtles among pelagic Sargassum habitat in the Gulf of Mexico, as well as within the neritic foraging grounds of St. Joseph Bay and St. Andrew Bay, FL, (Gulf of Mexico, USA). Cloacal swabs were taken from each turtle as a proxy for fecal bacteria and DNA were isolated for analysis of the 16S rRNA sequences. Hypotheses tested were: (1) Did the shift in dietary selection and habitat lead to variation in the bacterial community as identified from cloacal samples between the two groups of turtles? (2) Did juvenile individuals in neritic environments develop increased representation of cellulolytic and fermentative bacteria in cloacal samples due to a shift towards an herbivorous diet? The results we present provide a preliminary characterization of some common bacteria within the hindgut of green turtles and how developmental shifts in these animals affected their microbial communities.

EPIBIOTIC DIATOMS ARE UNIVERSALLY PRESENT ON ALL SEA TURTLE SPECIES

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Interest in sea turtle epibiosis has grown rapidly in recent years. Much is now known about the macro-epibiota on sea turtles; however, only a single study has ever provided direct evidence that sea turtles also host unique and diverse micro-epibiotic communities. This study, which exclusively studied olive ridley turtles, discovered that the most abundant micro-epibionts are diatoms. We expand on these findings by providing the first evidence that diatoms are found universally on all sea turtle species. Using Scanning Electronic Microscopy, we examined carapace or skin samples from the 7 sea turtle species in search of epibiotic diatoms. In total, we discovered at least 20 unique epibiotic diatom species. Diatom communities appeared largely distinct between host species and only 3 diatom species were present on more than a single host species. At least 1 of the diatom species identified in this study has not been described in the scientific literature and is likely a new species. We predict that many more previously undescribed species will be discovered with continued research. As it is currently not known which factors influence the settlement of epibiotic diatoms on sea turtles nor is it known how these diatom communities affect the settlement of other epibionts, there are many avenues for future research. In addition, we demonstrate that, even under a variety of storage conditions, sea turtle carapaces can retain evidence of their epibiotic diatom communities for over 15 years. Archived carapace specimens, therefore can be used to investigate how climatic phenomena, such as the El Niño Southern Oscillation (ENSO) or anthropogenic climate change are affecting trends in sea turtle epibiosis.

IS JUVENILE GROWTH PATTERN AND MORPHOLOGY SHAPED BY PREDATION RISK? HYPOTHESIS TESTING THROUGH COMPARISONS BETWEEN FLATBACKS (*NATATOR DEPRESSUS*) AND GREEN TURTLES (*CHELONIA MYDAS*)

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All species of marine turtles are long-lived as adults but endure high rates of juvenile mortality, especially as hatchlings. Females compensate by producing large clutches and hundreds of hatchlings during their lifetime. In 6 of the 7 marine turtles, the hatchlings migrate offshore to oceanic waters where the benefits are fewer predators but the costs are a less abundant food supply. However, for a small and virtually defenseless juvenile turtle, the benefits apparently exceed the costs for most species. The flatback, however, is an exception. It grows to maturity in the coastal waters of Australia where there are many predators. These circumstances provided us with an opportunity to compare and contrast growth patterns and antipredator structural development between flatbacks and their close relative, the green turtle, to determine whether differences in predation pressures shape the development of young turtles. We predicted that in flatbacks, those adaptations would be better developed and/or more extreme than in green turtles. Our results provide data consistent with those predictions.

SKULL MORPHOMETRICS IN EAST PACIFIC GREEN TURTLES (*CHELONIA MYDAS*) IN SECHURA FEEDING GROUNDS

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Skulls of Pacific green turtles were collected during the period 2002-2004. Most of the specimens came from the northern coast, specifically from the feeding ground of Secure Bay. A smaller number came from Lobos de Tierra Island and another group was from an unknown area, probably on the central coast. The objective of this study was to find any aggregation related to geographical areas. Skulls were measured following Kamesaki and Matsui (1995). Additionally, carapace ratios were obtained in some specimens from Sechura Bay. Twenty-four measures were considered, included mandibles. Measures were analyzed with a principal component analysis (PCA) where 99.47% of the variability was explained in the first component. Biplot was selected to also visualize the distribution of specimens. The result was a cloud showing graphically a lack of variability in skull morphometry, even in specimens collected from different areas. A box plot chart was used to visualize the variability of each measurement to decide if any of them could be influencing the reduced variability obtained in the PCA. LC1 (cranial length), LC2 (cranial length at condylus mandibularis), WPTO (width of postorbital), WC (width of cranium) and WSO (width of supraorbital) had the most variability, both below and above the media. In consequence, they were selected to test any variability within specimens and their relation with curved carapace length (CCL). Correlations

were tested and the Spearman's R coefficients obtained were above 0.81, suggesting a strong correlation in all these measures. LC1 had R coefficients above 0.91 with LC2 and WC; LC2 was more correlated with WPTO, WC and CCL, WPTO had a high correlation with WC. Only LC2 had a high correlation with CCL; for the other variables CCL was correlated with coefficients between 0.87 and 0.90. Variability of the selected measures was tested with an ANOVA resulting in a p-value between groups of 1, suggesting that even with a selected group of variables, specimens did not present any geographical variation based on skull morphometrics. The Peruvian coast represents a feeding area for the Pacific green turtle, and it has been suggested that most of the population in this part of their distribution is composed of young or immature specimens from the Galapagos Islands nesting beaches. In this analysis, age was not considered a factor affecting the skull morphometrics relations because it was assumed that all were young specimens. Our results did not show any kind of bias, which might be related to an external factor like age, because samples and variables were strongly aggregated even with the effect of age, consequently, for our sample, age did not affect the aggregation. In relation to specimen length (CCL), we observed that correlation with skull measures is representative, but with a lower coefficient. In contrast, the correlation between skull variables seemed more representative than the correlation between skulls variables and CCL, and one variable (LC2) presented the highest correlation with CCL. LC2 is related to the development of feeding structures, so the growth of Pacific green turtles seems to be more correlated with feeding habits. As most of the specimens came from the Sechura feeding ground, our results present evidence that specimens who frequent that area did not have any kind of variability related to skull morphometrics. Comparisons with skulls from other important feeding areas like Paracas on the southern coast will be necessary to find if there is a population aggregation distinctive for each feeding ground or to find if it is absent and represents evidence that feeding areas in Peru are used indistinctively by the population of pacific green turtles.

EFFECT OF INCUBATION CONDITIONS ON DNA METHYLATION IN TURTLES WITH ENVIRONMENTAL DEPENDENT SEX DETERMINATION

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Temperature-dependent sex determination (TSD) is a mechanism by which temperature determines the sex of the embryo. Experimental studies with turtles presenting TSD suggest that moisture conditions during egg incubation may influence sex determination, showing that wetter substrates produce males, whereas drier substrates produce females. This relationship is consistent with findings from field studies where sex ratios obtained from loggerhead turtle (*Caretta caretta*) nesting beaches show a poor relationship with temperature recorded in situ. However, when the effect of moisture (particularly rainfall) is added to nest temperatures, sex ratio trends become more predictable. Still, the mechanisms by which environmental factors (temperature or moisture) affect sex determination remain unknown. It has been suggested that embryonic sex differences are determined by different patterns of DNA methylation. Evidence supporting this was found in the American alligator, Alligator mississippiensis, where males showed elevated aromatase promoter methylation compared to females. Aromatase is a key gene in ovarian differentiation since it catalyzes the synthesis of estrogens. Methylation of the aromatase promoter represses its expression. The opposite trend was found in the alligator Sox9 promoter, a key gene in testis differentiation, which displays an inverse relationship between methylation and expression levels. From these findings we hypothesize that moisture can also influence levels of DNA methylation in the gonadal aromatase and Sox9

promoter, which in turn would affect gene expression, and hence sex ratios in turtles with TSD. We utilized a model species, the red-eared slider *Trachemys scripta*, to examine this hypothesis. *T. scripta* eggs were incubated under different moisture treatments that paralleled conditions used previously in studies of loggerhead incubation temperature, moisture and sex ratios. Undifferentiated gonad samples were collected before the thermosensitive period (TSP); differentiated gonads were collected after the TSP. One gonad from each embryo was preserved for DNA/RNA extraction and its counterpart was prepared for histological identification of sex. Aromatase and Sox9 promoters will be isolated and examined to identify different methylation patterns and finally gene expression analysis will be performed. This study is designed to support or refute the effect of moisture as an epigenetic driver of sex determining pathways in turtles. *T. scripta* is a model for understanding other turtle species. Identifying the factors that determine sex and thus future breeding populations is a critical factor to ensure sea turtles continued survival.

CAN SEX-SPECIFIC PROTEINS IN BLOOD BE USED AS A RELIABLE METHOD TO IDENTIFY THE SEX OF SEA TURTLE HATCHLINGS?

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Marine turtles exhibit temperature dependent sex determination (TSD). During critical periods of embryonic development, the nest's thermal environment directs whether each embryo will develop as male or female. Warmer nest temperatures tend to produce female-biased sex ratios in the lab yet thermal conditions in the field yield less predictable results. The rapid increase of global temperatures highlights the need for a clear understanding of nest environmental effects on sea turtle sex ratios. Estimating hatchling sex ratios at rookeries remains imprecise due to the lack of sexual dimorphism in young marine turtles and delayed sexual maturity. Most common practices for estimating sex ratios are indirect, based on nest temperatures, air and sea surface temperatures, incubation duration and estimated thermosensitive period durations. However, there is insufficient evidence that these proxies indeed result in realistic primary sex ratios from natural sea turtle nests or rookeries. The lack of a simple, nonlethal technique to verify the sex of hatchlings is at the foundation of this problem. Current assessments rely upon hatchling sacrifice (and hence limited sample sizes), or laparoscopy and biopsy to verify neonate sex. The latter is logistically burdensome because it requires turtles to be raised in a laboratory for several months until they reach a minimum size. Histology of dead-in-nest hatchling gonads yields hatchling sex ratios, but there is little evidence that these ratios match those of the surviving hatchlings. Additionally, in some species, morphological sex can be ambiguous, even at the histological level. The purpose of this study was to develop a technique to identify sex in loggerhead sea turtle (*Caretta caretta*) hatchlings via analysis of blood samples. We used Western blots to detect the expression of several proteins known to play an important role in sex differentiation, such as AMH, in the blood and gonadal tissue of the hatchlings. The presence of the protein was then compared to the results from laparoscopic procedures in order to validate this approach. Developing a technique to identify the sex of turtle hatchlings through blood samples will greatly enhance our ability to reliably determine sex ratios across nesting beaches, a crucial step in assessing the impacts of climate change on turtle demographics.

FIRST SKELETOCHRONOLOGY ANALYSIS ON LOGGERHEAD (*CARETTA CARETTA*) YEARLINGS AND POST-YEARLINGS

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Endangered species management requires appropriate strategies to conserve their populations; the knowledge of individuals' ages is especially important for migratory animals like sea turtles. Age estimation has been assessed through different methods such as carapace length or skeletochronology. Previous skeletochronologic studies have determined that sea turtle age can be estimated through skeletal growth marks (GM) produced by bone growth fluctuations, sometimes related to environmental conditions. A dark thin line, called the line of arrested growth (LAG) is deposited during periods of slow growth (adverse conditions) and light broad lines reflect active bone formation during high growth rate periods (favorable conditions). Favorable or unfavorable conditions can be related to different factors such as temperature (as sea turtles are ectothermic), food resources, injuries, or illness. Most skeletochronologic studies identify a GM with one year of turtle life. This study focused on skeletochronologic analysis of 31 known-age loggerhead yearlings and post-yearlings (from 1 to 3.7 years of age). The specimens died during their captive rearing. Histological bone cuts (25µm) from the right humerus, at the deltopectoral crest, were done with a cryostat after a specific decalcification process. All turtles used in the study had a constant food supply throughout their captive rearing. Also, they were subjected to significant seasonal thermal fluctuations, with seasonally cold (18-22°C) and warm (22-25°C) seawater. We observed a strong correlation between seawater temperature and carapace growth rates – measured in minimum straight carapace length (SCLmin) – in all animals studied. Results showed that 20 turtles did not have any GM and 11 turtles – all of them with growth deficiencies – formed LAGs, some of them complete LAGs – creating GM – and others only partial LAGs. In conclusion, seasonality of seawater temperature had an important effect on turtle carapace growth rates, but nevertheless, was not reflected in GM formation. Our study suggests that humerus GM generation could be affected by different factors, which are not always present. Consequently, skeletochronology may not be a proper way to determine the age of loggerhead yearlings and post-yearlings.

OVARIAN DYNAMICS IN WILD LOGGERHEADS IN A FORAGING AREA*

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Given their migratory nature, the number of studies on the reproductive physiology of sea turtles is relatively limited. Although hormonal correlates of ovarian sex steroids have been published, little is known about the dynamics of the ovary with regard to vitellogenin (VTG), the egg-yolk protein precursor. VTG concentrations in nesting females have been published; however, no data are available on gonadal recrudescing concentration of this protein prior to the nesting season. The Florida peninsula supports one of the largest loggerhead sea turtle nesting aggregations in the world. Florida Bay is an important foraging area for juvenile and adult loggerheads belonging to this population. In a multiyear study, we sampled adult and subadult loggerheads in Florida Bay during the month of March, prior to the nesting season. Blood samples were used to directly measure VTG with an in-house ELISA developed specifically for loggerhead VTG. Additionally, we measured ovarian steroids (testosterone and estradiol 17B) using sensitive commercial steroid ELISAs. Measurement of these humoral factors assisted us in characterizing their dynamics during ovarian recrudescence. These data can help us estimate the proportion of loggerheads likely to reproduce in future nesting seasons and inform our knowledge of reproductive periodicity, an important vital rate for estimating and monitoring nesting female abundance.

THE CURRENT STATE AND FUTURE DIRECTIONS OF MARINE TURTLE TOXICOLOGY RESEARCH*

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Chemical pollutants that are known to impact the health of humans and wildlife are accumulating in marine turtles globally. However, due to the logistical and ethical constraints of conducting toxicological research on large, endangered animals, very little is known about the effects of these contaminants in marine turtles. In this study, we investigated the current state of marine turtle toxicological research, with the aim of highlighting future research directions in this field. A thorough search of the literature identified a total of 44 publications relating to marine turtle toxicology, with two-thirds (29) directly relating to toxicology, and a further 20% (9) on biomarkers of chemical exposure and 14% (6) on cell culture establishment for in vitro toxicity assays. Of the 29 publications on toxicology, 13 (45%) correlated contaminants with a toxicological effect, nine (31%) and five (17%) involved in vitro and in vivo exposure experiments, respectively, and just two (5%) presented screening risk assessments. There were twice as many publications on the effects of

organic contaminants, compared to metals, and more than half of all studies have been on the green turtle (*Chelonia mydas*). Publications correlating contaminants with a toxicological response had a wide variety of endpoints, but results were not consistent between studies. This makes it difficult to draw general conclusions on the effects of contaminants on marine turtle health using correlative studies. The screening risk assessment (SRA) studies largely used toxicological data from other reptiles and birds, creating significant uncertainty around the use of SRAs in assessing marine turtle health. In vivo exposure publications have provided important information on the reproductive effects of contaminants in marine turtles, but these studies involved direct contaminant exposure and/or sacrificing animals for sex determination, and are thus not ethical for threatened species. More recently, the use of in vitro (cell-based) toxicity bioassays using marine turtle cell lines have been established as an ethical, representative and high throughput approach studying the toxic effects of contaminants in marine turtles. However, to date, very few contaminants for a small number of toxicological end points and species have been investigated using these methods. Further advancement of this line of toxicological research to include additional contaminants, end points and species is therefore necessary to gain a broader understanding of the effects of contaminants accumulating in marine turtles. This is critical to better inform conservation and management strategies for these threatened species.

REPORT ON DIGESTIVE CONTENTS OF STRANDED WASHBACK HATCHLINGS

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The early stages of a sea turtle's life as it enters the ocean still, in many regards, remain a mystery. These "lost years", as they are commonly known, see hatchlings enter the ocean and disperse into the currents, until they return to feeding grounds at a larger juvenile size. Studies have shown post-hatchling loggerhead turtles (*Caretta caretta*) to feed primarily on pelagic material including sargassum, crustaceans, molluscs and hydrozoans. Analyses of diet composition from full digestive tract samples can provide important information on habitat use and the effect of marine debris on these endangered species. Mote Marine Laboratory's hatchling hospital in Sarasota, Florida, treats anywhere from 1,200 to 2,600 sick and injured hatchlings every year. During the 2015 sea turtle nesting season the hatchling hospital received 397 hatchlings over a 3-week period that were considered "washbacks". Washbacks were classified as any post-hatchlings (straight carapace length > 5cm) or hatchlings with signs of algae growth and/or barnacles, indicating an extended period of time in the water. This is an unusual occurrence for Mote's hatchling hospital, as generally only a few hatchlings with these characteristics are seen each season. Prevailing onshore winds and the close proximity of a weedline to the coast may have been contributing factors to this stranding event. Any washback hatchlings that died while in care were frozen and necropsies were conducted at a later date. Over 160 washback hatchlings were collected for analyses, ranging in size from 25.7mm to 50.9mm. All washback hatchlings collected were loggerhead turtles and were found on beaches along Sarasota and Manatee County coastlines. Weight, straight carapace length and straight carapace width were measured for each washback hatchling, as well as any remaining yolk reserves measured by diameter (mm). The full digestive tract of every hatchling was examined to look for evidence of blockages or marine debris, including any plastic or tar found in the mouth and cloaca. The digestive tract was divided into two sections for analyses: the stomach and intestines (large and small intestine combined). Contents from both stomach and intestines were weighed and identified to lowest taxonomic level when possible. In instances

where prey could not be identified, gross observations were made of the materials present. Some hatchlings did consume food or were force-fed while in care, but these dietary items were easily distinguishable from other digestive tract contents and were eliminated from the analyses. Information gathered from these washback hatchlings can provide some insight into these very early days, when hatchlings no longer rely on yolk reserves and begin to forage for food.

USE OF HYPOXIA TO EXTEND EMBRYONIC ARREST IN TURTLE EGGS AND PREVENT MOVEMENT INDUCED MORTALITY*

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Turtle eggs are often relocated large distances for research or conservation purposes. Relocation of eggs is associated with significant risk, as turtle eggs suffer from movement-induced mortality. The standard protocol for relocating turtle eggs over substantial distances involves chilling the eggs to between 6-10°C to slow the rate of embryonic development. Use of this technique can result in death of embryos, particularly when the temperature drops too low or becomes too high. We recently discovered that green sea turtle eggs placed into hypoxia (low oxygen levels) up to 12 hours after oviposition will remain in embryonic arrest for at least 3 days until they are exposed to normoxia (normal oxygen levels). There was no significant reduction in hatching success of eggs subjected to hypoxia. In previous studies, we only used heavy and expensive Perspex containers to maintain arrest using hypoxia. These containers are a significant limitation on this method being widely used by conservation groups and researchers around the world. Therefore, in this experiment, we investigated the validity of using other, more practical and cost-effective methods for transporting eggs under hypoxic conditions. Olive ridley sea turtle eggs were randomly divided among four different treatments after oviposition. In the first treatment, eggs were placed immediately into Perspex containers. In the second treatment eggs were placed immediately into Ziploc plastic bags. Nitrogen gas (N2 > 99.0%) was then pumped into the containers and plastic bags until the desired oxygen level for each treatment was reached (approximately 1% oxygen). The containers and bags were then sealed. In the third treatment, eggs were placed into vacuum sealed plastic bags. The excess air in the bags was then removed using a vacuum device. Eggs remained in their respective treatment for 3 days before being removed from their container or bag and placed into artificial incubators. In the fourth, control treatment, eggs remained in normoxia and were placed into the artificial incubators as soon as possible following oviposition. A proportion of eggs from each treatment was also inverted when removed from their respective treatment in order to test the validity of using each treatment to prevent movement induced mortality. We then assessed the average time taken to form a white spot, the hatching success and hatchling morphology of each treatment group. The majority (98.3%) of the eggs formed a white spot with no difference between treatments. There was a significant difference in the average time taken for the white spot to form between each treatment. Eggs in the vacuum sealed bags took on average 2.4 days longer to form a white spot than the control eggs, while eggs in both the Perspex and Ziploc bag treatments took 3.3 days longer on average than the controls. These ongoing studies demonstrate that plastic and vacuum bags can be used for

maintenance of hypoxia in turtle eggs, thus allowing a simple and cost-effective method for transportation of eggs for conservation and research purposes.

ISOLATION, CHARACTERIZATION, AND ANTIBIOTIC RESISTANCE OF VIBRIO SPP. IN SEA TURTLES FROM NORTHWESTERN MEXICO

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The aerobic oral and cloacal bacterial microbiota and their antimicrobial resistance were characterized for 64 apparently healthy sea turtles captured at their foraging grounds in Ojo de Liebre Lagoon (OLL), Baja California Sur (BCS), Mexico (Pacific Ocean) and the lagoon system of Navachiste (LSN) and Marine Area of Influence (MAI), Guasave, Sinaloa (Gulf of California). A total of 34 black turtles (*Chelonia mydas agassizii*) were sampled in OLL, 8 black turtles in LSN and 22 olive ridley turtles (*Lepidochelys olivacea*) were sampled in MAI from January to December 2012. We isolated 13 different species of Gram-negative bacteria. The most frequently isolated bacteria were *Vibrio alginolyticus* in 39/64 (60%), *V. parahaemolyticus* in 17/64 (26%), and *V. cholerae* in 6/64 (9%). However, *V. cholerae* was isolated only from turtles captured from the Gulf of California (MAI). Among *V. parahaemolyticus* strains, six O serogroups and eight serovars were identified from which 5/17 (29.4%) belonged to the pathogenic strains (tdh+ gene) and 2/17 (11.7%) had the pandemic clone (tdh+ and toxRS/new+). Among *V. cholera* strains, all were identified as non-O1/non-O139, and in 4/6 (66%) the accessory cholera enterotoxin gene (ace) was identified but without virulence gene zot, ctxA, and ctxB. Of the isolated *V. parahaemolyticus*, *V. cholerae*, and *V. alginolyticus* strains, 94.1, 33.4, and 100% demonstrated resistance to at least one commonly prescribed antibiotic (primarily to ampicillin). In conclusion, the presence of several potential (toxigenic) human pathogens were found in sea turtles; these may represent risk of transmission of environmental microbes and a high-risk of food-borne disease. Therefore, based on these findings, and the fact that it is illegal, we discourage the consumption of sea turtle meat or eggs in northwestern Mexico.

ASO Network: Special Session

ASO NETWORK*

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The South Western Atlantic (ASO, for Atlántico Sur Occidental) is the region comprised by territorial waters of Brazil, Uruguay, Argentina and the international waters adjacent to the South Atlantic Ocean. These three countries cover 12,000 km of coastline and they share common characteristics concerning the way sea turtles' habitat is used and the threats they face, among which pollution, fishing and habitat degradation are highlighted. The ASO is an important area for the development, feeding and migratory corridor of the green turtle (*Chelonia mydas*), the loggerhead turtle (*Caretta caretta*), the leatherback turtle (*Dermochelys coriacea*), the hawksbill turtle (*Eretmochelys imbricata*), and the olive ridley turtle (*Lepidochelys olivacea*). Although countries in the region have legislations and they adhere to international conventions that protect sea turtles, current research, conservation and protection are not enough to ensure the survival of the sea turtles in the ASO. On such grounds, and in order to improve conservation efforts for these species, in 2003 the Karumbé Project (Uruguay) propounded to researchers from the ASO region the creation of a network of regional integration composed by conservationists, scientists, fishermen and government representatives; under the consensus of the following objectives: • Provide reliable scientific information about the biology, medicine and conservation of sea turtles. • Standardize work methodologies and scientific protocols among different research and conservation projects implemented in the region. • Create joint actions to improve the efforts and results of conservation for sea turtles, and strengthen integration and collaboration between researchers and institutions of the ASO Network. • Develop and propose strategies addressed to the fishing sector with the aim to reduce incidental capture of sea turtles, contemplating the socioeconomic factors of the activity. ASO Network Conferences are a space to disseminate scientific research, environmental education and to discuss methodologies for research, as well as to get to an agreement on regional conservation strategies. Between 2003 and 2013, a total of 7 meetings were carried out alternately in Uruguay, Argentina, and Brazil. Researchers, fishermen, government representatives and NGO's members related to marine research and conservation participated in these meetings and a total of 310 papers were presented. The attendance to ASO Network Conferences has increased markedly with the years. During the first meeting in 2003, 50 people participated and only 12 papers were presented. The record of attendance was reached in 2011, with an approximate attendance of 200 people and the presentation of 59 papers. Also, the integration, fellowship and work dynamics achieved by the members of the ASO Network over the past 12 years, facilitated the rapid integration and coordination of its members with other international forums, such as: The South Atlantic Network (South America and Africa) and the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC). Education, community development and promotion of new conservation policies are the cornerstones of the ASO Network with the aim to protect sea turtles and their habitats at a regional and international level.

GEOGRAPHICAL AND TEMPORAL PATTERNS OF GREEN TURTLES ALONG THE SOUTHWESTERN ATLANTIC COAST

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Green turtles (*Chelonia mydas*) are commonly found along the eastern coast of South America. Here we use a large-scale data set (N = 20,938) to investigate the spatial and temporal distribution of green turtles recorded in Brazil, Uruguay and Argentina from June 2005 to May 2011 (six years of observations). The green turtle is currently classified as Vulnerable in Brazil, Vulnerable in Uruguay and Threatened in Argentina, and is globally listed as Endangered by the International Union for Conservation of Nature (IUCN). The turtles were recorded between latitudes 2.93 and 42.57 degrees South (from Ceará, northern Brazil to northern Patagonia, Argentina), a region comprising about 6,800 km of coastline. The records were obtained by sea turtle conservation organizations in the three countries during their regular activities, rather than through dedicated sampling. Turtles were observed either alive or dead in four different ways: (1) stranded on beaches; (2) floating along the coast; (3) incidentally captured in coastal fisheries; or (4) intentionally captured in coastal waters by sea turtle researchers. Only turtles for which the curved carapace length (CCL, from the anterior point at midline (nuchal scute) to the posterior tip of the supracaudal scutes) was measured were included in the analyses. As a way of avoiding sampling bias, some analyses were only carried out for turtles found stranded on beaches regularly monitored for strandings in the six years (N = 6,929). Here we present analyses of the CCL variation by latitude and time, of the relationship between CCL and sea surface temperature, seasonal patterns of green turtle occurrence, and other analyses. The CCL of sampled individuals was in the range of 8-130 cm. The estimated sea surface temperature at sampling was in the range of 8.74-30.50 °C. The most conspicuous pattern in the available data is a latitudinal variation in the CCL distribution, with a clear gradual narrowing of its spread from north to south: the quantiles 0.05 and 0.95 of the CCL are, respectively, 30.0 and 96.0 cm to the north of latitude 15° S (Bahia, Brazil) (N = 5,729), 30.5 and 55.0 cm between latitudes 15° S and 30° S (Rio Grande do Sul, Brazil) (N = 13,392), and 32.0 and 50.0 cm to the south of latitude 30° S (N = 1,817). Fifty-five very small turtles (CCL ≤ 20 cm) were found, of which 53 (96.4%) were to the north of latitude 15° S, and 400 turtles with CCL ≥ 90 cm were found, of which 373 (93.3%) were also to the north of latitude 15° S. This research advances the current understanding of green turtle population biology in the Southwestern Atlantic and provides a wider scientific basis for regional conservation of the species.

CHARACTERIZATION OF FIBROPAPILLOMATOSIS IN GREEN TURTLES, *CHELONIA MYDAS* (LINNAEUS, 1758) (CHELONIIDAE), CAPTURED IN A FORAGING AREA IN SOUTHEASTERN BRAZIL

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Fibropapillomatosis (FP) is a multifactorial infectious disease that affects all species of marine turtles, mainly green turtles (*Chelonia mydas*). It is characterized by the development of internal or external tumourous masses that, depending on their locations and sizes, can affect locomotion, feeding, respiration, vision and health of the turtles. The etiology is not completely known, but it is associated with a specific herpesvirus and a series of environmental and biological stressors such as climatic changes, chemical

contaminants, bacterial infection and ectoparasites. Tumours may regress, progress or remain stable in size and quantity. Environmental factors may also play an important role in the regression and progression of tumors. However, there are few studies about this in the world, probably because the observations from the regressions and progressions derived from a continuous and long term capture-recapture of specimens with tumors. The goal of this study was to characterize the disease in *C. mydas* captured incidentally and intentionally in trawl beach nets in the coastal region of Itaipu, Rio de Janeiro, a foraging area in Southeastern Brazil, evaluating the prevalence in the mentioned area, and correlating the presence/absence, size, body distribution, number of tumours, and disease severity with the biometric variables of the captured green turtles. Each turtle also had its curved carapace length (CCL – cm) recorded and was examined for the presence of tumors. At each capture, we photographed the carapace, plastron and head of the turtles to allow for the photographic identification of individuals and to verify, by comparison of photos of capture and recapture, the presence of progression and regression of tumours. Between 2008 and 2014, the prevalence of FP was 43.09%, out of 246 green turtles. The CCL ranged from 28.0 to 81.5 cm (48.7 ± 13.8 cm, Mean ± SD). The size of the animals with FP was relatively higher than animals without tumours and the prevalence of FP increased with animal size, with a peak in the 60-80 cm size class. From 2013 to 2014, the macroscopic evaluation of fibropapillomas was performed. The number of tumours per turtle ranged from one to 158. The size of tumours ranged from ≤ 1 cm (size "A") to > 10 cm (size "D"); tumours "A" and turtles slightly affected by the disease (score "1") were both predominant, which may suggest a fatal disease (most animals moderately and severely affected eventually die). Most animals showed fibropapillomas distributed in the anterior section of the body (85.75%), which may be due to a significantly greater soft tissue surface area on the front. Some recaptured turtles and with comparable photos showed tumour progression (72.1%) and regression (32.8%). Moreover, 24.6% of these turtles showed both progressions and regressions of tumours.

DIVE PATTERNS AND MOVEMENTS OF LOGGERHEAD TURTLES (*CARETTA CARETTA*) IN FEEDING AREAS IN SOUTHERN BRAZIL

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The south of Brazil is an important feeding area for sea turtles. Previous work reported a high incidence of strandings and incidental captures of *Caretta caretta* in this region. ARGOS-linked Wildlife Computers PTTs, SPLASH models, were attached to 5 juveniles and 4 adults of loggerhead turtles (mean Curved Carapace Length=77.1 cm, sd=13.2), caught by bottom pair trawlers on Rio Grande do Sul continental shelf. The deployment date range from December 2014 to April 2015 and 5 turtles were transmitting until October 2015. Sea surface temperature (SST) (http://ghrsst-pp.metoffice.com/) and bathymetric data (www.gebco.net) were integrated for physical analyses influencing the turtles' movements. Bathymetric data were used to classify the positions into 4 groups: Inner Continental Shelf (depth 1000 m). The number of transmitting days ranged from 58 to 240 (mean=168 days, sd=71.4). The individual number of dive histograms registered in a day ranged from 1.2 to 5.8 (mean=2.3 histograms/day). The transmitted positions go from the north of Argentina (42º S) to Paraná State (25º S), with a maximum coastline distance of ~1500

km (36º W). Most of the positions were located at the abyssal plain (42%), followed by the Inner Shelf (37%) and Outer Shelf (19%). All turtles have registered most Time-At-Depth (TAD) in shallow dives (20% of dives) for 6 turtles. The results presented here are very important and help to better understanding loggerhead behavior in foraging area. Also, these data can be used as support in defining priority areas for conservation and helping to reduce incidental captures in fisheries.

WORKING WITH FISHERMEN TO MINIMIZE SEA TURTLES CAPTURE AND MORTALITY IN PELAGIC LONGLINE FISHERY IN BRAZIL

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Bycatch has been identified as a major cause of sea turtle deaths worldwide. For this reason, the adoption of mitigation measures regarding this issue is very important. These strategies rely on an institutional environment for fisheries management, enabling managers to properly evaluate and monitor the outcomes and results. Currently, Brazil is at an unstable moment regarding fishing policy and management by governmental institutions. As a means to face this issue, management actions have been undertaken by a variety of institutions, creating relevant and consistent results for sea turtle conservation. This paper reports on the collaborative experience between researchers from Projeto TAMAR and fishers, in an attempt to reduce sea turtle bycatch in pelagic longline fisheries. This strategy was inspired by the results from TAMAR´s previous experiments in sea turtle nesting areas, as well as from other research groups, such as, Projeto Albatroz and NEMA - Núcleo de Educação e Monitoramento Ambiental. Since 2004, TAMAR, in partnership with fishing companies and fishers, has been working to introduce circle hooks and mitigatory tools (de-hooker and line-cutter) into the pelagic longline fleet that operates in southern Brazil, which mainly captures *Caretta caretta* and *Dermochelys coriacea*. The daily interaction between on-board observers and fishers, as well as the direct contact with fishers at the mainly longline harbors has created a powerful bond of trust. Mutual trust built over the years has allowed the development of integrated conservation strategies. The main results of this cooperative work are: 1) Consensual permission from the fishing companies and the boat's captain to embark observers to collect data during the fishing operations. All information collected is shared to the companies and the crew, making this process transparent for all; 2) The crew is trained to properly handle entangled or hooked sea turtles. 3) Captain's logbook, containing detailed information about fishing operations, are shared to Tamar's researchers 4) Adoption of mitigation measures. Circle hooks, which had previously been rejected by most captains, are now accepted and partially used by 18 of the 35 vessels operating at the ports of Itajaí and Navegantes, and fully used in eight of them. 5) Development of mitigation tools. Although industrialized de-hookers have been distributed to fishermen and they had been trained to use them, it became clear that they don't use them. Instead, they prefer to use two other models they themselves developed. The first was developed with a wooden handle with a "V" cut at its end. In the second method, the hooks are removed from the turtles using the own branchline as a tool. This procedure is known as the "loop technique". Both models / systems are highly

efficient and much cheaper than industrialized de-hookers. Even if there is some difficulty in policy and fisheries management, the experience related here shows that cooperation between fishers and researchers toward to understand the problem of bycatch and looking for solutions is very important for promoting sustainable fishing, reducing unwanted captures and consequently protecting sea turtles.

HABITAT USE, SITE FIDELITY AND CONSERVATION OPPORTUNITIES FOR JUVENILE LOGGERHEAD SEA TURTLES IN THE RÍO DE LA PLATA, ARGENTINA

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The loggerhead turtle (*Caretta caretta*) is listed as vulnerable on the IUCN Red List due to threats that spread across its geographic range. Among all the threats faced, the mortality of juveniles and adults due to bycatch in longline, trawling and gillnet fisheries in foraging grounds seems to have the most harmful effect on populations as these stages offer the greatest potential for population recovery. Thus, knowledge of the behavior and spatial distribution of individuals in foraging grounds may help design more effective local conservation strategies, such as bycatch reduction technologies or time-area closures. This study assesses the habitat use of juvenile loggerheads in the Río de la Plata estuarine area, at the boundary of their distribution in the temperate SW Atlantic. Data from the satellite tracking of 6 neritic juveniles are analyzed through switching state-space models and kernel density estimation to identify preferential putative foraging areas and routes. Results indicate that immature turtles exhibit a strong foraging site fidelity to the Río de la Plata; either by remaining in the same 8,000 km2-area during 60% of their foraging time (7-8 months) or by migrating back to the same foraging spot in successive years (inter-annual site fidelity). Some loggerheads overwinter in coastal, warmer waters off Brazil and Uruguay, and also in oceanic areas. The fidelity of juvenile loggerheads to the Río de la Plata encourages site-based conservation tools. Spatial planning may result in special management areas supported by current regional treaties. sustainable fishing, reducing unwanted captures and consequently protecting sea turtles.

SCIENTIFIC PRODUCTION IN THE SOUTHWESTERN ATLANTIC: WHERE WE ARE AND WHERE WE'RE GOING?

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The ASO-Turtle Network is a group of people that work in research and/or conservation of sea turtles in the Southwestern Atlantic Ocean (ASO), in Brazil, Uruguay and Argentina. It was founded during its first formal meeting in Montevideo, in 2003. During this 12 years-period, the Network increased the number of institutions and people, the number of sites where research and conservation are being developed, and expanded its geographic range of activities. Due to these contributions, a remarkable increase in scientific and academic products has resulted, and their potential to contribute to the conservation and management is evident in each of the countries in the region. This study presents a review and analysis of the scientific contributions made by ASO members in the international context. Our approach started with a search in SCOPUS database, which shows that a total of 89 publications (0 to 13 per year) belong to ASO. This contribution represents, in total, 4.7% of the indexed global scientific production on sea turtles. Although in some years nothing indexed had been published, in other years it reached 6.7% of the global published papers on sea turtles, as in 2010, with some stability around 5% after 2008. A broader analysis of materials published in indexed journals showed that there are 591 scientific publications on turtles in the SWA. The growth in the number of studies is evident and also the increase that occurred in the post ASO-Turtle Network phase, with at least 20 publications each year from 2006. Regarding the development of scientific production in the region, it could be classified into three stages: the first (historical) period started in 1839 with the initial publication that refers to the presence of sea turtles in the region. The second phase is associated with scientific productivity generated by the creation of Projeto TAMAR (Brazil), leading to a paradigm shift in terms of the issues, and not only mentioning presence and distribution of turtles in the region, but topics included conservation and biology. The third phase is the one that covers the period post ASO-Turtle Network, during which a continued increase in number of publications is evident. Analyzing the diversity of themes, on which some studies were placed in more than one category, resulted in 28% were on biology and ecology, 18% on management and policy, 19% on distribution and migration, 15% on veterinary or parasitology, 12% on interaction with fisheries, 7% on population genetics, 6% on ethnobiology and 5% on contamination by chemicals or plastics. The cooperation, exchange of information and experiences, as well as discussion of strengths and problems in common among countries, in recent years have resulted in joint publications with two or three countries in the region, allowing broader biological and conservation issues to be addressed. Thus, sea turtles found in the waters of the ASO are benefited in various ways by these actions, in particular the scientific cooperation and continuous increase in scientific knowledge on sea turtle species.

GENETIC DIVERSITY AND NATAL ORIGINS OF GREEN AND LOGGERHEAD SEA TURTLES FROM RIO DE JANEIRO AND RIO GRANDE DO SUL STATES, BRAZIL

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In Brazil, there are five species of sea turtles, the loggerhead, green turtle, hawksbill, olive ridley and leatherback turtles. All of them are currently considered endangered. *Chelonia mydas* is the most abundant species feeding along the Brazilian coast, while *Caretta caretta* is the most common nesting sea turtle found on continental beaches of Brazil. Genetics is a useful tool for understanding many aspects of the sea turtle life cycle, including natal origins, migratory behavior and connectivity. In the present study, we aimed to (a) genetically characterize green and loggerhead sea turtles based on ~800bp mtDNA fragments, (b) evaluate genetic differences between stranding and bycatch samples, from different life stages, collected in different years, and (c) define their natal origins and connectivity. For this purpose, we analyzed 261 samples of green turtles from Rio de Janeiro state: 61 captured by trawling and 200 stranded. We also analyzed 265 samples of loggerheads: 82 captured by pelagic longline fishery in Elevação do Rio Grande (a seamount located ca. 800 km off the south coast of Brazil), 155 stranded along Rio Grande do Sul coastline, and 28 stranded along beaches in Rio de Janeiro state. We identified 16 longer mtDNA haplotypes among *C. mydas* samples, including a new one (different from CM-A8 by one polymorphic site). The most frequent haplotypes were CM-A8 (52.1%) and CM-A5 (34.5%). Among *C. caretta*, we identified 12 longer mtDNA haplotypes, including seven new subtypes (two of CC-A4, one of CC-A11, one of CC-A25, two of CC-A33 and one of CC-A34) and a new haplotype (different from CC-A33.1 by one polymorphic site). The most frequent haplotype was CC-A4.2 (69.5%). Mixed Stock Analysis (MSA) showed that Ascension Island, Suriname, Aves Island and Guinea Bissau were the main sources for Rio de Janeiro *C. mydas* samples. Contributions from Trindade Island were possibly underestimated. MSA also indicated that Brazilian nesting colonies were the main sources of *C. caretta* sampled in Rio de Janeiro, Rio Grande do Sul and Elevação do Rio Grande, with less expressive contributions from the Pacific (mainly from Australia), North Atlantic and Mediterranean. Differences observed between *C. mydas* and *C. caretta* can be directly attributed to behavioral aspects: while juvenile and adult green turtles undertake long migrations among breeding and feeding zones, loggerhead turtles tend to feed near their natal beach, except for oceanic juveniles. For both species, there were no significant genetic differences among years, stranding and bycatch samples, and life stages (juveniles and adults). Our results confirmed the usefulness of expanded mtDNA sequences in detecting novel polymorphisms, especially for *C. caretta*. However, it is crucial that more sea turtle populations are characterized with longer mtDNA sequences to allow increased resolution of MSA. Considering the importance of the study areas, reducing mortality of these organisms, mainly due to the interaction with fisheries, is urgent. Given the connectivity among Brazilian populations (especially for *C. mydas*) and several other populations in the world, conservation of these species requires global efforts.

ANTHROPOGENIC IMPACT AFFECTS BIOCHEMICAL NUTRITIONAL PARAMETERS OF JUVENILE GREEN TURTLES IN BRAZIL

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Chelonia mydas is a species classified as vulnerable to extinction. In Brazil, it has a neritic distribution associated with the feeding areas. In the first phase of life, they present an omnivorous diet and becomes herbivores as juveniles and adults. Environmental contamination by industrial effluents, agricultural runoff and domestic sewage have a harmful influence in marine environment affecting the abundance and diversity of food resources for green turtles. In addition to dietary changes, impacted environments provide a favorable scenario for the occurrence of diseases. Little is known about the anthropization effect on the nutritional status of *Chelonia mydas* in Brazil. This study evaluates the relationship between the pollution of the marine environment and biochemical parameters related to the nutritional status of juvenile green turtles. Three feeding areas with different degrees of human disturbance were evaluated. Between October 2012 and May 2014, we captured 21 turtles at Espirito Santo bay in the city of Vitória, 42 at Abrolhos Marine National Park, Bahia, and 60 at Atol das Rocas Biological Reserve, Rio Grande do Norte State. Biometric measures (curved carapace length, curved carapace width, weight) were taken and the animals were classified as in bad, average or good body condition. Body index was calculated (kg/CCL3). Blood samples were taken for plasma quantification of glucose, triglycerides, total protein, albumin, globulin, albumin:globulin ratio, urea, uric acid, calcium, phosphorus, calcium:phosphorus ratio, iron and magnesium. The ANOVA test ($p < 0.05$) with integrated normality test, and Tukey test post hoc were performed to verify differences in variance of the parameters between the three feeding areas using SPSS 17.0 software. The body condition and calculated body index were similar ($F = 2.63$, $p = 0.076$) among the studied areas, however parameters such as glucose ($F = 38.3$, $p = 0.00$), triglycerides ($F = 13$, 7, $p = 0.00$) , urea ($F = 10.2$, p $32 = 0.00$), albumin ($F = 7.2$, $p = 0.01$) , albumin:globulin ratio ($F = 4, 1$, $p = 0.19$) , phosphorus ($F = 36.3$, $p = 0.00$) , Ca: P ratio ($F = 4.25$, $p = 0.016$) and magnesium ($F = 19.9$, $p = 0.00$) showed significant differences. Turtle plasmatic phosphorus showed a visible direct correlation between the degree of human influence on the area. We concluded that environmental anthropization affects the nutritional status of *Chelonia mydas*. Biochemical parameters varied according to the degree of human impact, however subclinical diseases should be taken into account when interpreting the results. The level of plasmatic phosphorus in green turtles may be a possible environmental quality indicator in feeding sites, but studies of this relationship should be undertaken to develop a more complete understanding. We also recommended studies about *Chelonia mydas* diet variations in environments with different levels of human impact.

IMPLICATION OF METALS IN FIBROPAPILLOMATOSIS IN JUVENILE GREEN SEA TURTLES *CHELONIA MYDAS* FROM SOUTHERN ATLANTIC OCEAN

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Environmental contaminants have been suggested as a possible cause of fibropapillomatosis (FP) in green sea turtles. In turn, reduced concentration of serum cholesterol has been indicated as a reliable biomarker of malignancy in vertebrates, including sea turtles. In the present study, a set of haematological, serum biochemical parameters, metal (Ag, Cd, Cu, Fe, Ni, Pb and Zn) concentrations and oxidative stress parameters [(antioxidant capacity against peroxyl radicals (ACAP), protein carbonyls (PC), lipid peroxidation (LPO), micronucleated cells (FMC)] were analyzed in the blood/serum in green sea turtles (*Chelonia mydas*) with (n = 14) and without (n = 13) fibropapillomatosis (FP). Individuals were collected in coastal waters of the southern Atlantic Ocean (Ubatuba, São Paulo, southeastern Brazil) from January 2011 to March 2012. Only juvenile (29.3 – 59.5 cm curved carapace length) female (serum testosterone concentration < 10 pg/ml) green sea turtles were evaluated. Haematological parameters analyzed included hematocrit, total red blood cells, total leucocytes, heterophils, lymphocytes, eosinophils, monocytes, and basophils. Serum biochemical parameters analyzed were cortisol, glucose, cholesterol, triglycerides, uric acid, urea, creatinine, total proteins, albumin, globulin, total bilirubin, direct bilirubin, indirect bilirubin, sodium, potassium, chloride, magnesium, calcium, phosphorus, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, gamma glutamyl transferase, creatine kinase, lactate dehydrogenase, and 3-hydroxy-3-methylglutaryl-CoA reductase (HMGR). Green turtles were grouped and analyzed according to the severity of tumors. Individuals heavily afflicted with FP showed significantly higher blood Cu, Pb and Fe concentrations, blood LPO level, as well as significantly lower serum cholesterol concentration and HMGR activity than turtles without FP. Cholesterol concentration and HMG activity were positively correlated, as well as LPO level and Fe and Pb concentrations. The reduced cholesterol level observed in turtles with FP seems to be associated with an inhibition of the activity of HMGR, an enzyme catalyzing the rate-limiting step in sterol biosynthesis, as well as a higher rate of cholesterol oxidation. On the other hand, Cu and Pb concentrations were significantly and negatively correlated with HMGR activity and cholesterol concentration. Moreover, Cu, Fe and Pb were positively correlated with each other. Thus, the reduced concentration of serum cholesterol observed in green sea turtles heavily afflicted with FP is related to a Cu- and Pb-induced inhibition of HMGR activity paralleled by a higher LPO rate induced by increased Fe and Pb concentrations. Our findings indicate that reduced serum cholesterol concentration can be a potential biomarker of tumoral development (FP) in juvenile female green sea turtles. Furthermore, as oxidative stress is implicated in several pathogenesis of viral infections, our findings support the idea that metal contamination, especially Cu, Fe and Pb, may be related in the etiology of FP in green sea turtles through oxidative stress generation.

HAWKSBILL X LOGGERHEAD SEA TURTLE HYBRIDS AT BRAZILIAN FEEDING GROUNDS*

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Natural hybridization between Cheloniid sea turtles has been reported worldwide for several species, and genetic analyses are increasingly being used to confirm and evaluate the extension of these events. Hybrid sea turtles are exceptionally common on the Brazilian coast due to unknown causes, and with unknown consequences. It has been shown that 42% of adult hawksbill turtles nesting at the Bahia rookery in Northeast Brazil are actually hybrids, presenting mitochondrial DNA (mtDNA) haplotypes typical of loggerheads. The hybrid offspring of these females was reported in literature for the first time in 2014, when mtDNA of samples collected from 157 immature hawksbills along the coast were analyzed, and four hybrids identified. Hybrids were present in areas common for loggerheads (Ceará and Rio Grande do Sul states), suggesting that these animals could present ecological adaptations more similar to this species. Classified as a priority in the National Plan for Marine Turtle Conservation, this subject requires thorough investigation in order to better understand the distribution and management strategies of hybrid animals. This work further investigates the hybridization process between hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*) turtles along the coast of Brazil, through genetic analysis of 66 additional hawksbill samples from Ceará, Bahia and Rio Grande do Sul states. DNA was extracted and the mtDNA D-Loop amplified through PCR using primers LCM15382/H950. PCR products were purified and sequenced in both directions, and sequences were aligned and classified according to GenBank®. In the 66 new samples, we found a high frequency of haplotype Ei A01 (n=52), and a lower occurrence of haplotypes Ei A32 (n=4), Ei A61(n=1) and Ei A62 (n=4). Haplotype Ei A01 is the most common haplotype in the Atlantic Ocean, and the remaining haplotypes occur frequently in Brazilian nesting and feeding populations. We also encountered four additional hawksbill x loggerhead hybrids (haplotype Cc A4.2), and one hawksbill x olive ridley (*Lepidochelys olivacea*) hybrid (haplotype Lo 78920). Once again, most hawksbill x loggerhead hybrids were observed at areas where loggerheads occur more commonly, such as the cold waters along the extreme South of the coast (Rio Grande do Sul), where hawksbills are rarely found. The hawksbill x olive ridley hybrid was found at Ceará and is one of the first records of this type of hybridization. The genetic analysis conducted revealed that immature hybrids are relatively common in Brazilian populations when compared to other areas in the world. The next step is to analyze the nuclear DNA of samples in order to enhance hybrid detection, as well as clarify the generation, parental species, and distribution of these animals. In this manner, we hope to contribute towards the understanding and aid in the elaboration of management strategies of hybrid sea turtles in Brazil.

SKULL SHAPE AND SIZE IN JUVENILE GREEN TURTLE: ONTOGENETIC AND BIOGEOGRAPHIC VARIATION*

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Marine ecosystems and biodiversity are under threats because of human activities. Knowledge about morphological variations is the basis to evaluate the level impact and the threat of species extinction. The cranial morphology is a result of interaction between gene expression and environmental action, which is an essential parameter in the population assessment. The present study aimed to analyze skull shape and size variation in juvenile green turtles on a feeding ground composed of mixed genetic stock, considering the sex, age and origin as variation factors. Analyzed animals came from strandings on the Paraná coast and the sex and ages were determined in previous studies. In addition, the origin determination was evaluated in this study from the mitochondrial DNA (10 haplotypes). The mixed stock analysis suggests that juvenile green turtles of Paraná feeding ground originate mainly from Ascension Island (65%), with less contribution from Suriname (10%), São Tomé (9%) and Bioko (6%) rookeries. The results of morphometric geometry including all sample shows differences in skull shape between males and females. This variation does not necessarily reflect sexual dimorphism, but can be a genetic factor. When evaluating age, the skull size was structurally larger in green turtle of 5 yrs compared with younger juveniles, which suggests an ontogenetic phase change. The origin was the main factor in intraspecific variation in skull morphology of green turtle, with individuals from the southern Caribbean (CM-A5) having a stretching in the anterior portion of the skull and a narrowing of the posterior region in relation to the population of South Atlantic (CM-A8). Molecular studies suggest distinct evolutionary lineages to green turtle in Atlantic Ocean, which can justify differentiation in skull shape and size. These results provide evolutionary, ecological and biogeographic information about the species. In addition to indicating the connectivity between the feeding areas in southwestern Atlantic Ocean with the nesting areas of the south Atlantic, Africa and the southern Caribbean, this work highlights the importance of migratory corridor and integrated management. Thus, the analysis of cranial morphology is an important tool in the evaluation of population stocks and to support the establishment of management units for the conservation of green turtles.

WHERE DOES THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) COME FROM? FROM POPULATIONS GENETICS TO ELEMENTARY SCHOOL

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Uruguayan waters are an important feeding area for immature and mature loggerhead sea turtles (*Caretta caretta*), considered as endangered by the IUCN. Similar to other sea turtle species, *C. caretta* females have philopatric behavior, which allows identification of different haplotypes and establishment of individual's geographic origin through mitochondrial DNA (mtDNA) analyses. Molecular genetics provides powerful tools to develop conservation plans. Yet any successful effort needs environmental education programs promoting awareness of the importance of sea turtles in ecosystems and the major threats they face. Within a student project focused on genetic diversity analysis of stranded individuals along the Uruguayan coasts, two activities were conducted with 11 to 12 year-old school children from Montevideo. While this city has extensive physical and cultural contact with the coast, its inhabitants are often unaware of Uruguayan marine biodiversity. Activities were designed to bring scientific knowledge to school alumni and teachers, which resulted in a learning experience for all involved. It began with an interactive talk to provide children with knowledge on sea turtles biology, major threats and the contributions of population genetics to their conservation. The second activity was a visit to the NGO Karumbé Marine Turtle Museum and Rehabilitation Center, where children could reinforce acquired knowledge by touring the museum and actually observe sea turtles in rehabilitation, paying special attention to the reasons why those specimens were in rehabilitation. The whole activity was closed with a Q&A game using a giant world map where 5 different turtle groups (haplotypes) departed from their nesting beaches towards their feeding spots in Uruguayan waters. Children formed 5 color teams, each one representing a haplotype, and to reach Uruguayan waters they had to overcome a series of questions and challenges linked to threats faced by loggerhead turtles throughout their life cycle. Children were highly interested, showing high integration levels of the acquired knowledge during the activities. In turn, for young researchers the activity was a challenge to adapt lab results to an educational instance in order to meet key concepts associated with the biology and conservation of the species. This work constitutes an example of bringing scientific knowledge to non-scientific stakeholders. In the context of conservation research and education, we argue that these educational activities should be included in curricular activities of undergraduate students. Acknowledgments: The authors would like to thanks Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesquería y World Wildlife Fund.

INSIGHTS FROM LONG-TERM IN-WATER CAPTURE-MARK-RECAPTURE ON A GREEN TURTLE FORAGING POPULATION IN BRAZIL

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Using an example from Brazil, we highlight the insights that could be obtained from long-term capture-mark-recapture in foraging areas. We present the results of one of the longest ongoing capture-mark-recapture studies of juvenile green turtles (*Chelonia mydas*) worldwide. From 1988 to 2013, 1,279 individual turtles were tagged in Fernando de Noronha, Brazil (3°51′S, 32°25′W). The size distribution at first capture varied between 27 and 87 cm (mean ± SD 47.9 ± 11.3 cm) curved carapace length (CCL). Median residence time was 2.4 year (with long-term residence of up to 11.2 year), with individuals exhibiting some site fidelity within the Archipelago. Turtles at this site are slow growing (mean 2.6 ± 1.6 cm year−1; range −0.9 to 7.9 cm year−1; n = 1,022), with a non-monotonic expected growth rate function and a peak in growth rates occurring at 50–60 cm CCL. At these rates, turtles in Fernando de Noronha would need to spend ca. 22 years to grow from 30 to 87 cm CCL and even longer to reach minimum adult breeding size. A Cormack–Jolly–Seber model was used to estimate the apparent survival of the residents and recapture probabilities (2001–2012). The estimated annual abundance ranged from 420 to 1,148 individuals. Confidence around abundance estimates was low, and there was no significant trend over the period, despite steep recent increases at the major source rookery. Slow growth and stable stocking numbers may be suggestive of density-dependent regulation having taken place following initial population recovery that occurred prior to the current study.

HEMATOLOGICAL EVALUATION OF INTENTIONALLY CAPTURED GREEN TURTLES (*CHELONIA MYDAS*) IN PARANÁ STATE, SOUTHERN BRAZIL

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The green turtle, *Chelonia mydas*, regularly feeds along the Brazilian coast and nests mainly on ocean islands. Unfortunately, this species is still at risk, mainly due to anthropogenic activities, and little is known about their health parameters and diseases. Fibropapillomatosis is a chronic disease characterized by single to multiple tumors that primarily affects green turtles. In order to assess the hematological parameters of juvenile green turtles that feed along the coast of Paraná, southern Brazil, the animals were intentionally caught in gill nets placed daily in two different areas, Mel island (25°29'S 48°20'W) and Cobras island (25°28'S 48°25'W) during one week. Curved carapace length (CCL) and body mass (BM) were recorded for each animal. Additionally, turtles were also evaluated for nutritional status: good (1), medium (2) and poor (3) and for the presence of fibropapillomas. Blood samples were withdrawn from the dorsal cervical sinus into heparinized tubes. Blood smears were made using a spreader slide toward the drop of whole blood. PCV was determined using the microhematocrit method. Red blood cell (RBC), white blood cell (WBC) and thrombocytes were manually counted in a Neubauer chamber, using a Natt-Herrick solution. Blood smears were fixed and stained with Diff-Quick (Laborclin) and differential WBC count was held in the optical microscope lens of 100X. Hematological values of sea turtles with or without fibropapillomatosis were analysed using a t-test for parametric assays or Mann-Whitney for non-parametric assays (Sigma Stat; $P \leq 0.05$). A total of 43 animals were sampled, of which 10 presented fibropapillomas (23.8%). The CCL and BM mean were 41.5 cm (±4.8) and 8.7 kg (±3.2), respectively, and turtles were in medium body condition (median=2). The results are as follows: erythrocytes $1.4 \times 10^5/\mu L$ (±1.4), packed cell volume (PCV) 25.6% (±8.3), mean corpuscular volume (MCV) 262fL (±200.1), leukocytes $45.3 \times 10^3/\mu L$ (±17,6), heterophils $32.4 \times 10^3/\mu L$ (±15.5), lymphocytes $10.6 \times 10^3/\mu L$ (±7.9), monocytes $0.7 \times 10^3/\mu L$ (±1.2), eosinophils $0.7 \times 10^3/\mu L$ (±1.7), and thrombocytes 184.4 (±141.7). No statistically significant threshold differences were found between green turtles with and without fibropapillomas. Both groups had a slightly elevated heterophil count. The primary function of heterophils is phagocytosis and significant increases are usually associated with inflammatory disease, especially microbial and parasitic infections or tissue injury. It is relevant to note that heterophils and WBC may vary and be influenced by seasonal factors and stress. Wide variation in hematologic values across chelonian species emphasizes the importance of establishing species-specific baseline health data for both captive and wild sea turtles. Acknowledgments: The authors thank the ONG MarBrasil for their assistance in the field.

"EDUCATION FOR ACTION" SHARED EXPERIENCES OF ENVIRONMENTAL EDUCATION IN THE SOUTHWEST ATLANTIC NETWORK – ASO

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The ASO-Turtle Network, established in 2003, consists of researchers, educators, conservationists and students from Brazil, Uruguay and Argentina. The network has formed several topical groups to promote information exchange and collaboration, and thereby enrich both new and experienced researchers. One of these groups focuses on environmental education (EA). At the second ASO meeting (2004) a Workshop on Strategies for Environmental Education was organized was to understand the different dynamics of working groups that make up ASO and share experiences, activities, information, and methodologies. In 2005, at the 3rd ASO meeting, educators met to present and discuss actions and join forces to develop common environmental education goals of network. The 4th meeting (2007), saw the workshop on "Building the foundation for Environmental Education of the ASO-turtles network" was conducted by professor José Matarezi, of Laboratório de Educação Ambiental (LEA), Brazil. At the 5th meeting (2009), the workshop "Education for Action: Pollution anthropogenic garbage", focused the group's commitment to take action, and concentrate on anthropogenic debris in marine and coastal environments that expose the marine turtles to risks. An instrument was developed to help integrate participants and programs in the three ASO countries to help sensitize people (mainly students, fishermen, and decision-makers) about environmental pollution. An informative, illustrated poster about the problems of pollution and risks to sea turtles was produced and then used widely by projects in the three countries. The workshop at the 6th ASO meeting (2011) focused on creating opportunities for: mapping environmental education and environmental awareness, developing opportunities for training in areas related to environmental education, strengthening integration of environmental education in the training courses for scientific observer on board; and promoting exchanges and opportunities for partnerships among different actors. A sequel to the 2011 ASO EA agreements was a meeting of professionals in EA hosted by LEA, with follow-up electronic communications, and the development of the project proposal "Diagnosis of environmental education initiatives". The diagnosis aims to establish a foundation of basic information and materials as well as promote stronger development and collaborations among EA actors and programs in the ASO network. Finally, at the 7th ASO meeting (2013) oral presentations, and informal discussions generated valuable exchanges of experiences and teaching materials among Network members. The the above-mentioned proposal was also presented, with the aim to strengthen and continue environmental education activities

throughout the ASO network. In conclusion, we note that the diversity of these diverse activities (carried out by members of different NGOs, from different countries) have generated rich exchanges of ideas and inspiring discussions. Overall, the results presented at the different workshops and ASO meetings were convergent and complementary. There were also similar criteria to define the subject matter and most important actions on which to focus environmental education. Finally, we extend our gratitude and affection to all the people who over the years have participated and built this beautiful and collaborative group. Acknowledgments: Many thanks to the ISTS for the travel grant support.

LIVING WITH ANTHROPOGENIC DEBRIS: DESCRIPTION OF CLINICAL CASES

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Marine debris is one of the main causes of morbidity and mortality of sea turtles. In Uruguay, this threat is the second cause of strandings of green turtles (Che*lonia mydas*). The green turtle is the most frequent species affected. Previous studies in Uruguay indicated that more than 80% of the stranded and necropsied green turtles had marine debris in some part of their digestive track. According to rehab data, from 2001 to 2011, 300 sea turtles were brought into the centre (*Chelonia mydas* and *Caretta caretta*). During this period, 195 sea turtles died, 50% of these turtles had intestinal obstruction caused by anthropogenic debris. In the rehabilitation protocol, medical treatment is the first option but if the procedure fails, then surgery could be proposed. But the surgery is expensive, requires infrastructure and the probability of death of the turtle during the surgery or after, provoked by a postsurgical peritonitis is common. And the improvement of this medical treatment is important. Along these years, in the rehabilitation centre of the NGO Karumbé, many turtles were treated medically and surgically but without success. The objective of this work is to describe some cases of juvenile green turtles that had an interaction with marine debris, their different treatments and their subsequent progression. On March 9, 2015, a juvenile green turtle was captured in the long-term monitoring study of a green turtle aggregation on the northeast coast of Uruguay. It was in fair condition, weighted 6.3 kg, 40, 5 cm of curve carapace length. There was present a fishing line coming out of the cloaca, measuring 15 cm in length. We fed the turtle with algae and it continuously defecated debris like fishing line, pieces of plastic bags and hard plastic. A combination of methods to counteract the obstruction was realized as oral treatment with mineral oil, metoclopramide (0.3 mg/kg), esophageal lavage and physiotherapy. The turtle started to eat and defecate but was floating constantly. The turtle defecated with debris for 7 months a total of 16 g of marine debris (25% of plastic bags, 25% of fisher line, 25% of stones, 15% hard plastic and 10% vegetable fiber). It finally died with a very bad condition (5.35 kg). The findings of the necropsy revealed an impaction with marine debris in the large intestine and a lage abscess in the esophagus serosa. On May 8, 2015, another juvenile green sea turtle was affected by a fishing line, but in this case the line was coming out from the mouth and cloaca. It was in poor condition, had a 40.2 cm curve carapace lengh and weigthed 6.25 kg. The x-ray did not show any hook. After 18 days of medical treatment (fluidoterapy and antibiotics) the turtle was operated upon. Two long fishing lines were extracted during the enterotomy. The intestine was fragile, with multiples injuries in the mucosa and it required an anastomosis. The turtle survived the surgery but died 20 days after. A peritonitis around the intestinal anastomosis and other parts of the intestine was the cause of the death. Impaction and obstruction of the gastrointestinal track is a complex pathology, the result depends on the initial body condition of the turtle,

the type of obstruction and the occurrence of secondary diseases. Acknowledgments: The authors would like to thanks The University of Uruguay Veterinary Laboratory and Imagenology, the "Villa Dolores" Zoo vet team, the Seaturtle reablist group.

NEGATIVE INTERACTION BETWEEN SEA TURTLES AND VESSELS IN NITERÓI AND RIO DE JANEIRO – BRAZIL

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Marine turtles have a long and complex life cycle, facing a variety of natural and anthropogenic threats, from the egg until the mature phase. After the first five years of life, turtles migrate shoreward inhabiting coastal waters and hence getting more exposed to vessel collisions. The number of accidents increases every year, mostly during spring and summer when coastal tourism peaks. Furthermore, turtles may be affected by the presence of fibropapillomatosis (FP), which is a benign but debilitating neoplastic disease that could affect swimming and/or feeding, depending on tumor size and place. This work aimed to analyze the prevalence of turtles affected by vessel collisions, determining factors such as turtle size (carapace length and weight), the seasonal frequency of collisions, lesion patterns and the presence of FP. This research is part of "Projeto Aruanã - Sea Turtle Monitoring and Conservation Program" operating in Guanabara Bay and surroundings, Rio de Janeiro – Brazil. Data was collected through (a) intentional population monitoring captures occurring during eight consecutive days four times a year since 2013, in Itaipu beach, Niterói, Brazil (22º53'14"S, 43º22'48"W); (b) incidental captures in the artisanal fishery; and (c) strandings of dead or debilitated turtles in various places within the monitored area. Out of 215 animals recorded, 11 (5.1%) showed possible vessel collisions marks, with nine occurrences during spring and summer, suggesting an increase in boat traffic at this time of the year due to tourism. Average Curved Carapace Length (CCL±SD) was 55.8±12.3 cm and body weight (±SD) 22.7±14.7 kg. The distinguishing lesion marks included scars, carapace tissue loss and deep scratches on carapace and head. Additionally, five turtles had FP, suggesting that reduced mobility due to FP increased the chances of collision with vessels. Lesion patterns were consistent with previous records. Sea turtle interactions with vessels have been reported in the Canary Islands (prevalence = 23.0%), Australia (12.0-16.0%), and the Mediterranean coast of Spain (9.0%). The lowest prevalence in our study and the Paraíba state (3.8%) may be a consequence of the Brazilian law, which prohibits navigation within 200m of the shoreline. Nevertheless, monitoring and enforcement is needed to effectively protect sea turtles within shallow waters. To date, few studies focused on the prevalence of turtles affected by vessel interactions. Further studies are needed to quantify the impacts on sea turtle populations and provide additional mitigating strategies. Acknowledgments: The authors would like to thank Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq and Coordenadoria Aperfeiçoamento Pessoal – CAPES, for the fellowships during this study.

DETECTION OF ALPHAHERPESVIRUS IN SECRETIONS OF *CHELONIA MYDAS* IN THE BRAZILIAN ATLANTIC COAST*

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The green turtle (Che*lonia mydas*) is the most affected sea turtle species by fibropapillomatosis disease, which can be considered fatal because of the severity of the lesions. The most likely primary agent of this disease is a herpesvirus, the CFPHV (Chelonid fibropapilloma associated herpesvirus). This pathogen is recognized by the presence of a latency cycle, characterized by the absence of replication in a specific tissue, and by a lytic cycle, in which viral particles are released and can infect other hosts. The dissemination of the herpesvirus can occur through secretions, aerosols, feces or infected cells, but this feature of the virus has been poorly studied in CFPHV. The leech species, *Ozobranchus sp.*, was pointed to as one of the main possible vectors of the parasite. In order to detect the presence and prevalence of CFPHV in green turtle secretions in different regions of the Brazilian coast, oral and ocular swabs of 96 individuals from Ubatuba-SP (25), Vitória-ES (31) and Fernando de Noronha-PE (40) were collected and the observed prevalence was 6.25% (6/96), 20% in Ubatuba-SP (5/25) and 2.5% in Fernando de Noronha-PE (1/40), and no detection in turtle secretions in Vitória-ES. The CFPHV detection was performed by PCR, which verified the presence of 5 genes - UL18, UL22, UL27, DNA polymerase and F-US3B. Fragments of the genes for DNA polymerase and F-US3B were amplified and evaluated regarding the substitution of nucleotides. There were no substitutions in fragments of the detected F-US3B gene, while fragments of 460 bp of DNA polymerase allowed the detection of a viral variant of the CFPHV, which had not been detected in previous studies in Brazil, showing 100% identity with CFPHV present in Puerto Rico. The haplotype of individuals that presented the herpesvirus in secretions were also identified by mtDNA. Individuals belonging to the CM-A3 and CM-A8 haplotypes possessed the virus in at least one of the secretions. The observed results permitted the inference that individual green turtles, particularly among different feeding areas, could carry the CFPHV and infect more than one haplotype. Furthermore, it is also possible to suggest that the agent can stay in the water or even be eliminated through the analyzed secretions, demonstrating that these can be potential transmission routes of the virus in the replication phase. Both identified haplotypes and viral variant are related to the Atlantic Ocean, leading to the conclusion that the viral variants can move through this area. Acknowledgments: The authors wish to thank the Tamar/ICMBio. Also, the authors wish to thank the Foundation for Research Support of the State of São Paulo (Fundação de Amparo à Pesquisa do Estado de São Paulo – FAPESP; Process 2012/14319-6) and the Coordination for the Improvement of Higher

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CYTOARCHITECTURE OF SEA TURTLES BRAINS

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The work related to the characterization of the nervous system in sea turtles has a strong limitation, since these animals are threatened of extinction and work can only be performed with stranded individuals that die. Studies about the external morphology of the brains of sea turtles are known, however works describing the cytoarchitecture of the brain of these animals are nonexistent. Therefore, little is known about their neurobiology. Thus, this study aimed to describe the dopaminergic system of the sea turtle midbrain as a way to help the understanding of biological questions and provide neuroanatomical bases for future motricity functional studies. For this, dead stranded individuals in the Projeto Cetáceos da Costa Branca rehabilitation´s Base/Universidade do Estado do Rio Grande do Norte were necropsied and the brains removed. The material was fixed in 4% formalin and later 50 μm thickness cuts were made with a microtome. The brainstem sections, stained by the Nissl method and/or subjected to an immunohistochemistry allowed verification of the presence of TH-immunoreactive neurons for the ventral tegumental area (VTA) and in the black substance (BS). We also observed neurons in a retrorubral area (RRF). The nuclei were characterized for its architecture and limits by analyzing with the Nissl method. Given the unprecedented results obtained for this taxonomic group, it is necessary to continue with these studies in order to develop the descriptions of the brain cytoarchitecture of sea turtles, perform quantification, volume measurement and length of these neuronal bodies as well as of their own dopaminergic nuclei of the brain.

COLLABORATIVE RESEARCH WITH LOCAL FISHERMEN TO REDUCE GREEN TURTLE BYCATCH IN UBATUBA, BRAZIL

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Located in southeastern Brazil, the Ubatuba coast is an important feeding ground for juvenile *Chelonia mydas*, where turtles originating from multiple nesting areas, aggregate. It is therefore considered a "mixed stock area". Since 1991, with the voluntary collaboration of local fishers, Projeto Tamar has already recorded 10,994 turtles incidentally captured in different artisanal coastal fisheries. Our results show that juvenile *C. mydas* were by far the most common species captured and that gillnets are the major source of mortality for this species in the region. Among the different types of gillnets used, we noticed that surface gillnets, kept close to the rocky shore, capture a larger number of green turtles, since they normally feed in nearshore habitats. Once entangled, the turtles drown and often die from forced apnea. In a survey conducted between 2007 and 2010, we recorded 154 fishermen using gillnets in the rocky shores in Ubatuba. This study aims to present an efficient strategy to mitigate green turtle bycatch in Ubatuba, as part of a collaboration between local fishers and Tamar researchers. According to Projeto Tamar´s studies and observations, *C. mydas* reduce their activity level at night, resting under ledges in reefs and rocks. Comparing this information to the experiential knowledge of local fishers, that night fishing is much more productive than day fishing, we conducted a study between March 2009 and February 2011, aiming to reduce green turtle entanglement and mortality in surface gillnets, with little impact in the fishing activity. This study compared the catch rates of targeted fishes and turtles in gillnets during daytime and nighttime fishing. The experiment was conducted setting the fishermen's own gillnets in traditional fishing sites. A total of 49 sets with 24 hours of duration each, were monitored through regular visits every four hours, where the total amount of catches and sea turtle bycatches were recorded. Green turtle captures were significantly higher during daytime while fish captures were significantly higher at night. Our findings were then presented in different fishing communities with the purpose of sharing the results and discussing a proposal to avoid gillnet fishing in shallow waters near the rocky shore, during the day. Due to the difficulty of bringing all fishers together in a meeting to discuss the results, we have printed the results in A3 panels in order to share the outcomes of the meeting with fishers who were not able to attend. The proposed solution has been well accepted by fishermen, demonstrating to be an effective strategy to reduce green turtle mortality with minimal interference with fishing activity.

MORPHOLOGICAL ASPECTS AND LESIONS OF GREEN TURTLE FIN BONES (*CHELONIA MYDAS*) STRANDED IN THE POTIGUAR BASIN (RN/CE) BEACHES IN NORTHEASTERN BRAZIL

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Green turtle (*Chelonia mydas*) is the chelonian with the most stranding in the Potiguar Basin (RN/CE), but despite being endangered, there are few osteological descriptions. This work aims to analyze the bone morphology and lesions of the fins of green turtles stranded on beaches in this region. The analysis was performed on 186 fins of green turtles from the collection of Marine Biota Monitoring Laboratory (PCCB / UERN). The samples were derived from carcasses recorded during periodic monitoring on the beaches of the Potiguar Basin, between the city of Aquiraz (03 ° 49'20.9 "S and 38 ° 24'07.8" W) and Caiçara do Norte (05 ° 05'28.6 "S and 36 ° 17'37.9" W). The information about the turtles was obtained from the Projeto Cetáceos da Costa Branca (PCCB) database, Universidade do Estado do Rio Grande do Norte. The fins were X-rayed after being identified and stored in a freezer. The determination of the phalangeal formula was conducted by counting the bones of phalanges and the inclusion of the metacarpal bone. The analysis of the radiographic images allowed the description of the morphology of bone structures and lesions identifications. The fins have pentadactyl standard, the largest digit is the third one. The pectoral fin (n=93) consists of standards bones: humerus, radius, ulna, carpal bones, metacarpal and phalanges. The humerus bone is greater in length and width. The carpal consist of wider intermedium at the proximal end, ulnare wider distally, radiale, pisiforme, centrale positioned below the intermedium and five distal carpals. The radio is longer than the ulna and connects to the distal radiale. The ulna is wider at the proximal end and connects distally to ulnare and the intermedium. The predominant pectoral fin phalangeal formula was I: 3, II: 4, III: 4, IV: 4, V: 3 representing 96.5% of the total of intact fins (n=86) . Only three samples had four phalanges in digit V. The pelvic fin (n=93) is composed of a femur, fibula connects distally with the calcaneum and astragalus, tibia which also articulates with the astragalus, four tarsal, metatarsal and phalanges. The femur is the longest bone of the pectoral fin. The predominant pelvic fin phalangeal formula was I: 3, II: 4, III: 4, IV: 4, V: 4 (98.9%, n = 87). The most distal phalanx located on the 5th digit is the smaller size in both pectoral and pelvic fin. Injuries derived from fractures and cuts were recorded in thirteen turtles. Five of them showed signs of fractures and calluses on the radio (N=1), ulna (N=1), humerus (N=1) and phalanges (N=2). Some animals (N=12) showed no signs phalanx due to cuts and injuries. Most turtles with signs of injury (83%) treated is juvenile. Juveniles were the most affected by injuries showing that young animal already suffering anthropogenic pressures and the environment in this age class. The analysis of bone structures of fins turtles can assist in osteopatologies analysis and studies of anthropogenic interactions derived by shock, trauma or cuts in marine turtles that can help in threats estimation of conservation plans. Acknowledgments: The monitoring was conducted by project made through IBAMA Environmental Condition to E&P activities of Petrobras.

INCIDENTAL CAPTURE OF SEA TURTLES IN ARTISANAL AND INDUSTRIAL FISHERIES IN SOUTHWESTER ATLANTIC*

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Sea turtles are subject to various threats during their complex life cycles, and the incidental capture in fishing gears has been treated as one of the most worrying. Due to the great mortality of sea turtles recorded in fisheries worldwide, the study of captures in fishing gears is the focus of many conservation projects. In the region of the southwestern Atlantic (SWA), since 2003, sea turtle experts have been meeting in the context of promoting the integration of research in the marine corridor comprising the countries Brazil, Argentina and Uruguay. The main fisheries practiced in the region are beach trawl, fixed enclosure, gillnet, bottom trawl and pelagic longline, the two first strictly artisanal. Studies conducted in the region indicate that the beach trawl and fixed enclosure is little concern regarding mortality, since the turtles swim free within the net. Gillnet fishing is the main artisanal fishing gear causing major mortality of sea turtles. The main species caught in these three artisanal fisheries is the green turtle (*Chelonia mydas*), but there are records for all other species. In Rio de la Plata (Uruguay and Argentina) there are records of captured loggerhead turtles (*Caretta caretta*), leatherback turtles (*Dermochelys coriacea*) and green turtles in artisanal gillnet and bottom trawls. Industrial longline fishing has been extensively studied in the past 13 years, achieving positive results in terms of area and number of hooks monitored and mitigation measure applications. Between 1998 and 2010 data were collected from Brazil and Uruguay on 25,144,089 hooks, with a catch of 8573 turtles. In this fishery, the most captured species were loggerhead (77%) and leatherback turtles (16.1%). The mortality in this fishery is worrying, both by drowning and hook intake. Tests done with circle hooks in Brazil and Uruguay have shown a reduction of over 50% in catches. The industrial gillnet fishery was monitored in the southern and southeastern Brazilian regions between 2002 and 2008 through spreadsheets completed by captains and these registered the capture of leatherback, loggerhead and green turtles (n = 252, 47, 25, respectively, in 1794 km of net). The assessment of the interaction between sea turtles and the industrial bottom trawl has become a priority in recent years within the SWA, as it still a little-studied fishing gear and causes significant mortality of sea turtles. A preliminary study conducted in southeastern Brazil, through spreadsheets completed by captains, found that 44 turtles were captured in 1996 tows. In southern Brazil, monitoring work with on-board observers has been carried out since 2011, with 614 tows monitored with a capture of 101 sea turtles. Studies in these two regions are still running in a standardized way. In this type of fishery, the main species caught are loggerhead and olive turtles (*Lepidochelys olivacea*), but catches of green and leatherback turtles have also been observed. The challenges for conservation of sea turtles in the case of incidental catch is assessing its impacts and identifying mitigation solutions that favor the turtles without economic damage to fishing.

EVALUATION THE USE AND EFFICIENCY OF TURTLE EXCLUDER DEVICE (TED) ON THE PERCEPTION OF CAPTAINS THAT ACTING IN THE INDUSTRIAL BOTTOM TRAWL FLEET OF SOUTHEAST REGION OF BRAZIL

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The incidental capture of sea turtles by fishing gears is one major threat to the survival of sea turtle populations. The trawl fishery (shrimp and/or fish) is considered one of the major causes of mortality of sea turtles, with an estimated annual catch of 150 thousand individuals worldwide. In order to allow the escape of turtles caught incidentally, the Turtle Excluder Device (TED) was developed in the United States in the late 1980s. In Brazil, the use of TEDs is obligatory by Normative Instruction n☐ 31/ 2004, by the Ministry of Environment. Some of its requirements are the minimum size of the grid of 81 cm in diameter, maximum size of the spacing between bars of 10 cm and an inclination of 30° to 55° on grid. Despite being regulated by law, the use of TED still suffers resistance from captains, so the aim of this study was to identify the opinion of trawlers captains, active in the southeastern Brazil fleet, about the use and efficiency of TED. From November 2014 to February 2015, interviews were conducted with 30 captains of motorized trawl vessels active in southeastern Brazil. All interviews were realized in two main fishing ports in the metropolitan region of Rio de Janeiro state, São Gonçalo and Niterói, Brazil. The questions asked were related to professional information of the captains, general information of the vessel, general information about the TED, questions about TEDs in operation and opinion questions about the device and its advantages and disadvantages. The captains had an average age of 50 years and 30 years in fishing. According to the interviewed captains the main species captured are shrimps (various species), *Pseudupeneus maculatus* (spotted goatfish), *Merluccius hubbsi* (Argentine hake) and *Lophius gastrophysus* (anglerfish). The largest species cited as an important target were *Pseudopercis numida* (Namorado sandperch) and *Dasyatis spp*. (rays). This involves a problem relative to the size of the space between bars in TED, since larger fish that have greater economic representation in the production, can escape through the TED, according to captains. Only 10 captains (33.3%) said they received instruction about how to set up the TED on net. This lack of technical instruction of captains and others fishermen reveals how the law's implementation about the use of the device was not adequate to the training needs of the fishing industry. The percentage of captains who think the TED works in avoiding sea turtle captures was 40% (n = 12) and 60% (n = 18) do not believe that TED works. The negative view of captains about the effectiveness of TEDs, and the fact that only 10% (n = 3) of them affirm using the device, demonstrates the urgent need to rethink the obligation and TED specifications in the country, since part of the reason fishers said they are not used is because they are not appropriate and efficient for the trawl fishery characteristics in Brazil. An alternative way to solve this problem would be to establish a new TED model that satisfies the country's fleet characteristics.

EPIBIONTIC HYDROIDS (CNIDARIA, HYDROZOA) FROM MARINE TURTLES: A GLOBAL REVIEW OF LITERATURE AND A CASE STUDY FROM JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) OF THE SOUTHWESTERNATLANTIC COAST*

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Marine turtles are a particular substrate for several fouling organisms worldwide and can be colonized by benthic organisms in different stages of their development. Most surveys of marine turtle epibiota are conducted on nesting females due to the easier access to them when they leave the ocean. Nevertheless, studies with adults and juveniles of *Caretta caretta* indicate that the epibiota community differs across ontogeny, thus highlighting the importance of studies at foraging areas of marine turtles. Hydroids, i.e., species of the benthic sessile stage of the class Hydrozoa (Cnidaria), are among the most abundant and characteristic sessile organisms of marine communities on hard substrates that can be transported by nektonic organisms such as marine turtles. The aim of this study was to review the knowledge on epibiontic hydroids of marine turtles worldwide, and to survey the epibiontic hydroids species of the juvenile green turtle *Chelonia mydas* at a temperate foraging area of Uruguay (ca. 34°S). Specifically, the Marine Protected Area of Cerro Verde and Islas de La Coronilla (Department of Rocha) is a foraging area of the juvenile green turtle, which occurs mainly during warmer months. Worldwide, 19 papers reported the presence of hydroids as epibionts on four species of marine turtles: *C. mydas, C. caretta, Eretmochelys imbricata* and *Lepidochelys olivacea*. Most parts of these reports were on nesting females of the loggerhead turtle (*C. caretta*) from the Northern Hemisphere. Seven of the 15 taxa reported were identified at the species level, three to the genus level and five were indeterminate. None of the papers examined were focused on hydroids, thus our study is the first aiming to survey the records of epibiontic hydroids on marine turtles. In this study, 101 juvenile green turtles from Cerro Verde and adjacent areas (sampled between 2009 and 2011) were analyzed. The six species of hydroids recorded were *Obelia dichotoma, Clytia cf. gracilis, Coryne cf. eximia, Bougainvillia sp., Nemertesia antennina* and *Ectopleura crocea*, with the first two the most frequently found. Only two of these species (*O. dichotoma* and *E. crocea*) were previously recorded as epibiont on nesting *C. caretta*, the others were recorded for the first time as epibionts of marine turtles worldwide. All species have cosmopolitan distributions or are widely distributed along subtropical-temperate areas. All of them are substrate generalists and were herein recorded on different microsubstrates on the body of the marine turtle. Moreover, all species recorded were found at the intertidal and shallower

subtidal zone of Cerro Verde, except for *Coryne cf. eximia*. The fragility or similarity with algae and/or size implies that hydroids were probably unnoticed in previous studies on epibionts of marine turtles. This study highlights the importance of analyzing epibiont communities in detail and to direct efforts of sampling specific groups not previously considered worldwide, for foraging and nesting areas. The results gathered here, together with the extension of this line of research, shall provide additional and new information on biogeographic and evolutionary aspects of marine benthic organisms as a whole.

OVERVIEW OF SEA TURTLE OCCURRENCES DURING PROJECT PROMONTAR-ANGRA'S MONITORING PROGRAM (2013/2015 SEASONS) AT THE ANGRA DOS REIS'S NUCLEAR POWER PLANT

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This study presents the results of a sea turtle monitoring program performed at the only Brazilian nuclear power plant, located on the coastal region of Angra dos Reis and Paraty, south of Rio de Janeiro State. The general objective is to monitor events and generate time series of sea turtle data in the area of influence of the nuclear power plant. The monitoring program was divided into two basic parts: in-shore and in-water activities. In-shore activities were done daily and the Coastal Patrol monitored the beach for stranded sea turtles. Two methods were used. Beach surveys were performed to find stranded turtles, and the Rescue Remote Network Services, activated by public phone calls (tourists, fishermen) provided information to PROMONTAR-ANGRA teams for the rapid and effective rescue of injured and dead animals. In-water activities were done monthly to monitor free-living sea turtles by intentional capture. At diving sites, we used an artisanal fishing net to surround the area and optimize the capture efforts, reducing the time and increasing the number of sea turtles captured. After all technical procedures, healthy turtles were tagged and released back to the sea, injured turtles were transported to veterinary centers for complete rehabilitation, and dead turtles were necropsied. From July 2013 to June 2015, the monitoring program was conducted daily, with no interruptions. The Coastal Patrol recorded 886 hours and 46 minutes of beach surveys, resulting in a monthly survey duration of $42:12 \pm 11:15$ min (mean $\pm$ SD). Only four dead green turtles were found with poor carcass conditions; they ranged in size from 34.5 to 46.5 cm (CCL), but they could not be weighed. The Rescue Remote Network had a total of 166 public phone calls. Of these, 113 resulted in a sea turtle rescue. For those rescued, 105 individuals were green turtles. On average, they measured 38.3 ± 6.9 cm (CCL) and weighed 4.8 ± 1.6 kg. Three individuals were identified as hawksbill turtles ranging in size from 30.3 to 94.5 cm (CCL), and weighing from 2.2 to >60 kg. Three individuals were identified as loggerhead turtles, measuring 68.5 to 79.0 cm (CCL), while the weight could not be measured. Only one individual was identified as an olive ridley; it measured 70.0 cm (CCL), but the weight could not be taken. Additionally, one individual was identified as a leatherback turtle. The CCL was estimated at >100.0 cm because it was in a poor carcass condition. Only green and hawksbill turtles were alive and taken to rehabilitation. For the Intentional Capture Diving, 72 events were performed, and 132 individuals were captured. Of those, 130 were green turtles, averaging 39.6 ± 5.6 cm CCL and weighing 6.9 ± 3.0 kg. Only two individuals were identified as hawksbill turtles, and they measured 40.4 cm, and 59.0 cm CCL; they weighed 6.5 kg and 21.4 kg, respectively. About 18% of individuals were found with

fibropapilloma tumors; these were only recorded in green turtles. The Project PROMONTAR-ANGRA monitoring program confirms that Angra dos Reis and Paraty may be considered an important development and feeding area, especially for green turtles.

CONSTRUCTION AND CONSERVATIONISTS SHARES OF SEA TURTLES OF THE BRAZILIAN NORTHEAST NETWORK (RETAMANE)

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Five species of sea turtles are registered in northeastern Brazil (*Caretta caretta, Eretmochelys imbricata, Chelonia mydas, Lepidochelys olivacea* and *Dermochelys coriacea*). Given the importance of this region for the conservation of these species, several institutions founded on October 23, 2012 the "The Brazilian Northeast Sea Turtle Network" (RETAMANE). The Network aims to establish relationships between institutions, researchers and conservationists, in a way that the data can be optimized and to secure the best communication between research and sea turtle conservation groups in northeastern Brazil; seeking a unification of technical management and conservation for the species and the ecosystems where they live. It is formed by 12 institutions, namely: Instituto Biota de Conservação (Alagoas), Projeto Cetáceos da Costa Branca/Universidade do Estado do Rio Grande do Norte (Rio Grande do Norte), Universidade Federal do Rio Grande do Norte (Rio Grande do Norte), Universidade Federal Rural de Pernambuco (UFRPE), Reserva Biológica do Atol das Rocas (Rio Grande do Norte), Núcleo de Meio Ambiente Renovável (NUMAR- Rio Grande do Norte), Eco Associados (Pernambuco), Associação Guajiru (Paraíba), Instituto Tartarugas do Delta (Piauí), TAMAR-ICMBio (Rio Grande do Norte), Fundação PRO TAMAR (Bahia), PAT ECOSMAR (Bahia) and Universidade Federal de Alagoas (Alagoas). All these institutions conduct research and/or extension with issues related to sea turtles and act researching conservationist strategies for the species. As with the first interventions of RETAMANE in those first three years, we highlight: i. annual regular meetings to discuss a unified work methodology for all institituições of the network; ii. training courses (e.g. necropsies on Sea Turtles); iii. Writing, editing and publication of a book entitled "Studies of Sea Turtles in the Northeast of Brazil: Challenges and Prospects", which portrays the state of the art research and conservation strategies carried out by the institutions that make up the network, with launch scheduled for the beginning of 2016 through a partnership between the RETAMANE and UFRPE; among others. All

these institutions conduct research and/or extension with issues related to sea turtles and act searching strategies for the species. Thus, RETAMANE comes to contribute to the advancement of scientific knowledge regarding the populations of sea turtles occurring in northeastern Brazil, a region which for many decades was considered a gap ib publications that would direct management strategies and efficient conservation; a fact that does not agrees with the reality, since a significant number of publications has been effective, demonstrating that conservation interventions by institutions members of RETAMANE are having a positive effect in the conservation of these species, a fact evidenced by the exponential growth in the number of nests and hatched offspring monitored, as we can see in the scientific publications and technical reports.

A PRELIMINARY INVESTIGATION ON TOXIC MICROALGAE IN THE GUT CONTENT OF GREEN SEA TURTLES FROM PARANÁ COAST, SOUTHERN BRAZIL

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Seaweeds and seagrasses are important food sources for post-recruited green turtles (*Chelonia mydas*); however, these marine-estuarine plants can be vectors for different toxic microalgae. This study aimed to identify the occurrence of toxic microalgae in gut samples from juvenile green turtles that stranded dead on the coast of Paraná, southern Brazil, and also to relate it to the presence of toxins in selected turtle tissues (e.g. liver, muscle). The contents from the stomachs and the upper intestines of 16 specimens of green turtles found between 2013 and 2015 were sampled during necropsy sessions. Microscopic examination of stomach and intestine contents revealed the presence of low cell densities of the toxic dinoflagellates *Prorocentrum lima* (in 31.3% of turtles examined), *Dinophysis acuminata* (6.3%) and *D. tripos* (6.3%), producers of diarrheic toxins; and the cyanobacteria *Phormidium sp.* (6.3%) and *Lyngbya sp.* (18.8%), producers of cyanotoxins. Non-toxic diatoms dominated the microflora in the gut of green turtles. Although the abundance of toxic microalgae was relatively low, continuous ingestion of these microorganisms could cause immunosuppression and chronic sub-lethal effects to the turtles. Toxin analysis by LC-MS/MS on selected turtle tissues and histopathological analysis of liver, kidney and muscles tissues are currently undergoing and the results will provide a better understand about toxins accumulation and possible effects on turtle health.

FEEDING ECOLOGY OF *CHELONIA MYDAS* (LINNAEUS, 1758) IN THE REGION OF GUANABARA BAY AND ADJACENCIES, RIO DE JANEIRO, BRAZIL

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The green turtle (*Chelonia mydas*) uses the Brazilian coast for feeding, reproduction, or as a migration route to other areas. As hatchlings, green turtles have an omnivorous behavior, with a strong carnivorous trend. After the recruitment phase, when they have migrated to coastal regions, the juveniles are predominantly herbivorous, consuming algae or seagrasses as the primary diet and animal matter as a secondary diet. However, this food preference may be influenced by the availability of the resources in foraging sites. This study is a pioneer in the area of Guanabara Bay (23°1'7"S, 43°28'44"W / 22°55'10"S, 42°49'07"W), Rio de Janeiro, Brazil, and aims to analyze the gastrointestinal content of green turtles found dead. This research is part of the "Projeto Aruanã" Sea Turtle Monitoring and Conservation Program acting in Guanabara Bay and surroundings. The sea turtles were obtained from individuals stranded dead in various places within the monitored area between 2013 to 2015. Each individual was photographed, the curved carapace length (CCL) and curved carapace width (CCW) were measured, the state of decomposition was evaluated and classified as fresh, moderate or advanced stage. Necropsies were realized and the digestive tracts collected and conditioned. The food contents were screened, and washed in a fine mesh strainer (1 mm) in flowing water, separated and plant, animal and anthropogenic waste was identified for subsequent frequency of occurrence calculation (FO%). We registered 45 individuals of juvenile green turtles, with CCL ranging from 30 to 77 cm (mean = 43.7, SD = 11.4). Among these, 20 (44.4%) were in fresh or moderate decomposition stage, still containing the internal organs, and consequently the food contents. Food items of plant origin were present in the digestive tracts of 19 individuals (FO = 95%), with identification of four genres of algae, *Gelidium sp., Codium sp., Sargassum sp.* and *Ulva sp.*, with the last one with the highest frequency of occurrence (85%). Animal items were present in 6 individuals (FO = 30%). Among them, bones were identified, scales, otoliths and fish guts, cephalopod beaks, small fragments of appendages of invertebrates and cnidarians. This may be evidence of food opportunism according to the availability of the item on the environment. Anthropogenic waste occurred in 9 (FO = 45%) of the digestive tracts. There was no significant difference between the size of turtles who consumed or did not consume material of animal origin (W = 26; p > 0.05) and those who consumed anthropogenic waste (W = 10.5; p > 0.05), with both small or large animals feeding of both items. This study is still in progress and other parameters will be evaluated. However, previous data indicate a diverse diet, allowing classification of the species as opportunistic users of resources according to availability in the environment, corroborating several works of feeding ecology.

POTENTIAL THREATS TO SEA TURTLES AT ECOLOGICAL SANCTUARY OF ILHABELA – SOUTHEAST BRAZIL

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Interactions between humans and sea turtles date back millennia. Its uses were extended from religious rituals, built artifacts and ornaments to funeral ceremonies. Currently the survival of marine turtles is threatened by several human activities such as fishing, meat consumption, poaching, vessels collisions, environmental pollution and climate change, among others. A study conducted in the São Sebastião Channel in Ilhabela, São Paulo, characterized the area as a feeding and resting ground for sea turtles. This location is part of the Ecological Santuary of Ilhabela, a marine protected area. In Brazil, since 2000, protected areas are named Unidades de Conservação and ruled by the law of SNUC – Sistema Nacional de Unidades de Conservação (National System of Conservation Units). However, the nomenclature "Sanctuary" is not listed in the new law and needs to be adapted. The area has not had any audit and therefore the activities classified as prohibited by the law are practiced indiscriminately. The objective of this study is to diagnose and characterize potential human impacts to sea turtles in the Ecological Sanctuary of Ilhabela to contribute to the framing process of the region in SNUC. Monitoring was conducted in order to gather information about activities carried out in Sergio, Portinho, Oscar, Praia das Pedras Miúdas and Piuva beaches. During the observations, data regarding vessels including engine characteristics, vessel category, purpose, distance of the coast and speed were collected. In addition, information about activities performed at each beach, such as swimming, snorkeling, kayaking, SUP, and other relevant activities, were observed, as well as information such as the presence of nets and sport fishing. The results demonstrated that the largest number of vessels traveling along the channel occurs on weekends (58%), showing that boat traffic increases with the presence of tourists who attend Ilhabela on weekends. The most observed vessel was the motorboat with 62% of the observations with the main purpose as "Leisure" (61%). Regarding the distance from the coast and speed, 32% of vessels travelled at a shorter distance than 200 m from the coast and 83% had a speed above 19km/h, classified as "Fast" for turtles to escape. Boat traffic close to coast developing high speeds is of great risk to sea turtles that remain most of the time in shallow waters, increasing probability of collisions. The most observed activity was snorkeling (43%). If not practiced in a responsibly manner, snorkeling can represent a risk to marine biodiversity. Other activities such as spear fishing, collection of marine specimens and animal feeding were observed. For fishing activities, 50% of nets were recorded at Portinho Beach, whereas the sport fishery was more common at Oscar Beach. These findings demonstrate the need for planning activities and legislation regulating the uses of the area as vessels traffic, fishing permits, collecting specimens, among others, as would be possible through the creation of a protected area.

PREDICTION OF CARAPACE LENGTH BY THE HUMERUS OF GREEN TURTLES (*CHELONIA MYDAS*) STRANDED ON BEACHES OF THE NORTHEASTERN COAST OF BRAZIL

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Life parameters such as growth are essential to understanding the biology of species. The humerus of sea turtles can be an important tool to identify the life history of these animals, especially in areas where the weather is warm and favors the increase of animal decomposition rate. Age, maturity and growth rates were identified as biological aspects of green turtles (*Chelonia mydas*) that have insufficient information and studies are still needed to model the growth trajectories of populations. Although *C. mydas* is under threat of extinction and is the turtle most registered on beaches in the Potiguar Basin, northeastern Brazil, information about its biology is still scarce. The objective of this study is to estimate the carapace length of green turtles using measurements in the humerus and identify to the better prediction. The analysis was performed in humerus of 159 green turtles deposited in the collection of Laboratório de Monitoramento de Biota Marinha. The bones were from carcasses recorded during periodic monitoring in the years 2011 and 2012 on the beaches of the Potiguar Basin, between the cities of Aquiraz (03°49'20.9"S and 38°24'07.8"W) and Caiçara do Norte (05°05'28.6"S and 36°17'37.9"W). The analysis only included the exemplars with sex and size data. The information of turtles was obtained from the Projeto Cetáceos da Costa Branca (PCCB) database of the Universidade do Estado do Rio Grande do Norte. The pectoral fins of turtles collected and stored in a freezer were dissected, macerated, washed and dried for preparation of the bones. Twelve measures were performed on the humerus using a digital caliper of 300 millimeters. The regression test was used to correlate the curved carapace length (CCC) with the humeral measurements using the Statistic 6.0 program. The results showed the humerus maximum length ranging from 49.36 mm to 272.68 mm with a mean of 124.24mm and standard deviation $\pm$ 63.87mm. The thickness of the humerus varied between 5.02mm and 25.97mm averaging 12.56mm and SD $\pm$ 5.72mm. We observed that the R^2 values were greater than 0.94 ($p > 0.05$, $n = 159$), showing that the measurements are good indicators of the humerus to estimate turtle CCC. As it showed better prediction was the distal width with straight line equation: $y = 14,888x + 13.916$ ($R^2 = 0.9774$), where y=CCC and x=distal width ($p > 0.05$, $n = 159$). The lowest prediction measure of the humerus was the thickness with the equation: $y = 0,6262x + 15.369$ ($R^2 = 0.9475$), where $y = CCC$ and $x = $ thickness ($p < 0.05$, $n = 159$). The prediction of the size of turtles that have incomplete or missing shells through the humerus measures proved to be an extremely useful tool for estimates involving mortality, age of maturity in action plans for conservation of the species of tropical areas. Acknowledgments: The monitoring was conducted by project made through IBAMA Environmental Condition to E&P activities of Petrobras.

USE OF ENVIRONMENTAL ENRICHMENT TO PROMOTE THE WELFARE OF AN INDIVIDUAL OF *LEPIDOCHELYS OLIVACEA* IN REHABILITATION CONTEXT AT THE CENTER "KARUMBÉ"

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Animal welfare (AW) is an animal state as regards its attempts to cope with its environment. The way animals in captivity are kept affects their behaviour, carrying consequences for their AW, leading to the emergence of stereotypic behaviours. The set of modifications introduced in captivity that enhance effective functioning of the animal is known as Environmental Enrichment (EE). It seeks to increase behavioural diversity; reduce frequencies of abnormal behaviour; increase the number of normal behaviour patterns, positive utilisation of environment and ability to cope with challenges. In Uruguay, stranded sea turtles are sent to "Karumbé" rehabilitation centre. On 06/02/2013 an adult female *Lepidochelys olivacea* turtle was brought in with both front fins amputated. The objective was to define a plan of physical EE for it, that would promote good use of the available space and discourage the emergence of stereotypic behaviour. Ad libitum observations and focal sampling (20 min) were done before, during and after the implementation of EE. The frequency and duration of behaviours were registered, as well as use of space in the tank. The χ^2 (PAST) and Spread of Participation Index (SPI) tests were applied in the analysis of use of space. Twenty-two behaviours were registered, 4 of which were catalogued as abnormal and had not been reported previously in sea turtles held in captivity. The Stereotype (S) behaviour consists of: swimming with head in contact with the edge of the tank, while moving it from left to right repeatedly. This behaviour experienced a significant decrease ($p < 0,001$) in frequency and percentage of total time of realization. It was 43 events p/hour initially, to 19 and 11 events p/hour during and after the implementation of EE. A total of 83.92% of time of observation was used engaging in this behaviour, prior to the implementation of EE, with the lights on in the rehabilitation area, and 58.74% when the lights were off. During and after applying EE the value decreased to 24.50% and 9.95%, respectively. An abnormal behavioural sequence was identified, in which the components experienced a significant increase in frequency ($p < 0.005$) when turning off the lights in the rehabilitation area, prior to the implementation of EE. All components (except one), experienced significant decrease ($p < 0.05$) in frequency during and after the application. EE was set in quadrants B and D. Before and during the installation, the animal showed a clear preference for quadrants A and C (SPI=0.445). During the installation, this preference was maintained with a less restricted use of space (SPI=0.082). Afterwards, the animal showed preference for B and D with an even more homogeneous use (SPI=0.024). Regarding the use of centre and edge of the tank, an increase in the homogeneity of the use of space was found, during and after the EE (SPI Prior=0.241; During=0.062 and Post=0.018). However, a preference for the edge of the tank was maintained in all experimental conditions. The EE implemented reduced stereotypic behaviour and promoted a homogeneous use of space, giving the animal behavioural options, and more control over environment promoting its welfare.

MULTIPLE THREATS ANALYSIS FOR LEATHERBACK TURTLES IN THE SOUTHWEST ATLANTIC

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The southwest Atlantic (SWA) is an area of development, feeding and reproduction of leatherback turtles. Although the largest rookeries are located in the eastern Atlantic (e.g. western Africa) a small nesting population occurs in Brazil, in Espírito Santo. Recent studies with satellite telemetry, mark-recapture and genetics have provided information about habitat use and movements for this species. These studies showed that the adult female leatherbacks that nest in beaches of west Africa migrate to multiple foraging areas, including waters off the coast of South America. In these foraging grounds the leatherbacks, mainly adults, spend most part of the year feeding on jellyfish and other gelatinous preys along neritic and oceanic waters. These areas are subject to a high fishing pressure from multiple fisheries that operate throughout coastal and oceanic environments. Sea turtles have complex life histories making it difficult to identify threats and mortality sources. Thus, to better understand and quantify the main impacts to leatherback populations in the SWA we conducted a threat analysis based on the Bolten et al. (2010) approach. Adapted from Bolten et al. (2010), threats were identified and classified for the different life stages and ecosystems inhabited by the sea turtles. For the construction of the matrix we considered 8 life stages: nesting females, eggs, hatchlings, juveniles neritic, juvenile oceanic, adult neritic, adult oceanic. We grouped all identified threats into six main threat categories: fisheries bycatch, resource use (direct and indirect use), habitat alteration, pollution, species interaction and climate change. Also as threats vary depending on the ecosystem inhabited by the turtles, thus we incorporated three environments: 1) terrestrial (beach), 2) neritic and 3) oceanic. Annual mortality was estimated for each life stage/ ecosystem, with respect to each specific threat. As the information is very heterogeneous and it is difficult to assign actual mortality rates we used a range of mortality values based on the best available information (e.g. published data, projects database information and expert opinion). Mortality range estimates were classified as follows: 0 (no evidence of mortality); >0 (mortality has been documented or is likely to occur; however, data are insufficient to estimate mortality); 1 -100 (low mortality); 100-1000 (medium mortality); >1000 (high mortality). Results pointed out that fisheries bycatch represent a major threat for leatherbacks in the SWA. Juvenile and adult stages are subject to incidental mortality in coastal and high seas fisheries.

GENETIC DIVERSITY AND NATAL ORIGINS OF GREEN AND LOGGERHEAD SEA TURTLES FROM RIO DE JANEIRO AND RIO GRANDE DO SUL STATES, BRAZIL

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In Brazil, there are five species of sea turtles, the loggerhead, green turtle, hawksbill, olive ridley and leatherback turtles. All of them are currently considered endangered. *Chelonia mydas* is the most abundant species feeding along the Brazilian coast, while *Caretta caretta* is the most common nesting sea turtle found on continental beaches of Brazil. Genetics is a useful tool for understanding many aspects of the sea turtle life cycle, including natal origins, migratory behavior and connectivity. In the present study, we aimed to (a) genetically characterize green and loggerhead sea turtles based on ~800bp mtDNA fragments, (b) evaluate genetic differences between stranding and bycatch samples, from different life stages, collected in different years, and (c) define their natal origins and connectivity. For this purpose, we analyzed 261 samples of green turtles from Rio de Janeiro state: 61 captured by trawling and 200 stranded. We also analyzed 265 samples of loggerheads: 82 captured by the pelagic longline fishery in Elevação do Rio Grande (a seamount located ca. 800 km off the south coast of Brazil), 155 stranded along Rio Grande do Sul coastline, and 28 stranded along beaches in Rio de Janeiro state. We identified 16 longer mtDNA haplotypes among *C. mydas* samples, including a new one (different from CM-A8 by one polymorphic site). The most frequent haplotypes were CM-A8 (52.1%) and CM-A5 (34.5%). Among *C. caretta*, we identified 12 longer mtDNA haplotypes, including seven new subtypes (two of CC-A4, one of CC-A11, one of CC-A25, two of CC-A33 and one of CC-A34) and a new haplotype (different from CC-A33.1 by one polymorphic site). The most frequent haplotype was CC-A4.2 (69.5%). Mixed Stock Analysis (MSA) showed that Ascension Island, Suriname, Aves Island and Guinea Bissau were the main sources for Rio de Janeiro *C. mydas* samples. Contributions from Trindade Island were possibly underestimated. MSA also indicated that Brazilian nesting colonies were the main sources of *C. caretta* sampled in Rio de Janeiro, Rio Grande do Sul and Elevação do Rio Grande, with less expressive contributions from the Pacific (mainly from Australia), North Atlantic and Mediterranean. Differences observed between *C. mydas* and *C. caretta* can be directly attributed to behavioral aspects: while juvenile and adult green turtles undertake long migrations among breeding and feeding zones, loggerhead turtles tend to feed near their natal beach, except for oceanic juveniles. For both species, there were no significant genetic differences among years, stranding and bycatch samples, and life stages (juveniles and adults). Our results confirmed the usefulness of expanded mtDNA sequences in detecting novel polymorphisms, especially for *C. caretta*. However, it is crucial that more sea turtle populations are characterized with longer mtDNA sequences to allow increased resolution of MSA. Considering the importance of the study areas, reducing mortality of these organisms, mainly due to the interaction with fisheries, is urgent. Given the connectivity among Brazilian populations (especially for *C. mydas*) and several other populations in the world, conservation of these species requires global efforts.

FIRST REPORT OF HISTOLOGICALLY CONFIRMED CASES OF GREEN TURTLE FIBROPAPILLOMATOSIS AT ABROLHOS MARINE NATIONAL PARK, BAHIA, BRAZIL

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Green turtle fibropapillomatosis is a cutaneous infectious neoplasia associated to Cheloniid Herpesvirus 5. It has a panzootic distribution with high prevalences consistently associated to polluted coastal waters where agglomeration occurs. Since the first report in 1986 it became of great occurrence in the whole Brazilian coast (average prevalence of 15%), but it has not been reported on oceanic islands. The Abrolhos coral bank is the largest coral reef of the south Atlantic (42 Km2) and includes the Abrolhos Marine National Park, 60 Km off the coast of Bahia State (17°57'46.71''S, 38°42'16.01''W). The Park is important for the maintenance of marine biodiversity as it contains endemic coral colonies, is a nursery area for humpback whales and many fisheries species with great social economic relevance. It is also an important feeding area of *Chelonia mydas* and *Eretmochelys imbricata*. The coast near the park does not have large urban centers and accounts for an estimated population of 117,585 people, but is under direct influence of the runoff from four rivers covering a drainage area of 23,750 km^2. Abrolhos bank is threatened by coral diseases, the presence of paper mill activities near the coast, fisheries, and tourism. From 14-16 October 2012, during a survey on green turtle health, 4 turtles within a group of 32, were captured with cutaneous tumors suggestive of fibropapillomatosis (13%). The afflicted turtles' sizes varied from 40.3 to 57.1 cm of curved carapace length and their mass varied between 6.7 to 20.1 Kg. Two of them were classified as in good corporal condition and the other two in average. Three turtles presented just one tumor smaller than 1 cm (FP score 1) and another presented 44 tumors with less than 4 cm each (FP score 2). This turtle presented low plasma triglycerides, total protein and albumin concentrations suggesting a compromised nutritional status although it was not in a bad corporal condition. Two tumor samples were collected and processed for histological examination, confirming the general feature of fibropapillomatosis consisting of papillary fibroepithelial proliferation with abundant fibroblastic stroma. Diffuse moderate orthokeratosis, hiperplasia, acantosis and koilocitosis were present. Epithelial basal layer cells presented extensive moderate vacuolar degeneration with cleft formation. In March 2013, 28 turtles were captured but no cases of fibropapillomatosis were recorded, but, in October 2015, a photographic registry was made by a tourist of a green turtle with tumors on the neck in the same area, suggesting that the disease remains. This is the first report of fibropapillomatosis at the Abrolhos archipelago, which is considered relatively conserved, especially if compared to the more coastal areas. Although not considered oceanic, it is probably the easternmost report of fibropapillomatosis on Brazilian waters. The disease is a threat to juvenile green turtles that comes to Abrolhos to feed. We suggest that sea turtle health monitoring should be included in the management plan of the Park, as fibropapillomatosis occurrence is considered a suggestive indirect signal of environmental degradation and green turtles are considered sentinel species.

THINKING GLOBALLY, ACTING LOCALLY AND AN ATTEMPT TO INSTALL AN UNKNOWN ANIMAL AS A FLAGSHIP SPECIES

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The coasts of Argentina are an important feeding area for 3 species of sea turtles (*D. coriacea, C. caretta* and *C. mydas*) during more than a half year (from November to May at least), however until relatively recently it was believed that their occurrence was rare on this coast. In the last years there have been several studies showing the frequent use of the estuarine and coastal regions of Argentina by sea turtles, however this information has not yet been incorporated by society, particularly for coastal communities who are amazed with the appearance of a stranded turtle on the beaches (events that occur with increasing frequency as a result of the coast's urbanization, the increased use of 4x4 vehicles and the increase in fishing effort and its consequent bycatch). The main anthropogenic threats to sea turtles in this region are common to the threats all over the world. That is, bycatch and marine debris pollution. Two severe anthropogenic impacts on the marine ecosystem of the region and the rest of the marine organisms that it hosts. Sea turtles are frequently used as flagship species in different regions of the world to achieve sustainable fisheries, the proper management and reduction of waste, care and protection of other less conspicuous species, and protection of the marine environment in general. However, the use of sea turtles as flagship species in Argentina has the difficulty that the communities don't feel like part of its marine fauna due to the difficult sighting them in this area and the scarce information. In order to instill in society the presence of sea turtles in Argentina and its main threats in a local and global level, various educational and outreach activities were carried out in Villa Gesell, the second most important touristic city off the coast of Buenos Aires province. Within the educational and outreach activities were included: talks in kindergartens, primary schools and high schools, an itinerant exhibition of skeletons, photographs, games and educational material related to sea turtles, training about the biology and conservation of sea turtles for teachers, park rangers and lifeguards of the city, presentations on radio, television and newspapers, diffusion of videos and photographs of our research activities through our facebook fan page, the celebration of the sea turtles International Day with an exhibition of skeletons, photographs, cartoons and documentaries of sea turtles, and the participation during a parade of floats during a popular festival. Acknowledgments: The main author would like to thank to the ISTS for the travel grant and to Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesquería and World Wildlife Fund for the financial support that made possible this grant.

MERCURY CONCENTRATIONS IN THE BLOOD OF GREEN TURTLES (*CHELONIA MYDAS*) CAPTURED IN BRAZILIAN COAST – PRELIMINARY RESULTS

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Chelonia mydas is a sea turtle with a worldwide distribution in tropical and subtropical seas between 40°N and 40°S latitude. This species has the most coastal habit of sea turtles and is capable of entering river and lake estuaries. This species is considered threatened by the International Union for Conservation of Nature (IUCN) and vulnerable by the List of Endangered Species of the Chico Mendes Biodiversity Institute (Instituto Chico Mendes de Biodiversidade - ICMBio). The decrease in green turtle populations has been attributed to coastal development, accidental capture in fishing gear, human consumption, climate changes, pollution and pathogens. In this context, we determined the concentration of mercury (Hg) in the blood of green sea turtles captured in four different points of Brazilian coast, with 48 from Vitória/ES, 40 from Fernando de Noronha/PE, 48 from Ubatuba/SP and 9 from Almofala/CE. One milliliter of blood was collected from the cervical venous sinus using the occipital bone as a reference. The turtles were released immediately following blood collection, the blood samples were placed in Vacuette® Trace Elements Sodium Heparin (Greiner Bio-one, Americana, SP, Brazil) tubes and kept in ice until they were stored at -20ºC for further analysis. The analyses were conducted with an inductively coupled plasma mass spectrometer (ICP-MS) operating with high-purity argon (99.999%, Praxaair, Brazil). The preliminary result consists of average and standard deviation performed in Excel 14.0 (Office 2010) and are shown respectively in parenthesis for each point of sample collection (µL-1): Vitória (11.38/18.27); Fernando de Noronha/PE (0.23/ 0.28); Ubatuba/SP (26.59/40.13); Almofala/CE (6.38/6.53). It indicates that animals feeding in continental waters (Vitória/ES; Ubatuba/SP and Almofala/CE) presents greater load of contamination by mercury than those in oceanic waters (Fernando de Noronha/PE). Furthermore, the result also suggests that animals feeding near the coast in urban/industrial development areas (Vitoria/ES and

Ubatuba/SP) have a greater load of mercury than those feeding in areas with less human density (Almofala/CE). Green turtles may be considered as biomonitors of marine environments, which can indicate the degree of ocean contamination in their feeding areas. More statistical analyses are being used to correlate the size of sampled animals (CCL – curved carapace length) in order to elucidate bioaccumulation of this chemical element. Acknowledgments: The authors wish to thank the Projeto Tamar/ICMBio and the Programa de Patologia Experimental da Faculdade de Medicina Veterinária e Zootecnia da Universidade de São Paulo - FMVZ-USP. The authors would like to the Fundação de Amparo à Pesquisa do Estado de São Paulo – FAPESP; Processo: 2012/14319-6) and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior- CAPES for the financial support for this study.

MICROSCOPIC EVALUATION OF THE DIGESTIVE TRACT OF SEA TURTLES AND THEIR RELATIONSHIP WITH DIETARY HABIT

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Despite the knowledge about sea turtle biology being expanded worldwide, morphological studies are still incomplete. These studies related to the digestive system show their morphology is closely related to dietary habits. This paper aims to describe the morphohistology of the sea turtles' digestive tracts from stranding in northeast Brazil and evaluate its relationship with the diet of these animals. The study was conducted by the data analysis of stranded animals during the daily monitoring of the beaches, from 2010 to 2012, in an area bounded on the north by the state of Ceará, and on the east by the state of Rio Grande do Norte, Brazil. Esophagus, stomach and intestine of 122 turtles belonging to *Chelonia mydas* and *Caretta caretta* were collected and fixed in 10% formalin, and the content was sorted and stored. Fragments of these organs were removed to the confection of histological slides. The dietary analysis has shown that juveniles and adults of *Chelonia mydas* fed preferentially on macroalgae. Individuals belonging to *Caretta caretta* presented a diet with a predominance of corals, crustaceans and gastropods. Histology of digestive tract of both species, follow the standard for vertebrates, with four tunics: mucosa, submucosa, muscle and adventitious or serous. The esophagus appears as a muscular tube, having as remarkable differential characteristic, the presence of esophageal papillae, which presents hyper keratinized epithelial cladding and is related to protection against friction. The distal region of the esophagus, near the gastroesophageal junction, in *C. mydas*, is characterized by the appearance of acinar gland. The function of this gland is mucus release, in order to facilitate the transit of food, which is configured as something new, since the esophagus had only

been described as having purely mechanical function. These esophageal glands were secreting glycosaminoglycans, probably protected against abrasion, in which case, it is of herbivorous origin. Also in *C. mydas* the stomach mucosa is lined by a simple columnar epithelium formed by superficial mucous cells, which are deepened to form gastric pits connected to glands. Tubulo-acinar glands became more abundant in the pyloric portion. The opposite occurs in the pyloric portion of the *C. caretta* stomach, once its remarkable a reduction of the gastric pits and the muscular layer appears fairly thick, which extends to the intestine, where the muscular layer becomes longer. Such characteristics are closely related with the diet of the species, based on rigid items such as carbonated shells, which requires a stronger mechanical digestion, justifying the thick muscle layer throughout the gastrointestinal tract. In both species, the submucosa presented itself formed by dense connective tissue with the presence of vessels. Muscular layer is formed by smooth muscle, with a thicker inner circular layer and a thinner longitudinal one. The presence of serosa was also found. Histology of the digestive tract thus shows microscopic specializations that encourage the best use of food items present in the diet, carnivorous or herbivorous, of the sea turtle species of the studied region.

POLLUTION AND SEA TURTLES IN SOUTH WESTERN ATLANTIC*

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The interaction with marine debris (mainly plastics) and chemical pollutants are one of the major threats for marine turtle conservation worldwide. The abundance and spatial distribution of different pollutants, both in coastal and ocean areas, is increasing in the last years due to the anthropogenic action of land-based sources, landfill sites and fishing residues. In the Southwestern Atlantic region (SWA) (Brazil, Uruguay and Argentina) some studies have been conducted in order to identify the impact of pollutants on marine turtles by quantifying the exposure to chemical contaminants, quantifying the interactions and identifying the mortality associated with the ingestion or entanglement with different marine debris. Several studies were conducted on digestive content analysis of juvenile green turtles (*Chelonia mydas*) in the SWA region demonstrating that, for all individuals analyzed, the frequencies of occurrence of animal with ingestion of debris is higher of 80% in all areas. For this reason, the region has been considered one of the most affected by marine debris worldwide. Juvenile green turtle of all size ranges were affected but the smaller turtles (curve carapace length, CCL, < 40 cm) presented higher frequencies and direct mortality associated with marine debris ingestion. The items with higher occurrence are soft and hard plastic, rope fragments and monofilaments and styrofoam. For other marine turtle species, marine debris was found in *Caretta caretta* and *Dermochelys coriacea*, in studies conduct in South of Brazil and Uruguay. A few studies have

quantified chemical pollutants in marine turtles. Trace elements (in particular mercury) and PCB compounds (polichlorinated biphenils) were analyzed. Total mercury was determined in *Chelonia mydas* and *Caretta caretta* in some coastal Brazilian areas in stranded turtles. Liver tissue had the highest concentration of mercury followed by kidney, blood and muscle. Between species, loggerheads had the highest contamination levels according to results from different world sites. In green turtles, contamination exposure is determined by trophic position and environmental impact. Juveniles have an omnivorous diet and higher mercury concentrations compared to adults. PCBs bioaccumulation was determined in green turtle blood samples from northeastern and southeastern Brazilian coasts. DNA damage caused by contaminants was observed by trace element biomarkers in green turtles from Uruguay. A Higher frequency of micronuclei was observed in green turtles next to agricultural areas. Despite scarce information, great extension and regional differences, all results point to chronic ecosystem contamination. Cooperation among scientists, industry, governments, and the general public is urgently needed in the ASO region, to confront this rapidly increasing form of pollution.

CONSERVATION POLICIES OF SEA TURTLES IN WESTERN SOUTH ATLANTIC

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The Western South Atlantic is comprised of Argentina, Brazil and Uruguay. The EEZs off these three countries are frequented by 5 species of sea turtles, which are under serious threat. In recent years, thanks to the growing information generated by the scientific community that study sea turtles, these three countries have incorporated into conservation agendas state policies that directly and indirectly protect sea turtles in the region. These actions include action plans, participation in international conventions and treaties, improvement of fisheries management rules and others national legislation addressed to the protection of marine wildlife. Both Argentina, Brazil and the Eastern Republic of Uruguay signed, approved and ratified by their national laws the following International Conventions: Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention on Migratory Species (CMS), Convention on Wetlands of International Importance (RAMSAR), Convention on Biological Diversity (CBD), United Nations Convention on the Law of the Sea (CONVEMAR) and Inter-American Sea Turtle Convention (IAC). The three countries have legislation that directly and indirectly protects sea turtles. It is important to highlight the value that represents local and regional level the contributions made by the different actors that make the ASO-Turtles Network. It is important to strengthen the role of this network as a tool for exchange of experience with other regions, as well as further qualifying protection policies to sea turtles in the respective countries.

MARINE TURTLE CONNECTIVITY IN THE SOUTHWESTERN ATLANTIC OCEAN*

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The Southwestern Atlantic Ocean (Atlântico Sul Ocidental - ASO) provides fundamental habitat for five marine turtle species: the loggerhead, hawksbill, olive ridley, green, and leatherback turtles. Not only are millions of hatchlings born there each year, but juveniles and adults from various rookeries also occupy its waters. Here we review the regional genetic work carried out over the past 25 years, from the early days of electrophoretic analyses to cutting-edge next generation sequencing. The most common nester in Brazil is the loggerhead turtle. Based on mitochondrial DNA (mtDNA) this unique group can be divided into three subpopulations. Juveniles and adults forage along the Northeastern and Southeastern Brazilian coasts, as well as in Uruguay and Argentina. Brazil is the major rookery of origin for these turtles. Animals in Ceará (Northeastern Brazil) waters have further been linked to Azores feeding grounds, and in the south, they are also connected to Omani, South African, and Western Australian rookeries. Different size-classes (adults versus juveniles) and habitats (near shore versus oceanic) present distinct haplotype frequencies. In Brazil, hawksbill turtles have two main nesting areas. These rookeries are distinct from one another based on mtDNA, and in the Bahian population hybrids with loggerheads are common. Overall haplotype frequencies differ between the major regional hawksbill feeding grounds, and Brazilian, Caribbean and West African rookeries are their primary natal sources. Hybrid juveniles are mostly found in waters of Southern Brazil, Argentina and Uruguay. Olive ridleys from the Brazilian rookery are considered distinct globally based on haplotype frequencies, although they do share haplotypes with Surinam and Guiana. Olive ridley and loggerhead hybrids occur in large numbers. Green turtles nest mainly at Brazilian oceanic islands. These rookeries are distinct from each other, and contribute to foraging areas in the Caribbean as well as throughout ASO. Ascension Island is the major source of turtles foraging along ASO's coast, but important contributions also come from Trindade Island and Surinam. Finally, leatherbacks nesting in Brazil constitute a small but unique population. Leatherbacks foraging in the ASO are primarily from large West African rookeries (Ghana and Gabon), with smaller contributions from the Caribbean, Brazil, Southwestern Indian Ocean and possibly even the Eastern Pacific. Understanding the connectivity of ASO's marine turtles is fundamental to the success of regional conservation efforts. Genetic data significantly contribute towards these efforts and highlight the importance of regional collaboration. We emphasize the ongoing need for phylogeographic marine turtle research to obtain essential information for their recovery within ASO, as well as in other linked areas around the world.

SURVIVAL OF LEATHERBACK TURTLES IN THE SOUTHWEST ATLANTIC: USING GENETIC DATA TO IMPROVE THE MANAGEMENT ACTIONS FOR CONSERVATION*

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The worldwide population of the leatherback turtle (*Dermochelys coriacea*) encompasses seven subpopulations among the Pacific, Atlantic, and Indian Oceans. It has experienced declines across parts of its distribution, with the subpopulation of the Southwest Atlantic listed as critically endangered by the IUCN Red List. The main causes of this decline are incidental capture in longline, gillnets, trawl, and coastal development. Improved understanding of the genetic diversity, population structure, and phylogeography of the species is needed for effective conservation. In this study, we sequenced mitochondrial DNA from 52 samples from Brazil and combined these with published data from Atlantic Ocean rookeries. Our analysis of the combined samples from Brazil revealed seven haplotypes in the pelagic aggregates and three in the nesting population. The genetic diversities of the Atlantic population rookeries ranged from 0.11 to 0.55 and are clearly not directly proportional to current population sizes. Although very small, with 1 to 19 females nesting per year, the rookery from Brazil had the second-highest haplotype diversity among all Atlantic rookeries (h=0.53), being higher than that of the largest population of leatherback turtles in the world (Gabon, h=0.39). We found signals of demographic expansion only in samples from Ghana and in samples collected in Brazil after 2004, which can be tied to a more recent colonization event and/or because of conservation management actions in Brazil. A mixed-stock analysis revealed that the Brazilian aggregate is composed primarily of animals from West Africa (84%) but also animals from the North Atlantic rookeries (overall estimated mean of 14%). Our analyses revealed evidence of migration between Southwest and Southeast Atlantic rookeries and philopatry in males from the Brazilian rookery. Leatherback turtles appear to have a complex phylogeographic pattern, showing evidence of multiple colonization events and a lack of isolation by distance. Our novel dataset, based on longer DNA sequences (695 bp), will provide baseline data needed for conservation efforts in the region and worldwide. Brazil is the only country in this region that contains both nesting and foraging areas, both with higher levels of genetic diversity than among others in the South Atlantic. Consequently, conservation policies in Brazil are crucial to the survival of the leatherback turtle in the Southwest Atlantic. Acknowledgments: Funding This work was supported by CNPq - Conselho Nacional de Desenvolvimento Científico e Tecnológico (Post-Doctoral scholarship number 201968/2014-2 to S.M.V.). The authors would like to thank the ISTS travel funds for the travel grants.

EPIBIOTA OF LOGGERHEAD TURTLE *CARETTA CARETTA* STRANDED IN ROCHA DEPARTMENT, URUGUAY

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In marine ecosystems, many animals are exposed to epibiota colonization. The knowledge of epibiota is important for ecological (microenvironment for meiofauna), biological (relationship between species) and biogeographic reasons (migratory routes). Although all marine turtle species can present epibiota, the loggerhead turtle (*Caretta caretta*) shows the greatest biodiversity of these organisms, even some authors consider it a true ecosystem. The epibiota may not be harmful for the turtles but sometimes they can cause buoyancy problems, carapace or muscle damage and they can even be disease vectors. *Caretta caretta* is considered as an endangered species by the IUCN. The aim of this study is to realize a taxonomic determination of epibionts found on carapace and skin of *C. caretta*. We sampled 38 turtles stranded on the coast of Rocha Department (Uruguay) between La Pedrera (34°35′S-54°07′W) and Barra del Chuy (33º44'S-53º22'W), from years 2002 to 2015. The turtles were found through censuses along the beach or reported to the Sea Turtle Rescue and Stranding Network, coordinated by the NGO Karumbé. The epibiota was collected with a scalpel and tweezers and put into alcohol 70% for preservation. The results show great taxonomic richness: algae, bivalve mollusks, echiurans, polychaetes, hirudineans and different types of crustaceans: amphipods, decapods, tanaidaceans and cirripeds. Of the nineteen determined taxa, only three of them show a high constancy in the study (*Mytilids* and *Amphibalanus* sp. With 80%, and *Platylepas hexastylos* with 100% frequency of occurrence), which are very common animals on floating objects. The presence of these type of epibionts besides the stranding may indicate a poorly health condition for these animals. As marine turtles are endangered species, the study of the ecological and biological aspects are necessary and relevant, specially the factors that put in danger the health of current populations. Acknowledgments: The authors would like to thanks ISTS travel funds for the support in attendance.

EPIBIOTA OF HAWKSBILL SEA TURTLE *ERETMOCHELYS IMBRICATA* STRANDED IN THE COAST OF ROCHA DEPARTMENT, URUGUAY

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The hawksbill turtle (*Eretmochelys imbricata*) is highly migratory with a circumglobal distribution in tropical waters and, to a lesser extent, in subtropical waters. Globally, it is the most threatened turtle species, categorized as "critically endangered" by the IUCN. The presence of hawksbill turtle is sporadic in Southwestern Atlantic waters because its principal distribution area is located between Ceará and Sao Paulo (Brazil). In Uruguay, there are only ten records of this species and only one report further south, in Samborombón Bay, Argentina. An important aspect of the biology of sea turtles is the study of colonizing fauna (epibiota). The knowledge of epibiota on turtles is important for ecological (microenvironment for meiofauna), biological (relationship between species) and biogeographic reasons (migratory routes). The aim of this study is to realize a taxonomic determination of the epibiota found on the carapace and skin of four hawksbill turtles stranded in the years 2009 and 2011 in Uruguayan coast. These turtles were found between Barra de Valizas (34°19′S-53°46′W) and Palmares de la Coronilla (33°50'S-53°26′W), in northeastern Uruguay. The turtles were found through censuses along the beach or reported to the Sea Turtle Rescue and Stranding Network, coordinated by NGO Karumbé. The epibiota was collected with a scalpel and tweezers and put into alcohol 70% for preservation. We identified a total of three taxa: algae from the class Phaeophyceae (*Sphacelaria* sp. and *Hincksia mitchelliae*), leeches (*Ozobranchus margoi*) and cirripeds (*Chelonibia testudinaria*, *Platylepas hexastylos* and *Amphibalanus improvisus*). These epibionts are common in hawksbill turtle but we did not found literature that described *H. mitchelliae* and *A. improvisus* as epibiota of hawksbill turtle. These southern strandings and the presence of these type of epibionts may indicate a poor health condition for these turtles. As marine turtles are endangered species, ecological and biological studies about them are necessary and relevant, especially about factors that put in danger the health of current population. Acknowledgments: The presenting author attendance is supported by ISTS travel funds. We are really thankful.

FEEDING HABITS AND ONTOGENETIC DIETARY SHIFT OF GREEN TURTLE, *CHELONIA MYDAS*, IN THE SOUTHWESTERN ATLANTIC OCEAN: WHAT WE KNOW UNTIL NOW?

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Aggregations of green turtles (*Chelonia mydas*) in the Southwestern Atlantic Ocean, SWAO (Brazil, Uruguay and Argentina) are composed by mixed stocks, originated primarily from nesting assemblages of Ascension Island, Surinam, Aves Island and Trindade Island. Early studies suggested that *C. mydas* shifts from an omnivorous diet −characteristic of the juvenile oceanic stage of their life cycle− to a primarily herbivorous diet after recruitment to neritic habitats. However, recent research has revealed regional differences in the timing of this process, with high levels of omnivory after recruitment. The combination of different techniques (e.g. stable isotope analysis, esophageal lavage, stomach contents) shows that *C. mydas* diet can differ strongly among ontogenetic stages, latitudes (spatial variation) and during climatic events (temporal variation), consuming high percentage of animal matter in some stages and areas after recruiting to a neritic zone. Such intraspecific variability can be expected for a species inhabiting a wide diversity of habitats, from tropical to warm temperate waters, as trophic plasticity will ensure survival in a wide range of local conditions. Our aim is to summarize the available information of regional patterns and ontogenetic diet shifts in the SWAO region (ca. 2º to 40º S) focus on juvenile *C. mydas* (CCL range 27.8 to 82.6 cm). Diet samples were obtained from different sources such as strandings, bycatch, intentional capture or underwater observation. Juvenile individuals from south Brazil and Uruguay often have omnivorous diets, but the abundance of vegetal material increases with turtle size. In the areas with presence of algal assemblages *C. mydas* had high frequencies of Rhodophyta (e.g. *Gelidium spp, Gracilaria spp, Pterocladiella capillacea* and *Grateloupia spp*; Chlorophyta (e.g. *Ulva spp., Caulerpa spp*); Phaeophyta (e.g. *Sargassum spp*) and in areas with presence of seagrass assemblages, *Halodule sp.* Conversely, in the southern limit of their distribution (southwest portion of the Río de la Plata estuary, Argentina) *C. mydas* feeding behavior changed to almost exclusively carnivorous (cnidarians). The high levels of animal prey ingestion in colder waters could be addressed to the scarcity or lack of macroalgae and seagrass assemblages and the relatively higher availability of gelatinous macrozooplanton. When the different studies conducted in SWAO are combined, a foraging plasticity -influenced by regional or local conditions- and a delay on the ontogenetic dietary shift emerged. Green turtles smaller than 45 cm CCL inhabiting the south Atlantic

to the latitude of 27ºS have an omnivorous diet, including plant material and gelatinous macrozooplankton as the main animal prey. The individuals larger than 45 cm CCL are primarily herbivores, occasionally consuming some animal prey. For example, in areas with a scarcity of submerged macrophytes, as in the turbid plume of the Río de La Plata estuary, neritic juvenile green turtles may resume a mainly omnivorous diet with higher presence of animal matter. We believe that a good understanding of the feeding strategies exhibited by *C. mydas* and its adaptation to different habitats is crucial to delineate next research steps to better understand the life cycle of this threatened species.

MARINE TURTLE BYCATCH IN SHRIMP TRAWLS IN SOUTH BRAZIL

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Marine turtles use the Southern coast of Brazil for development and feeding, and can be found stranded on the beach in highest abundance during the spring and summer. During these seasons, industrial shrimp trawling efforts are more intense in the region, targeting species such as *Pleoticus muelleri* and *Artemesia longinaris*, making marine turtle bycatch more likely. Trawl fishing is considered one of the least selective catch methods because trawl nets have a small mesh size, resulting in high catches of non-targeted species. Trawling is also considered one of the main causes of death in juvenile and adult marine turtles around the world, with an estimated mortality rate of 150,000 animals captured in shrimp trawl nets every year. In Brazil, since 1997, legislation requires the use of turtle excluder devices (TEDs). However, TEDs are often rejected by fishermen. Therefore, new approaches that cooperate with the fishery sector are necessary to minimize the impact of these captures. With this challenge in mind, this study aims to quantify and qualify turtle capture due to shrimp trawling and to understand the reluctance to use TEDs by interviewing the workers of the fishery sector. We conducted 54 interviews with vessel captains concerning the occurrence of turtles, 18 interviews about the use of TEDs during their last fishing trip. Of the 54 interviews, 20% affirmed to have captured turtles in the last travel (n=11), totaling 34 captured animals, of which 27 were *Caretta caretta* (23 alive and four dead), and four were unidentified. The fishing trips that captured turtles occurred between Farol da Solidão (30º42'S 50º28'E) and Rio Grande (32º02'S 52º05'E). Among the 18 interviewed captains, 72% (n=13) affirmed they did not use the TED, and 84% (n=15) mentioned capturing turtles. The main reasons cited for not using TEDs are: reduction in fish catch, inability to handle the equipment, damage caused to the net, complications with the device and trash, and problems with the TED getting stuck in the sludge at the bottom. Sixty-five percent (n=9) affirmed that if there were improvements made to the device, they would use it more frequently. During two research trips, the incidence of marine turtle captures by trawl nets in South Brazil were recorded, with two *C. caretta* and one *C. mydas* captured. The development of a more suitable TED in conjunction with fishery operations and the private sector, could mitigate turtle captures and has already shown positive results in several areas. In South Brazil, to promote the conservation of marine turtles and their ecosystem, the construction of a new TED model in cooperation with the fisheries sector has already begun.

WHAT CAN WE LEARN FROM SEA TURTLE STRANDINGS?*

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Stranding datasets may provide important information on sea turtle health, age, size composition, diet, reproductive status, population trends and cause-specific mortality. Additionally, they are also used to infer geographic distribution and abundance or even trends in mortality risk, attributable to anthropogenic threats such as coastal fisheries and pollution. Five species of sea turtle were recorded in 5260 strandings from January 2014 to September 2015, along the Brazilian coast, of which 3903 were *Chelonia mydas*, 914 were *Lepidochelys olivacea*, 290 were *Caretta caretta*, 83 were *Eretmochelys imbricata*, 4 were *Dermochelys coriacea* and 66 could not be identified. Almost 91% (n = 4756) of the stranded turtles were dead, whereas only 9% (n = 504) were alive. Although sea turtles are threatened with extinction as a result of many anthropogenic activities, incidental capture in fisheries is considered the greatest threat to sea turtle populations worldwide. However, stranded sea turtles, whether dead or alive, rarely exhibit external signs of capture in fisheries and the lack of external injuries may therefore underestimate the actual bycatch levels. In order to reduce the possibility of not detecting a turtle interaction, in 2014, we created an evidence protocol that basically distinguishes chronic illness from acute deaths or strandings. 23.2% of the turtles (n = 1220) were in good body condition, based upon subcutaneous and visceral adipose tissue and musculature. This condition suggests that the turtles had been feeding recently and had a sudden death, probably as a result of getting caught in fishing gear. In 12.95% (n = 681) of the stranded turtles, the presence of external tumors, suggestive of fibropapillomatosis, was observed. Most individuals that presented these tumors were green turtles (97.8%; n = 666/681), with CCLs ranging between 27.1 and 81 cm (mean = 43,8 cm). We performed necropsies on 40.39% (n = 1921/4756) of the dead turtles. Marine debris was present in almost 34% of the turtles (n = 653), however, only 13% (n = 249) had their death related to litter ingestion or entanglement. Most turtles affected by marine debris ingestion were juvenile *C. mydas*. These animals are particularly prone to eating litter since they are exposed to pollution in nearshore habitats, where they normally feed. Only 19% (n = 365) of the necropsied turtles had gross evidences of drowning. This percentage is probably underestimated as this diagnosis cannot be based on any one finding alone (e.g., sediment in the lungs), but relies on the exclusion of other potential causes of death. So, stranded sea turtles that drown due to incidental capture in fishing gear may have no conclusive cause of death or could be mistakenly attributed to some other cause. For this reason, we have decided to use parameters other than the cause of death itself, which is sometimes hard to be determined. We believe these results open new perspective on the contribution of stranding data to sea turtle conservation.

ASO - TURTLE NETWORK: COLLABORATIVE EFFORTS TO UNDERSTAND STRANDINGS*

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The ASO-Turtle Network was formally established in 2003 and encompasses the coastal areas of Brazil, Uruguay and Argentina. The network is formed by institutions that work with the research and protection of sea turtles in the Southwestern Atlantic Ocean (ASO). Since the beginning of ASO, more than 70 studies on physiology and health assessment have been conducted, using standardized data from stranding events. When sick, injured or dead turtles come ashore, they may be signaling changes in the marine environment. As a matter of fact, sea turtles serve as indicator species, alerting us all to potential environmental problems. Stranding datasets may provide important information on diseases, contaminants, diet, cause-specific mortality, among others. Additionally, they are also used to infer geographic distribution and abundance or even trends in mortality risk attributable to human related threats such as coastal and pelagic fisheries. Sea turtles strand due to a variety of natural and anthropogenic causes. Natural causes include disease, predation and aging, while human induced strandings are often related to fisheries interaction, marine debris ingestion, pollution, dredging interaction and many others. Current literature suggests however, that multiple factors, both natural and human-related, may act in combination to cause a turtle to strand. In order to improve the knowledge on sea turtle strandings, the network participants have started to evaluate the body condition score of stranded turtles as a means of distinguishing chronic illness from acute cases. Animals with body condition rated as good have subcutaneous and visceral adipose tissue and thick musculature. This condition suggests that they had been feeding recently and had a sudden death, probably as a result of getting caught in fishing gear. On the other hand, cachectic or underweight turtles (i.e. muscle atrophy, sunken eyes and concave plastron) normally have a chronic condition that is persistent. Like other animals, sea turtles frequently suffer from a variety of diseases and one of the most significant in terms of conservation is fibropapillomatosis (FP). The prevalence of the disease is associated with heavily polluted coastal areas and areas of high human density, suggesting that the rates of FP could be used as an indicator of ocean health. Although this disease may be quite severe, often leading the affected animal to death, there are reported cases of spontaneous remission. Another issue that deserves urgent attention is marine pollution and its effects on sea turtle populations. Every year, thousands of sea turtles die from becoming entangled or ingesting plastic debris. Litter ingestion may lead turtles to death from starvation and debilitation. These conditions cause depletion of fat deposits along with muscle tissues, leading to cachexia. This study aims

to present a new approach to evaluate strandings, considering not only the cause of death itself, which is sometimes hard to be determined, but also a simple parameter that may distinguish chronic illness from acute strandings. Finally, these findings were only made possible by collaborative work of ASO participants. In this context, we highlight the importance of cross-border collaboration in sea turtle conservation.

Conservation, Management and Policy

NINE YEARS OF SEA TURTLE CONSERVATION AND RESEARCH IN GHANA, WEST AFRICA: A REVIEW OF ACCOMPLISHMENTS AND ACTIVITIES

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Sub-Sahara West Africa holds significant foraging and nesting habitats for five species of marine turtles, including the critically endangered leatherback and hawksbill turtles. The region serves as a convergence zone for genetically diverged populations from the northern and southern Atlantic Ocean. Unfortunately, these animals face a significant number of anthropogenic mortality risks from (a) intensive near-shore fishery by-catch, (b) direct harvest of nesting individuals, (c) increased nest predation by pig and dogs, and (d) degradation of nesting habitat along the coast. Our unique project combines efforts of NGOs, academia, and government agencies to create community partnerships for enhancing sea turtle conservation in Ghana. Specifically, we work with community fishermen, school teachers, business owners, and village elders to strengthen conservation through a participatory management strategy that integrates traditional knowledge and taboos with government protection. We provide the resources, training, and guidance necessary to enhance protection while simultaneously improving local economies and creating long-term interest for protecting sea turtles. Highlights of past accomplishments include: training Ghanaian fishermen, University faculty, college students, and business owners on sea turtle conservation and survey mechanisms; eliminated sea turtle poaching in multiple communities; confirmed nesting activity by four species; established community by-laws to enhance sea turtle protection in multiple fishing communities, and have quantified sea turtle mortality in artisanal fisheries. Such activities work to strengthen community relationships and follow our philosophy that long-term sea turtle conservation is only successful when communities work to protect their turtles. Our approach enhances the local capacity for managing turtles in a way that boost economic development and reduces turtle mortality. Working with Ghana's Wildlife Division, universities, and communities ensure locally developed efforts have a high impact and low cost.

SEA TURTLES AND SHARKS... CLASSES APART, BUT NOT SO DIFFERENT*

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Sea turtles and sharks share a number of biological traits that necessarily imply the need for implementing similar or even the same conservation strategies. Both are long-lived, slow growing, and reach sexual maturity late in their life cycle. Gestation periods tend to be long, and offspring are few. Both have complex life cycles, with philopatric highly migratory species that depend on an array of coastal and pelagic habitats (true for all sea turtles, not all sharks). Sea turtles and sharks are both highly sought for human consumption, in coastal traditional communities and as a staple food in major cities. Furthermore, both are incidental catches (and in some cases directed) of commercial fisheries, from small-scale coastal fishers to industrial trawlers and purse seiners. This combination of biological traits and fisheries induced mortality has brought

many species of these two classes of vertebrates to the verge of extinction. Conservation policy designed for sea turtles, particularly pertaining to fisheries, is relevant to shark conservation, either in a positive or negative way. Use of different international instruments such as CITES and CMS to attain regional and global sea turtle and shark conservation will be discussed, as well as other instruments, such as the Central American Free Trade Agreement (CAFTA) and the United States Endangered Species Act (ESA). A case will be made for closer and more direct collaboration among the sea turtle and shark conservation communities.

SINGLE SPECIES ACTION PLAN FOR THE LOGGERHEAD TURTLE (*CARETTA CARETTA*) IN THE SOUTH PACIFIC OCEAN – AN INITIATIVE OF THE CMS4

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Loggerhead turtles nesting in eastern Australia and New Caledonia form a discrete genetic stock - the South Pacific subpopulation. This stock is in serious decline. Loggerhead hatchlings from this stock spend approximately 16 years in waters of the south Pacific travelling as far as the waters off Peru, Chile and Ecuador before returning to the Coral Sea-Tasman Sea region of the southwest Pacific. Throughout their range, loggerhead turtles are exposed to a variety of threats including: fisheries bycatch; entanglement in and ingestion of marine debris; climate variability; terrestrial predation of nests; light pollution; and changes to water table levels at nesting beaches. To address these threats and to reverse the decline in this stock, the Convention on the Conservation of Migratory Species (CMS) adopted the Single Species Action Plan for the Loggerhead Turtle (*Caretta caretta*) in the South Pacific Ocean (Loggerhead SSAP). The development of the Plan was led by the Australian Government and Dr Col Limpus, the CMS COP-appointed Councillor for Marine Turtles in conjunction with representatives of all range states. In unanimously adopting the Loggerhead SSAP at the 11th Conference of the Parties in November 2014, the CMS urged South Pacific Parties and other Parties with fishing fleets operating in the South Pacific Ocean to implement relevant provisions of the Plan. The CMS also encouraged other Parties to provide technical and/or financial support to activities outlined in the Loggerhead SSAP and invited other relevant organisations to support the implementation of the Plan. Implementation of the Loggerhead SSAP is being overseen by a committee of Range State representatives appointed by their respective governments.

THE ENVIRONMENTAL MANAGEMENT PLAN OF THE CONTAINER TERNINAL OF THE PORT OF MOIN, COSTA RICA; A TOOL FOR THE CONSERVATION FOR MARINE TURTLES

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The Pacific coastline and marine environment of Costa Rica extends approximately 1.254 km, with a geomorphological complexity of rocky coast, gulfs, islands and bays. There is also a 212 km coastline in the Caribbean, with sandy beaches in the north and reefs and carbonated seabeds in the south. The marine wealth of Costa Rica is contained within an exclusive economic zone of 613.683 km2. This area is occupied by a great diversity of ecosystems such as mangroves, reefs and sea grass meadows, serving both migratory and resident populations of invertebrates, fish, turtles and marine mammals, which travel along the length of the coastlines and the exclusive economic zone of the country. However, as the second smallest country in Central America, Costa Rica requires the development of a particular infrastructure that allows for imports and exports, maintaining its path of development. This paper describes a design tool for environmental managers for the development of the Moin Container Terminal (TCM), on behalf of the Dutch Company APM-Terminals. We describe the activities designed and their relationship to the anticipated impacts, the monitoring system of 10 variables relating to marine turtles, and the implementation of these measures. We evaluate sea turtle nesting in the area of the Project, with a record of over 1200 nests of *Dermochelys coriacea* in the Project zone and the adjacent area. We also record zero mortality due to the activities in the ocean, which shows the efficiency of the actions taken. Light, noise, staff interaction, dragnets, vehicles, sediments, marine traffic and waste are just some of the variables analyzed.

RELATING SATELLITE-DERIVED ARTIFICIAL LIGHT DATA TO BROAD-SCALE MARINE TURTLE NESTING BEHAVIORS FROM 1992 TO 2013 IN FLORIDA*

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Numerous studies have documented how artificial light deters nesting females from suitable nesting beaches. An experimental study demonstrated that loggerhead nest numbers at Melbourne Beach, Florida were significantly reduced when beaches were exposed to mercury vapor (white) lighting. Artificial night light may also increase nesting congregations on darker beaches, which may lead to nest destruction by other nesting turtles. Previous satellite-based studies lumped species and multiple years of nesting data or did not directly compare annual satellite night light data to actual nest numbers. Failure to compare concurrent satellite night light and nesting data may bias the interpretation of this relationship. To more fully understand how artificial night light influences nesting patterns, we analyzed annual satellite-derived night light imagery from 1992 to 2013 with respect to concurrent patterns of nesting and non-nesting ("false crawl") emergence data of the three predominant marine turtle species that nest in Florida: loggerhead

(*Caretta caretta*), leatherback (*Dermochelys coriacea*), and green turtle (*Chelonia mydas*). Simultaneous autoregressive (SAR) models were developed to reveal how marine turtle nesting patterns related to artificial night light in past two decades from 494 Index Nesting Beach Survey (INBS) beaches in Florida. The INBS is a systematic monitoring program that was established in 1989. Trained surveyors record emergences from May 15 to August 31 from the ~1 km beaches and forward the data to the Florida Fish and Wildlife Conservation Commission (FWC). Annual pixel brightness values representing artificial night light from the INBS beaches were obtained from a meteorological satellite. Most traditional statistical methods fail to consider the presence of spatial autocorrelation present in dependent and independent variables, which may yield models with artificially inflated relationships. However, with the SAR models, spatial autocorrelation from the artificial light and marine turtle nesting data was incorporated in the analysis. To assess the degree to which light ordinances may influence the levels of light on the beach, the presence/ absence and type of light ordinance associated with the different INBS beaches were also included as model parameters.

THE FRENCH SEA TURTLE GROUP, AN ACTIVE NETWORK IN 5 OCEANS AND SEAS

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France, with its 12 regions and overseas territories, has an international responsibility towards sea turtles, since all sea turtle species (except *Natator depressus*) are encountered in French waters and/or on beaches. Many actions are carried out in order to improve knowledge and conservation of sea turtles in the five oceans and in the Mediterranean Sea, where France is present. The development and structure of actions have been enhanced since 2007 through National Actions Plans and a collaborative network: the French Sea Turtles Group (Groupe Tortues Marines France, GTMF) initiated by the French Ministry in charge of the Environment. Four National Action Plans are actually under process in Guadeloupe, Martinique, French

Guyana, and more recently in the French territories of the South West Indian Ocean (Iles Eparses, La Réunion Island and Mayotte). The GTMF relays information downward and upward, and facilitates exchanges through organizing meetings, videoconferences and symposia. Four kinds of actions are performed in reference to sea turtles within the French territories: knowledge acquisition, protection of turtles and habitats, education and communication, and regional coordination. Protection and awareness actions are being taken in order to: - protect sea turtles from illegal trade and poaching (law and surveillance), - promote related ecotourism, - tackle light pollution, - lower human impacts on beaches, - develop homogeneous tools for sea turtle data collection, - approach effects of pollutant exposure and plastic ingestion, - save and heal injured turtles, etc. Research work is being done on numerous topics such as migration patterns, behavior, impact of marine debris, plasticity of species, indicators for management and conservation. The GTMF is composed of more than 160 stakeholders who work in coordination with regional networks, bodies and activity centers: RAC SPAW and WIDECAST in the Caribbean, CMS-IOSEA in the Indian Ocean, SPREP in the Pacific Ocean, RAC SPA in the Mediterranean Sea, SWOT, IUCN at the international scale, etc. The last GTMF symposium hosted in Paris (Maison des oceans, September 8-10, 2015), also welcomed French speaking colleagues from Africa, north and south America and Europe. During this event, more than ten workshops were held on priority topics by the Groupe Tortues Marines France, which acts as the national expert group for the Ministry in charge of the Environment and species conservation. The results of these workshops will help in building the next 2016-2018 national working program, including several national initiatives around which the GTMF stakeholders federate. One of these is the first National Atlas of Sea Turtles, currently under preparation by the Natural Heritage Department of the French Museum of Natural History, in charge of the coordination of the GTMF.

A LOOK BACK AT 12 YEARS OF GREEN TURTLE NESTING MONITORING IN VAMIZI ISLAND, MOZAMBIQUE*

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IUCN Vamizi Island, Mozambique

The conservation project of Vamizi Island is the longest ongoing turtle monitoring project in Northern Mozambique. For over 10 years, a nesting population of green turtles (*Chelonia mydas*) has been monitored on a daily basis with new nests registered and tracked throughout their incubation period. In 12 years, the project has recorded close to 2000 nests, and with a mean clutch size of 104 eggs per nest, an average emerging success of 90%, and little to no predation on land, close to 190,000 hatchlings are expected to have made their way into the ocean. Four females have been tagged with satellite tags, two of which were traced to Kenya, one to Tanzania and one to Madagascar. The main threat to this nesting population is erosion, as the loss of sand leads to natural barriers that keep the females from making their way up to the higher portions of the beach. Forced to lay their eggs below the high tide mark, the eggs are often flooded or washed away during spring high tides. To reduce the loss of eggs, a relocating project was initiated three years ago, resulting in similar rates of hatching and emerging for relocated nests in comparison to natural ones, which shows this can be a good solution in our nesting area. At the same time, we have been measuring beach profiles to track sand movement along all nesting beaches, which will hopefully help us understand what the priority areas for management are, with replantation of mangroves and creepers already underway. A big part of the success of our project is the work that has been done with the local communities, who went from poachers to protectors of the turtles that use their island to lay their eggs. Different programs

have been launched, initially with the local fishermen that involved a reward for returning turtles caught in their nets, and now focuses on working with the local Community Council for Fisheries in making sure these species are protected in the water as well as on land. Significant collaboration is done with the primary school, where children not only learn about turtle biology and ecology, but get a chance to learn first-hand what being a turtle monitor is like. Guests of the Vamizi Island Lodge are also educated about our turtle project, and are encouraged to participate in night patrols and hatchling releases, in the hopes that watching these amazing creatures in their natural habitat and being educated on the many threats they face, this will shape their behavior, with a positive impact on the overall effort of their conservation.

PRELIMINARY STUDY ON THE EFFECTS OF INCUBATORS ON THE MAGNETIC IMPRINTING OF LOGGERHEAD SEA TURTLE HATCHLINGS (*CARETTA CARETTA, LINNAEUS 1758*)

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It is thought that the starting point of a sea turtle's migratory route begins with the use of a range of cues, including visual, chemical and magnetic, the last of which is often considered the most important. Head-starting projects have become more common for the conservation and recovery of sea turtle species, so it is critical to understand how, and in what ways, we are affecting those hatchlings and therefore the entire population with these practices. The aim of this research is to analyze if there are differences in the magnetic orientation of hatchlings as a result of differences in their magnetic imprint developed in different environments of incubation. For this experiment, hatchlings from a loggerhead sea turtle (*Caretta caretta*, Linnaeus 1758) clutch were observed. This nest was found in San Juan beach, Alicante, East Spain (38.37261°N-00.40932°W) in July 2014. A total of 129 out of 131 eggs of this clutch were relocated, moving 89 to an egg chamber in La Punta beach, Valencia, Spain (39.31177°N-00.29426°W), and the remaining 40 to an incubator in the Rescue Centre, at the Oceanogràfic of Valencia. In comparison, we examined a loggerhead clutch on the beach, and after emergence, hatchlings were boxed until next morning, whereupon the box was removed and the hatchlings were left to make their own way to the sea crawling over the sand. When they crawled about 10 m, the hatchlings were taken to the rescue center. All resulting live hatchlings (N= 102) were kept in individual floating cages within a large tank for a year before release. None of the hatchlings had any contact with seawater prior to being collected by the Rescue Center. After several months of head-starting, we had a limited number of healthy individuals for the study (N=18 for incubator, and N=17 for beach hatchlings). Hence, this protocol was designed to be as simple and cost effective as possible, allowing easy replication of the experiment. Each hatchling was tested only once, fitted with a lycra vest with either a magnetic (test) or placebo (control) pill, both same size and weight. In the tank, every hatchling was filmed swimming, and their orientation was measured once every 30 seconds within a 45 minute period. Each of the groups (beach-magnet, beach-placebo, incubator-magnet and

incubator-placebo) had a significant mean orientation (Rayleigh test, p<0,05). The Mardia-Wheeler-Watson test showed that the four mean orientations obtained were different between them, being the largest difference shown between the incubator groups than between the beach groups. Moreover, incubator groups showed a westward deviation compared to the beach groups. Based on our results, we found there may be a possible effect of the incubators on the magnetic imprint of loggerhead hatchlings. The magnetic field in which the embryos are developing should be kept in mind when developing a relocation/head-starting project. Acknowledgements: The authors would like to thank the Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria, and WWF for travel assistance to the symposium.

GREEN TURTLE REPRODUCTIVE FAILURE AND MANAGEMENT INTERVENTION AT RAINE ISLAND*

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Raine Island is the nesting site for 90% of northern Great Barrier Reef green turtle population, the largest remaining green turtle rookery on the planet. Up to 100,000 green turtles from the northern Great Barrier Reef, PNG, Indonesia and SW Pacific migrate to their natal Raine Island beach to nest each year. This genetic population is in danger of collapse. Nesting and hatching failure is occurring on a grand scale. Clutches of eggs provide few offspring despite large numbers of nesting females. Nesting success is low, around 20%, due to two main causes. Dry and fine foraminifera-based sand causes body pit and egg chamber collapse and high-density nesting results in frequent inter-turtle nesting disturbance. Nesting failure necessitates repeated re-nesting efforts on successive nights, which depletes stored energy reserves and results in resorption of follicles. The result is fewer clutches laid in a season. Emergence success during the last four years has been low, from 20 – 56%, with embryonic death occurring in the first stages of development in around 70% of cases recorded. Inundation of the nesting area during high tides is being investigated as a major cause of hatching failure because turtle eggs inundated for even a short period cease development and die during this phase of development. Prior to the mid 1980's surface water had never been seen in the nesting area. Now around 60% of the nesting area is non-viable due to tidal inundation at nest level. There is concern that unsuitable nest environment conditions including low O_2, high CO_2, sand composition limiting gas exchange or increasing water capillary action and retention and/or toxins may also be contributing to hatching failure. With very low hatching success a large decomposing biomass remains within the nesting beach sand; up to 500,000 eggs per night are laid in a beach area of 1800 x 50m. It is hypothesised that this may be result in unfavourable nest conditions. Trial re-profiling of the nesting area (movement of sand above inundation height to improve hatching success) was carried out in 2014. This produced a more gradual slope within the nesting area, hypothesised to encourage more evenly distributed nesting, reduce disturbance and increase nesting success. Comparison of trial and control nesting beach areas showed an increase in nesting success (47% vs 26%), more even distribution and reduced disturbance of nesting turtles and increased hatchling production (almost double) within the trial area. Comparison of nests marked by dGPS and excavated post-hatching showed no difference between trial and control areas with an average emergence success of 56%. This indicates that hatching failure occurs above inundation

level and that inundation is not the sole cause of hatching failure. Investigations are underway to characterise the nest environment conditions responsible for hatching failure.

PRIORITIZING CONSERVATION ACTIONS FOR TERRESTRIAL THREAT MANAGEMENT FOR MULTIPLE MARINE TURTLE SPECIES ACROSS MULTIPLE LOCATIONS AT CAMPECHE, MEXICO

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At a global level, marine turtle populations are under pressure as a consequence of the variety of threats that influence their life cycle. Despite the efforts, their trends still decline in most places they exist, where threats, as well as life cycle dynamics and their interactions, are often not fully understood. In addition to this, budgets for implementing conservation actions and management are frequently limited. Decision making frameworks that integrate conservation objectives with costs and expected benefits can help to invest in the projects that have the highest return of investment. In the present study, we developed a cost-effective analysis for prioritizing management actions that adequately address terrestrial threats in strategic nesting locations where multiple marine turtle species coexist in Campeche, Mexico. This approach was developed in order to maximize the average population growth for marine turtle populations given a set budget and time frame, using empirical data containing the number of turtles, eggs and hatchling, and expert knowledge. This study highlights the valuable contribution of decision support schemes being used as guidance and support for the management of multiple species under multiple threats, integrating associated costs into conservation strategies. While current conservation efforts towards marine turtles recovery are valuable, it is extremely useful to know the necessary funding required for such management and how and where it should be spent to efficiently maintain and recover our marine turtle populations.

SOCIO-ECONOMIC AND POLICY ASPECTS OF SEA TURTLE EGG USE IN GUATEMALA*

Lucia Carolina García López and Colum Muccio

ARCAS, Guatemala

In Guatemala, efforts to conserve marine turtles have been based on an informal system of conservation quotas whereby a percentage of the eggs of each nest is given to a local hatchery while the rest of the nest is sold on the open market. Without any scientific basis or conservation strategy in mind, in the mid-80s the conservation quota was set at one dozen eggs per nest and the first sea turtle hatcheries were constructed along different points of the coast. In 1996, also on an arbitrary basis, the egg quota was increased to 20%. Olive ridley (*Lepidochelys olivacea*) are the principal turtle to nest on the Pacific coast of Guatemala, with

occasional nesting's of leatherbacks (*Dermochelys coriacea*) and Pacific greens (*Chelonia mydas agassazii).* It is a challenge to establish a clear conservation strategy for sea turtles in Guatemala. Most nesting beaches are not protected area, and the government authority in charge of biodiversity conservation - the National Council of Protected Areas (CONAP) - lacks the resources to enforce the egg quota system. There is also legal ambiguity because the egg quota system has never been fully legislated and CONAP has a legal mandate to protect endangered species and is philosophically not predisposed to permit the commercialization of eggs and the participation of the private sector in sea turtle conservation. Since 2003, ARCAS has been carrying out crawl count population surveys along the Pacific coast of Guatemala. These count data allow it to monitor the degree of compliance with the egg quota system. Roughly 10 years ago, sea turtle hatcheries in Guatemala began buying nests to augment the number of eggs they were receiving as conservation quotas. Since that time, the number of eggs rescued on a national basis has more than tripled, from under 100,000 eggs to over 300,000 eggs, much of this increase due to the purchase of nests by the private sector. In certain sectors of the coast, olive ridley nesting has increased, and local egg collectors have seen an increase in income from this activity. However, the introduction of inexpensive motorcycles from Asia has led to increased mobility and increasing conflict between motorized egg collectors and those on foot. Tourism is increasing in certain areas of the Pacific coast of Guatemala, offering local residents much needed economic alternatives, but also posing its own set of management challenges. CONAP lacks the resources and the organizational inclination to be able to effectively regulate private hatcheries and to ensure that sea turtle-based tourism is carried out without harming the turtle. Guatemala is a signatory of the Interamerican Sea Turtle Convention and must justify its "exception" (its use of sea turtle eggs) under that treaty as sustainable, traditional and for subsistence use. ARCAS is currently working together with CONAP and other sea turtle colleagues to develop a management plan to ensure that this exception meets treaty requirements.

RASTOMA A NEW NETWORK FOR SEA TURTLE CONSERVATION ACTORS IN CENTRAL AFRICA

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The Rastoma network is coordinating NGOs and individuals working on sea turtle conservation from the Democratic Republic of Congo, Republic of Congo, Gabon, Cameroon, Sao Tome and Principe and Equatorial Guinea. Rastoma exists to enable these actors to work towards the long-term conservation of sea turtles and their habitats in Central Africa. Rastoma members also share a common goal in their commitment to constructing a network where members are both politically independent and also strongly involved in its governance. Specifically, the network aims to: -contribute to the spread of knowledge and expertise; -promote synergies between actors and stakeholders; -support actors' conservation efforts (financial, logistical, scientific aspects); -and contribute to the establishment of a conservation strategy at the regional scale. Rastoma also benefits from funding from the French Environment Funds (FFEM), which has allowed for the recruitment of a permanent staff in Cameroon. Concrete priorities for this year are: i)

Developing the organizations's infrastructure; ii) Beginning training and capacity building for actors/members; and iii) Ensuring that sea turtle components are included in the regional MPA development strategy. A regional meeting will be held in Central Africa during the first half of 2016 to which international sea turtle experts will be invited to augment the capacity of the Central African sea turtle community and reinforce the international connections of the Central African Actors.

CHALLENGES FOR THE MID TO LONG TERM SURVIVAL OF A SEA TURTLE PROJECT IN THE NEOTROPICS: A 16-YEAR CASE STUDY FROM THE PARIA PENINSULA, VENEZUELA

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The year 1999 marked the start of the "Sea Turtle Research and Conservation Project in the Paria Peninsula" (Sucre State, Venezuela), which commenced at Cipara Beach and was extended to nearby Querepare Beach in 2002. The project goal was to protect leatherback sea turtles, the main species occurring along the northern coast of the Paria Peninsula and the second most important species nationally in terms number of nests and females. Field work has included tagging of nesting females and relocation of nests to protected hatcheries at both beaches, with associated efforts related to outreach, education and the promotion of sustainable alternative livelihoods. After 16 years, we are reviewing this project from several perspectives. Firstly, from a biological perspective the project has succeeded in tagging more than 1,000 nesting female leatherback turtles at both beaches and, in doing so, has determined the importance of the Venezuelan population of *Dermochelys coriacea* in the Southern Caribbean. Secondly, in terms of capacity building the project has had great impact. Nearly 100 Research Assistants and Local Assistants have been trained, including many from Latin America, USA, Europe and Africa. A sea turtle biology course for staff, students and stakeholders has been run on the Paria Peninsula since 1998. Over the years, the project has served to empower local people and it is now under the leadership of two local community members, which represents perhaps the most significant achievement of the project in the local area. Thirdly, from an institutional perspective, the network that has evolved around the project is a significant achievement, and the sea turtle project is seen locally as a reference for sustainable development and stakeholder participation. The development of the project has not been rapid, nor has it been straightforward. More than a decade's worth of professional expertise has been invested in the project. Tremendous effort has been put into creating awareness-raising materials, press releases and organizing workshops and lectures, as well as other activities to help create awareness about the importance of the Paria Peninsula for sea turtles and the

importance of live sea turtles for coastal ecosystems and for local communities. The development of conservation projects for long-lived species such as sea turtles is an enormous challenge, especially in the often-unpredictable socio-political environment that is typical of neotropical countries like Venezuela. In our case, field effort has diminished between 2012 and 2015. International volunteers are not coming as in previous years. The constant search for funding to enable operation of a project can become overwhelming, and detracts from doing high-impact science. International agreements, such as the Inter-American Convention for the Protection and Conservation of Sea Turtles, have a positive influence in the country, however, law enforcement is not sufficiently effective in the face of threats from poaching and unsustainable fishing practices. Patience, perseverance and enormous faith have proven indispensable in continuing to run such a project in order to bring about meaningful results for the situation of sea turtles and their habitats.

AN UPDATE OF CURRENT STATUS OF SEA TURTLE CONSERVATION IN SRI LANKA

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Turtle Conservation Project (TCP), Sri Lanka

Sri Lanka provides nesting beaches for five species of sea turtles--the green turtle, leatherback turtle, olive ridley turtle, loggerhead turtle and the hawksbill turtle. Both historic and recent studies suggest that all turtle populations are rapidly declining in Sri Lanka mainly due to anthropogenic reasons. Although some of the beaches such as Yala National Park (NP), Kumana NP, Wilpattu NP etc., have been declared as protected areas by the Wildlife Department, natural predators account for nearly 100% egg predation in many of these areas. Coastal communities of Sri Lanka depend on surrounding natural resources for their survival. In addition, development activities are taking place in many coastal areas of the island. As a result, very important coastal habitats and coastal fauna such as the coral reefs, sea grass beds, mangroves, marine turtles and other coastal vegetation are under serious threat of extinction. Sea turtle hatcheries are still illegally operated in Sri Lanka mainly as a tourist attraction and represent the ex-situ conservation. The Department of Wildlife Conservation has failed to regulate these hatcheries as there is a political influence to keep the illegal turtle hatcheries in operation. Sea turtle by-catch seems to be the biggest threat for sea turtles' survival in their aquatic habitat in the island. Thousands of turtles become entangled in fishing nets and drown each year. TCP has recorded several turtles with fish hook entanglements associated with long-line fisheries but further research is needed to fully understand this issue. In-situ conservation projects are carried out in Rekawa sanctuary and in Bundala National Park. Habitat destruction and alteration cause severe problems for nesting turtles and hatchlings. The new harbor which is being constructed in Hambanthota is posing a serious threat to sea turtles in Ussangoda-Godawaya National Park and Rekawa sea turtle sanctuaries. In addition, there is a proposal to remove beach sand from the Ussangoda-Godawaya Sanctuary. The planting of introduced beach pines Casuarina along the beaches of Ussangoda-Godawaya sanctuary disturbs the sand dune formation process and shows negative impact on nesting activities of endangered Leatherback turtles. Sea turtles that nest in Kosgoda beach forage in Hikkaduwa Marine National Park and these turtles are being tamed, fed and ridden by children and other tourists. Educational programmes to raise awareness on sea turtles are being carried out by TCP and occasionally by Wildlife Department. A National Action Plan for sea turtle conservation has been produced in Sri Lanka but yet to be translated in to local languages.

THE SHELL BEACH PROTECTED AREA AND SEA TURTLE CONSERVATION IN GUYANA*

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Protected Areas Commission, Guyana

The beaches of the Shell Beach Protected Area, in Guyana, are nesting grounds for four threatened sea turtle species - the leatherback, green, hawksbill, and olive ridley. Shell Beach was designated a protected area with the passage of the Protected Areas Act of 2011. The designation of Shell Beach was preceded by a boundary delineation process between 2009 and 2010. In December 2014, the Protected Areas Commission (PAC) completed a management plan for the protected area. The delineation and the management planning processes underwent extensive consultations with Amerindian stakeholder communities, several NGOs, and national government agencies. The protected area is located in the northwest part of Guyana, in Region 1, stretching over 120 kilometers (75 miles) of beach, mudflats, and coastal mangrove forests. It covers an approximate area of 123,055 hectares (304,075 acres). Mixed swamp forest and open swamps are found inland from the coast. The protected area is categorized as an IUCN Category VI - Managed Resource Protected Area, where communities can continue to use resources for their personal needs from within the protected area. However, the Protected Areas Act 2011 and the Wildlife Management and Conservation Regulations 2013, accord protection for sea turtles against harm and exploitation. There is a long history of sea turtle conservation at Shell Beach. The conservation programme, initiated by Dr. Peter Prichard, has been run by Guyana Marine Turtle Conservation Society (GMTCS) for the past two decades. Since 2015, the PAC, being responsible for its management, has taken on a more active role, with collaborative support from GMTCS and WWF, in securing the future of sea turtles in Guyana. As a new agency managing a new protected area that is fairly remote, there are many challenges for management of the protected area and for the conservation of sea turtles. From an operational perspective, this includes developing infrastructure and human resources; establishing relationships with stakeholders; collaborating with law enforcement agencies; and managing logistics and cost. From a sea turtle conservation perspective, it includes managing predation; monitoring primary and secondary beaches along the coastline; supporting seasonal employment for the local and other stakeholder communities; building capacity for turtle conservation and alternative livelihoods; creating conservation awareness among communities, resource users and youth to reduce poaching; and assessing the impacts of beach erosion on nesting beaches and turtles. The development of a conservation and monitoring plan offers, for the first time, a strategy for conserving and monitoring sea turtles in Guyana. It also offers an opportunity to share information and work with other organizations to support regional efforts towards sea turtle conservation in the Guianas.

DEVELOPMENT IN THE SCREENING STYLE OF LOGGERHEAD SEA TURTLES NESTS AGAINST PREDATORS ON DALYAN BEACH, TURKEY

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Dalyan beach is one of the most important loggerhead turtle nesting beaches in Turkey with about 100 sea turtle nests per kilometer. Dalyan Beach and the surrounding area is a Specially Protected Area (SPA) where sea turtle nests have been monitored for the last 27 years. Every year nests are recorded and screened to protect against predators such as red foxes and badgers. The number of nests and screened nests and predation rates were compared over the years. In the early years of monitoring, a 70x70 cm square metal grids, with 8 cm mesh size, were used to reduce predation. These cages were usually buried under the sand and positioned centrally over the egg chamber. This type of screening was not found to be effective and predation rates increased up to 70%, with majority of nests completely predated. The number of hatchlings produced was as low as 40% of total eggs. After increasing the screen size to a one meter square, predation rates were reduced by 40%. However, because we found that predators are still able to burrow into the nets from the sides of the screens, over the last 5 years we have started using these 1x1 meter metal grids, with 8 cm mesh openings, together with side cages that are 25 cm deep. These improvements in the screening techniques decreased the predation rates to as low as 10% and the majority of these instances were just after egg-laying before staff had a chance to find and cage the nests. We compared the predation sides (top, sea side, vegetation side and other sides) of the screens and added hooks from the corners of the cages to fix them in place more efficiently. We introduced these caging techniques to minimize the predation pressure of sea turtle nests. The screening and un-screening of these nests was quite labor intensive but found to be very effective against predation by foxes and badgers.

DO PUBLIC BEACH ACCESS POINTS AFFECT SEA TURTLE NESTING?*

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Florida, USA hosts some of the highest densities of sea turtle nesting in the United States. Florida also hosts millions of beach-goers during turtle nesting season (March-October) each year. Beach-goers can access the beautiful beaches in Florida by using one of many public access points. The effects of these accesses on turtle nesting have not been previously examined. We examined nest success and reproductive success to see if proximity to public beach access points had a measurable effect. We also examined the type of access to see if certain characteristics affected nesting differently. This study took place on Juno Beach, a 9.7 km-long beach located in southeast Florida, which has 36 public access points. When nest success was examined, loggerheads ($P<0.05$), green turtle hatch (Mann-Whitney U test, $P=0.003$) and emergence success (Mann-Whitney U test, $P=0.008$) were both significantly higher for nests laid away from accesses.

Sand compaction may explain this difference since green turtles nest higher on the beach, potentially close to points where people frequently enter and exit the beach. To determine if the type of access affected nesting, the 36 accesses were categorized by their physical structure (boardwalk or pathway) and whether the access was covered with continuous vegetation or if the vegetation was discontinuous. Nest success for loggerheads ($P<0.001$, Chi-square=10.865, df=1) and green turtles ($P<0.001$, Chi-square=23.877, df=1) was higher at pathway accesses. Pathway accesses might be less utilized by beach-goers than boardwalk accesses because they often pass through sea grapes and are difficult to navigate at night; their access points are also less conspicuous than boardwalks. An increased human presence may deter turtles from nesting near boardwalk accesses. Nest success was found to be higher at accesses with continuous vegetation for both loggerheads ($P=0.003$, Chi-square=8.724, df=1) and green turtles ($P<0.001$, Chi-square=17.784, df=1). Continuous vegetation can shield light from urban areas that are adjacent to nesting beaches. Discontinuous vegetation can deter nesting because of the urban light that is visible from the beach. It is likely that additional beach accesses will mean more human-turtle interactions in the future; however, increased education about "turtle-safe" beach practices will be essential in minimizing the negative effects of humans on nesting turtles. An alternative nest marking technique on Juno Beach might remedy the potential impacts of sand compaction on reproductive success. Results suggest that installing pathway accesses could be less impactful to turtle nesting. It might also be beneficial to keep vegetation continuous near access points to minimize urban light visible from the beach that can affect nesting behavior.

COMMUNITY BASED CONSERVATION OF MARINE TURTLES – A LESSON FROM DHARAN, PAKISTAN*

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Convincing a community to conserve marine turtles with little to offer in fringe benefits, is a difficult job. The Dharan community and WWF Pakistan have collaborated for more than a decade to conserve marine turtles on Dharan Beaches near the community. There have been significant setbacks primarily due to funding challenges but the project has continued to push forward. This paper reviews the benefits of a community based effort to conserve marine turtles, and how consistency and continuity of such an effort can ensure the program's success. This presentation highlights various phases of the project until government took it over and made it a permanent part of their conservation efforts.

FORTY-TWO YEARS OF GREEN SEA TURTLE (*CHELONIA MYDAS*) HEAD-STARTING IN THE OGASAWARA ISLANDS, 1973-2014

Satomi Kondo, Yukari Morimoto, Takayuki Sato, Emi Inoguchi, Shinichi Tanaka, and Hiroyuki Suganuma

Everlasting Nature of Asia, Japan

Head-starting has been globally employed to improve the first-year survival of endangered sea turtle hatchlings as a conservation strategy. The Ogasawara Islands are one of the sites where green turtle head-starting was initiated in the early days. During the 42 years from 1973 to 2014, 6,344 yearling turtles and 241 juvenile turtles at the ages ranging from two to eight years old were released into the wild. All green turtles were flipper-tagged before release, of which 944 turtles were also living-tagged from 2005 to 2010. A total of 193 head-started turtles were recaptured either dead or alive. Among them, 44 turtles were recaptured on the Ogasawara's coasts. The longest interval from the time of release to the recapture of the head-started turtles near Ogasawara resulted in 5 years and 29 days. Most of the other head-started turtles were recaptured along the Pacific coast of Japan, especially on the western Japanese coast (57.6%) followed by the Izu Islands (15.2%), Kanto region (11.3%) and Okinawa (9.9%). The longest recapture interval was 12 years and 5 months, and the turtle was recaptured in Kushimoto at the age of 13 years old with a Straight Carapace Length (SCL) of 64.3cm. Among all the turtles recaptured along the Japanese coasts, the smallest turtle had an SCL of 29.7cm. Moreover, there is a significant difference in the release size (SCL) between the head-started turtles recaptured around Ogasawara and the turtles recaptured in the other sites. The average release size of SCL for the turtles recaptured around Ogasawara is 33.2 cm and for the other sites is 24.6 cm. This significant difference might imply that turtles of a certain size instinctively choose a neritic habitat, skipping the pelagic period that has been seen in juvenile turtle behavior. The overall recapture rate for the head-started turtles released was approximately 2.9% and the recapture rate for the different body size-class (SCL) at the time of release shows significant variations. The recapture rate for the turtles with an SCL larger than 26.0 cm is 12.0% but the rate was only 1.9% for the group with an SCL of less than 26.0 cm. The recapture rate increases as the size class increases and the group with an SCL larger than 32.0cm shows a recapture rate of 18.6%. Presumably, Ogasawara's green turtles that are roughly 30cm in SCL may face an important period in their life cycle involving habitat shift and/or other processes that may have resulted in the disparities in selection of habitats and recapture rates according to their SCL size. Little is known about the influences of hatching in captivity and rearing of the first year on survivorship, growth process and imprinting mechanisms. However, the recapture rates and records of the head-starting individuals suggest that the head-started turtles have been able to adapt to the natural habitats and develop into juveniles and subadults. Nevertheless, we expect that in a few decades, the head-starting project including the experiment of living tags, would reveal the life cycle of the Ogasawara's turtle, such as habitat shifts, sexual maturity and its lifespan.

PROGRESS AND PROJECTS: AN UPDATE ON REVERSE THE DECLINE OF FLORIDA'S SEA TURTLES

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In collaboration with stakeholders, the Archie Carr Center for Sea Turtle Research at the University of Florida and the Disney Conservation Fund has developed a strategic plan for an initiative to "Reverse the Decline of Florida Sea Turtles". Using a conservation planning software tool, Miradi, strategies and actions were developed during a workshop with stakeholders to guide the implementation of this initiative to reduce threats and improve the conservation outlook for Florida sea turtles. Specific activities for the first year of plan implementation were identified and will be presented in a summary of our conservation planning efforts. We will demonstrate how the projects selected for this first year of implementation will aid in reducing threats to Florida sea turtles.

SEA TURTLE EGG HARVESTING IN GUATEMALA - IS IT SUSTAINABLE, TRADITIONAL, AND FOR SUBSISTENCE ONLY?

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Sea turtle conservation in Guatemala has been carried out since the early 1980's and relies heavily on an informal system whereby local egg collectors are allowed to harvest olive ridley eggs as long as they turn over 20% of each nest to a hatchery for conservation purposes. The collection of eggs from all other species is prohibited. Much has changed since the 1980s. Then, Guatemala had a population of 7 million; now it has over 14 million. Then, most beaches were sparsely populated; now most have vacation homes and hotels. Then, most residents made a living from fishing, farming and egg collection; now, tourism is an important employer. Institutionally, much has changed as well. The National Sea Turtle Strategy was recently renewed, putting greater emphasis on better managing the egg trade. Guatemala is a signatory of the Interamerican Sea Turtle Convention and must therefore justify its "exemption" - the harvesting of sea turtle eggs - as traditional, sustainable and for subsistence purposes only. To regulate the egg trade and monitor the sea turtle population, ARCAS carries out crawl count surveys on nine index beaches along the Pacific coast, and collects socioeconomic data to better understand the importance of sea turtles in the local

economy and culture. Using this data, it produces an annual Situational Analysis that is distributed to decision-makers, the press and regional counterparts. Among the principal findings of the 2014 Analysis: • The olive ridley population on the Pacific coast of Guatemala continues to grow. Crawl counts show an 86% increase in nesting in the Hawaii area in the last 10 years, with 1001 crawls recorded in 2004 and 1867 crawls in 2014. • In 2014, 12,754 olive ridley nests were laid on the Pacific coast of Guatemala, representing a retail value (including the market chain from collector, to buyer, to wholesaler and finally, to consumer) of Q7,090,864 or US$933,008, 1.59% of GNP. • In 2013, 274,635 eggs of a total of 884,768 eggs laid on the Pacific coast were rescued and incubated in Guatemalan hatcheries. In 2014, 366,733 eggs of a total of 1,181,811 eggs were rescued. Although the percentage of eggs rescued remained the same (31%), due to an increase in nesting in 2014, the total of rescued eggs rose by over 25%, representing a significant increase in national capacity to manage the resource. • The private sector remains a key player in this increase, and in 2014, half of all eggs buried in Guatemalan hatcheries were purchased by hotels, tourists, and vacation home owners. • The use of sea turtle eggs can be considered traditional because it arises from the same Guatemalan culture and is not a response to external demand (as, for example, ivory poaching in Africa). However, it is not a practice that necessarily has any roots in the indigenous Maya culture. • Considering the levels of poverty that exist in Guatemala, that over half the population lives in poverty, and 13% lives in extreme poverty (earning less than US$1 per day), and the fact that each family needs at least two wage earners to fill the minimum commodities basket, it can be said that the collection of eggs is a subsistence activity.

ARRIBADAS OF TURTLES & TOURISTS: A PLAN TO IMPROVE VISITOR MANAGEMENT AT LA FLOR WILDLIFE REFUGE, NICARAGUA

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Though there is little concrete data, tourism on sea turtle nesting beaches around the world appears to be growing. Recent media coverage of massive crowds at an arribada at Ostional Wildlife Refuge highlight the threat that unregulated mass tourism can have on sea turtle nesting. La Flor Wildlife Refuge along Nicaragua's southern Pacific coast is a significant arribada nesting beach and one of the more popular tourist attractions in the country. Olive ridleys are the primary species with small numbers of green turtles, hawksbills, and leatherbacks nesting as well. La Flor is managed by the Nicaraguan Ministry of the Environment and Natural Resources and park rangers are tasked to manage visitors, who are primarily international, come from the nearby tourist town of San Juan del Sur. Currently the tourism to La Flor is lightly managed with a few basic regulations that are enforced sporadically. There are no restrictions on the number of people on the beach at a time or the number of people around the turtle and the local guides who bring people to the beach often end up managing visitors (their own clients and others) by default due to the lack of personnel. As part of "Environmental Leadership Project for Geotourism", a project of the Multilateral Investment Fund managed by Paso Pacifico (an international NGO that promotes conservation and sustainable development in Nicaragua's isthmus), a plan to improve turtle tourism plan is being organized that includes a carrying capacity study, recommendations and regulations for turtle watching, proposed zoning for the beach and surrounding areas, an interpretive guide for rangers and local guides, and training materials.

THE BIOLOGY AND MANAGEMENT OF OLIVE RILDLEY (*LEPIDOCHELYS OLIVACEA*) SEA TURTLE IN CENTRAL AMERICA

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The purpose of this study was to understand the applied biology of the olive ridley turtle nesting arribada at Playa Ostional, Costa Rica, and Playa La Flor and Playa Chacocente in Nicaragua. Hatchling production at Ostional and La Flor was insufficient to maintain the current populations of adults and production of hatchlings at Chacocente was marginal. To help ensure the stability of the region's olive ridley population it is necessary to produce as many hatchlings as possible from the beaches and to reduce at sea mortalities in the foreseeable future. Hatching success and the production of hatchlings were controlled by the same spatial, temporal, human and environmental factors on all three beaches so those controls appear to be general in nature, at least in the Central American Pacific coast. Density of eggs did not have a significant effect on hatching success or hatchling production. Plots open to harvest, dogs and poaching did not have higher hatching success or higher hatchling production. Thus, removal of eggs by humans and their animals is not an effective means to increase the number of hatchlings produced from these beaches. The best way to increase hatchling production is to stop poaching, reduce dog predation, and find ways to increase hatching success. It is not practical to eliminate the harvest at Ostional because the harvest provides important income for the members of ADIO. However, the legal harvest can be restricted to the dry season when mortality typically increases due to the heat and lack of moisture. In the wet season, the harvest can be restricted to eggs that are on the surface of the sand due to digging by turtles and eggs that are in danger of being washed away by the estuaries and tides. Ecotourism now produces more income at Ostional than the legal egg harvest. A combination of a well-managed harvest of doomed eggs and ecotourism would provide a conservation plan that would eventually provide new income for local residents and increase hatchling production. A participatory management program is needed on the other beaches as well.

SPATIAL ANALYSIS OF DISTRIBUTION OF THE GREEN SEA TURTLE (*CHELONIA MYDAS*) IN THE GALAPAGOS ARCHIPELAGO AND IDENTIFICATION OF PRIORITY ZONES FOR ITS CONSERVATION IN THE ISLANDS

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The Galapagos Islands host the second most important nesting population of East Pacific green turtles, after Mexico, and it is by far the most abundant sea turtle species in the Galapagos Marine Reserve (GMR). The archipelago also provides important feeding grounds for a partially resident stock, which aggregate in shallow coastal waters off the islands, while another part of the population migrate beyond the GMR boundaries. Despite the fact that the Galapagos Islands provide near 'pristine' conditions for green sea turtles, anthropogenic activities are threatening the population and have been increasing, both in the feeding

and nesting grounds. This clearly suggests that current GMR zoning could be improved to more efficiently protect key areas important for green sea turtle populations within the islands. Because of the migratory nature of this species, which is part of the regional Eastern Pacific green sea turtle population, it depends on the nesting beaches and feeding grounds in the Galapagos archipelago. Therefore, the Galapagos National Park Directorate (GNPD) and the Ecuadorian government depend on timely and accurate information to help safeguard turtle populations as part of the wider natural heritage. Consequently, this inventory of aggregation sites for green turtles aims to provide updated information about the distribution of green turtles within the Galapagos Marine Reserve, to be considered in the ongoing process of restructuring marine reserve zoning. This inventory consists of a collection of historical geographical information about nesting beaches and feeding grounds of green turtles in the Galápagos, as well as updated information from surveys from the GMR users, and the direct review of most of the points identified to check the presence of the species. With the data obtained, we elaborated layers of geographic information for nesting beaches and feeding grounds within the reserve. This data was then categorized quantitatively and qualitatively according to importance. From this information, macrozones in the GMR where delimited depending on the numbers present. The criteria for delimitation of these macrozones, were based on results of previous studies in nesting sites and feeding grounds of the species on the islands, and corresponded mainly to the abundance of nests and/or individuals per site, beach exchange of females during the nesting season, and records of recaptures of nesting females in feeding grounds and nesting beaches. The data show that the green turtle is present in about 80 feeding grounds and 100 nesting beaches around Galapagos archipelago. Applying Kernel density analysis of density of points of the GIS tool, and based on the criteria described above, 25 macro-areas of greatest importance to green turtles on the islands were obtained, which have a radius of approximately 7 km. The current zoning of the GMR has a large overlap of green sea turtle distribution and human activities, such as fishing zones, marine traffic routes and multiple tourist activities. Therefore, this information is available to the environmental authority (Galapagos National Park) to be considered during the new zoning process of the GMR in order to ensure the protection and conservation of green sea turtles and their key habitats within the Galapagos archipelago.

ENHANCED COMMUNITY BASED TURTLE PROTECTION IN MAIO, CAPE VERDE: LOCAL ASSOCIATIONS AS PARTNERS, THE "GUARDIANS OF THE SEA INITIATIVE" AND THE FIRST EXPLORATORY COMMUNITY RUN HATCHERY*

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After implementing a community based sea turtle protection strategy in Maio, Cape Verde, which in 2013 reduced nesting loggerhead poaching by 71% and nest poaching by 90%, the local NGO Maio Biodiversity Foundation decided to try new measures to increase community involvement: enhance the existing protection structure by involving local associations and fishermen in turtle protection patrols and create an exploratory community run hatchery. As a trial, in 2015 we established a) partnerships with a community association and a group of traditional female music performers (Batuku). Every night during the nesting season, each group send out a member to patrol the beaches together with the team of guards. We also provided b) small incentives (as cement for construction of fish cleaning table) to fishermen to be "guardians of their sea", meaning to not let locals and outsiders poach turtles in their waters. As a third new

measure we introduced c) the first trial hatchery in Maio under the care of the local community. Due to its experimental nature, only 10, exclusively at risk nests were selected for relocation, to minimize any possibly negative effects on population dynamics. Preliminary results show that through the involvement of local associations, over 80 people more were directly involved (on top of 45 guards, 12 team leaders and about 50 volunteers) in turtle patrols and outreach activities. In 2015, turtle poaching was reduced from 9.4% (2014) to 5.6% and nest poaching was maintained at 2.6%. Additionally, in 7 out of 11 communities no turtles were taken at all (compared to 4 in 2014). These results indicate that the new measures had positive impact, or as a turtle poacher affirmed: "Now you have really managed to make my turtle eating habit impossible, since my wife is part of the association and she says that no turtles enter her kitchen anymore." Looking at the situation at sea, we did not have any records of any turtles taken in the communities hosting the "Guardians of the Sea" initiative. Involved fishermen seem to be proud to be officially responsible for looking after the turtles in their waters. The community run hatchery also showed positive results, with local volunteers assisting in its construction and monitoring. After an initial period of constantly guarding the nests, it became apparent that due to community acceptance of the project, this was not necessary. When nests hatched, volunteers and school groups were brought the hatchery, allowing them to witness the positive outcome of their work and to forge positive, hands-on experiences with loggerhead sea turtles. Additionally, we witnessed beachfront home-owners switching to turtle-friendly red lights following their first encounter with hatchlings. In summation, these new measures seem to have had a significant positive impact on turtle conservation in Maio. We aim to expand the associations' involvement to more villages, enhance the "guardians of the sea" initiative and develop the idea of more communities having their own hatchery to safeguard.

SEA TURTLE HATCHERY MANAGEMENT PRACTICES IN SOUTH ASIA*

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Sea turtle hatcheries are common in South Asia, but their management practices are relatively undescribed and unregulated. A mixed-methods research approach, including reviews of published papers, reports, and news media, and interviews with hatchery managers or owners, was used to describe hatchery productivity in terms of eggs/nests protected and hatch success, and identify hatcheries and hatchery practices that are likely to contribute to sea turtle conservation and those with a potentially negative impact upon hatch success and hatchling survival. We present detailed descriptions of hatchery infrastructure and practices for handling, transporting and incubating eggs, and holding, rearing and releasing hatchlings from hatcheries across South Asia. While most hatcheries aim to protect sea turtle eggs from predation, poaching, habitat loss and beach erosion, or promote public awareness about sea turtle biology and conservation through ecotourism, of great concern is the low hatch success (as low as <10%) due to incubation practices of shallow and overcrowded nests, and holding and/or rearing of hatchlings that may negate the benefits of incubating nests in a secure environment. We recommend strategies for more effective hatchery management in each area or country based upon local practices and context.

A COMPARATIVE STUDY OF THE BIOMETRIC OF HAWKSBILL TURTLE HATCHLINGS ERETMOCHELYS IMBRICATA FOR THE HEAD-STARTING PROGRAM AT THE LOS ROQUES NATIONAL PARK

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Hawksbill turtles (*Eretmochelys imbricata*) have been severely threatened by anthropogenic impacts, including illegal hunting and habitat degradation, which have ultimately reduced their population by 80%. In fact, in the Caribbean, several regions have shown a decline or severe depletion of *E. imbricata* populations. Based on these reductions, the hawksbill turtle has been declared by the IUCN as critically endangered, and in Venezuela this species became completely protected in 1996. The Los Roques National Park was created to protect several marine species, including Hawksbill turtles, nests and hatchlings in the archipelago. As part of the management strategy, a hawksbill head-starting project was included in the original plan. This strategy aims to increase the survival of hatchlings by taking a portion of emerged hatchlings, raise them over a certain period, and then release them in the wild. However, there is scarce published data about the status of hatchlings in this program. Thus, the aim of this study was to describe the effects of the head-starting project strategies by comparing biometric values of hatchlings under different management conditions. Data collection took place from 2012 to 2013 at the National Park. Hatchlings were collected from nests that had higher risk of illegal harvest or natural threats (e.g. predation, erosion, among others). In addition, hatchlings given to the park authorities by fishermen were also used in the study. By using manual calipers and digital scales, we measured the Straight Carapace Length (SCL), Straight Carapace Width (SCW), and weight for 3 groups of hatchlings: 0 weeks (T0; n=129), 2 weeks (T2; n=47), and 5 weeks (T5; n=76). In general, measurements of the three different groups showed similar mean values: SCL – T0=4.34cm, T2=4.26cm, T5=4.40cm; SCW – T0=3.27cm, T2=3.24cm, T5=3.32cm; weight – T0=22.59g, T2=22.13g, T5=30.27g. The results indicated that no significant growth occurred from hatchlings with different ages. This may be due to having a greater sample for neonates than for 2-week-old and 5 –week-old hatchlings. In addition, it is important to note that older *E. imbricata* hatchlings had been kept by stakeholders until they were able to deliver them to the station. Hatchlings at the head-start program are meant to have a higher SCL, SCW and weight after a month than what is reported here. Thus, the conditions in which the T2 and T5 hatchlings were found before entering the project might explain their smaller growth when compared with the T0 hatchlings that were kept since emergence in the biological station. In summary, the period from emergence until delivery of hatchlings at the research station is crucial for increasing the body and health conditions, as well as the survival probability of hatchlings. From a conservationist point of view, we recommend encouraging and maintaining compliance of stakeholders and

ensuring they are well trained in in the use of care guidelines in order to improve the condition of hawksbill turtle hatchlings at the project site.

RECIPE FOR CONSERVATION SUCCESS: CASE STUDY OF A SMALL ISLAND IN THE SEYCHELLES HOSTING THE LARGEST HAWKSBILL NESTING POPULATION IN THE WEST INDIAN OCEAN

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Nature Seychelles, Sheychelles

The critically endangered hawksbill sea turtle (*Eretmochelys imbricata*) was once considered to naturally have dispersed nesting patterns, compared with other sea turtle species. These patterns are now thought to be the result of overexploitation of nesting rookeries that were once very large. Currently, there are a number of remaining regional populations with more than 1000 annual nesting females, including Oman, Australia, Mexico and the Seychelles. Analyzing successful programs, and the steps that were taken, can assist in implementing thriving conservation programs elsewhere. The Republic of Seychelles is an archipelago with approximately 90,000 people. It was colonized in the mid-1770s and used as an occasional pirate stop prior to colonization. Although the Seychelles is considered to have extensive nesting today, it was no exception to hawksbill overexploitation. Harvesting of hawksbills took place for over two centuries, until they gained complete protection in 1994. Today the country hosts one of the largest populations of hawksbills in the western Indian Ocean with the highest percentage nesting on Cousin Island Special Reserve. Human influence in the country could have extirpated the population; however, nesting from 1999 to 2006 recorded an eight-fold increase in nesting on Cousin. This success is from a compilation of many actions and decisions. Cousin was bought in 1968 by BirdLife International, a conservation NGO, to save an endemic warbler. The foundation of Cousins' wildlife success lies with Birdlife implementing an ecosystem based management in the 1970s and was continued through the 1990s. A turtle monitoring program was initiated in 1972 along with habitat restoration to return the island to a more natural state (was a coconut farm before purchased by BirdLife). Protection was further extended 400m around the island in 1974 allowing hawksbills safe passage around the waters of the island (safe from harpooners) as well as protecting nesting females and their eggs. Management was handed to Nature Seychelles, a local partner and conservation NGO in the late 1990s, and this ecosystem based management continued. With protected habitat, the next steps taken (along with continuing the long-term monitoring for detecting trends) included ecotourism as a source of funding and education, and hiring of local staff. The approach to continued management of Cousin through an ecosystem approach, habitat restoration, community education and involvement, combined, has allowed the 27 ha Cousin to be a stronghold for hawksbills in the western Indian Ocean with 807 nests in the 2014-15 nesting season. Results have been seen through the long-term trends and the reoccurrence of nesting females (two who have been seen over an 18-year period), setting an example for other programs.

SITAMAR: CONNECTING SEA TURTLE INFORMATION TO ACHIEVE BETTER CONSERVATION OUTCOMES IN BRAZIL*

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Sea turtle conservation in Brazil began in 1980 with the creation of Projeto TAMAR. Initially focused on protecting the country's main nesting beaches, the program expanded its activities to known coastal feeding grounds, and later started working with fisheries that interact with sea turtles. Currently, the initiative comprises a network of 25 sea turtle protection and research stations that collect data to support research, and conservation planning and program implementation. Standardized protocols and training have been essential to achieving and assuring the quality of this data and have required continuous upgrades to how the project stores and manages data. The initial database Projeto TAMAR relied on was designed in Dbase, but with the growth in the number of records, along with the new analysis methods and possibilities, a more robust platform became necessary to host and integrate the various data types and facilitate secure access for staff and associated researchers and environmental agencies. In 2006, the database was upgraded to a system called SITAMAR, which uses open source language, is centrally managed, is stored online, and provides easy access for uploading and querying data. The system also has an integrated GIS tool to facilitate mapping and integration with other data sources. These changes have made data more accessible and provided an invaluable information resource for future research. As a result, SITAMAR is now being prepared for use by the national government as the official sea turtle database, which will incorporate all of the research and conservation initiatives developed by other groups and universities throughout Brazil.

THROUGH THE LENS: UNDERSTANDING THE ECOLOGY AND IMPACTS OF *CANIS LATRANS* ON SANIBEL ISLAND, FLORIDA

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The coyote (*Canis latrans*), once strictly found in the western United States, expanded its range into Florida in the late 1970's. Coyotes were first documented on Sanibel Island, Florida in 2011 and since then the depredation rate of sea turtle nests has increased from 9% in 2011 to 32% in 2014. Wildlife cameras were mounted behind sea turtle nests in 2014 and 2015 to observe the ecology and behavior of coyotes that have colonized the beach habitat. Five Recoynx PC900 cameras were set to take 5 photos per trigger between

19:00 and 07:00. The primary objective in 2014 was to document and quantify predator-induced mortality on sea turtle hatchlings. The cameras were randomly placed at nests that were close to hatching to observe hatchling depredation. In 2015 the focus shifted to identifying spatial patterns of beach usage by coyotes and monitoring predator response to screened turtle nests. Five zones of equal length were established and a camera was mounted behind one nest per zone as soon as possible following oviposition. Cameras were shifted among nests within their assigned zones as nests hatched. Over two nesting seasons the five cameras were mounted for a total of 1,231 nights and collected 3,328 pictures of coyotes. Of the eight depredation events that were captured on camera in 2014 and 2015, three were confirmed as hatchling depredation. The number of hatchlings eaten during these events ranged from approximately 17-25. Preliminary results from a chi-square test indicate that the risk of nest predation is significantly associated with the degree of beachfront development on Sanibel (χ^2 (2, N = 524) = 55,97, p < 0.0001). This trend corresponds with increased nighttime coyote activity on undeveloped stretches of beach (72 pictures/month in less developed and undeveloped habitat vs. approximately 13 pictures/month in developed areas). Additional analyses included an assessment of the vulnerability of nests relative to their distances from the dune, coyote response to screened nests, preferred incubation period for depredation, time of night for highest coyote activity, and the relationship between the number of hatches and number of depredation events. Informal observations also provided interesting and useful information about family dynamics and learned behaviors. These results have contributed to the development of a coyote management plan focused on the protection sea turtles on Sanibel Island.

DEVELOPING AN ECOSYSTEM-BASED CONSERVATION PLAN FOR SEA TURTLES IN VIRGINIA AND MARYLAND, USA*

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The purpose of the Sea Turtle Conservation Plan (Plan) is to provide guidance for enhancing the survival and conserving the habitats of sea turtles in Virginia and Maryland. The Plan's conservation outline contains three goals, 12 objectives, 36 strategies and 134 action items as well as six appendices. The three goals for the Plan are to: 1) investigate sea turtle populations and ecology in Virginia and Maryland; 2) protect sea turtles and their habitats in Virginia and Maryland; and 3) promote sea turtle conservation in Virginia and Maryland through effective outreach, communication and coordination with partners, stakeholders, and the general public. The Plan has recommended time frames for review and update in order to maintain conservation strategies based upon the latest science, threats and regulatory actions affecting sea turtles in Virginia and Maryland. In 2010, the states of Virginia and Maryland proposed to develop a combined Sea Turtle Conservation Plan incorporating the shared sea turtle habitat of Chesapeake Bay, the largest estuary in the U.S. Previously, Virginia independently developed a conservation plan that included only the Virginia portion of Chesapeake Bay and Maryland, likewise, a plan for Maryland waters. The Plan development process included four years of research to update scientific data on sea turtle life history, health and abundance in the region, coordinated educational outreach for both the general public and targeted stakeholders, and a multi-step process to complete a conservation plan. The Plan took shape in

several stages. The first stage of development was planning for a conservation workshop, which included stakeholders from state and federal agencies as well as researchers presenting relevant data. To prepare, a one-day, facilitated meeting was held with key personnel from Virginia and Maryland to develop a draft of major goals and strategies to present at the workshop. These goals and strategies were refined and clarified by the facilitator and workshop organizers. The second stage was a 2.5 day workshop to get input from various stakeholders. The third stage was further refinement and assessment, where stakeholders were asked to rank strategies and comment on the Plan. The fourth and current stage was presentation of the Plan to state agencies followed by state adoptions of the Plan. Stakeholders included state conservation and fisheries personnel, sea turtle research and stranding network organizations, National Marine Fisheries Service (regional representatives), U.S. Fish and Wildlife Service (local and national representatives), as well as a trained facilitator. This project was completed in partnership with the Virginia Department of Game and Inland Fisheries and Maryland Department of Natural Resources. Most of the research was conducted by the Virginia Aquarium & Marine Science Center Foundation and collaborators, and included aerial surveys, telemetry studies, diet studies and analysis of stranding data. Development of the Virginia and Maryland Sea Turtle Conservation Plan was conducted by all agencies. This project also included extensive educational outreach efforts and development of a broad array of sea turtle conservation education materials.

EMPOWERING COMMUNITIES THROUGH LONG-TERM SEA TURTLE MONITORING SETS FIJI UP FOR RELIABLE LONG TERM MANAGEMENT OF SEA TURTLE POPULATION ALONG THE GREAT SEA REEF*

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Empowering traditional fishermen promotes the long-term protection and conservation of sea turtles. Sea turtles in Fiji are considered a delicacy and important cultural totem in many of the coastal provinces. Fifty-five local fishermen were identified in hawksbill and green nesting sites along the Great Sea Reef and were recruited as turtle monitors. Recent satellite telemetry results illustrated the Great Sea Reef (GSR) is an important feeding ground for hawksbill, green and loggerhead turtles. These fishermen who were once sea turtle hunters equipped with significant traditional knowledge about sea turtles' habits, foraging and breeding locations' and hunting skills. Establishing a turtle monitoring program in the two provinces of Bua and Macuata, along the GSR, has enhanced the long-term protection of sea turtles. The 55 turtle monitors are now spearheading sea turtle conservation efforts along the GSR. Interest from associated communities has increased and lead to an expansion of the network. The existing turtle monitoring programme is creating vast sea turtle conservation awareness throughout Fiji. Maintaining support from Regional Organizations, Government, NGOs and institutions is a continuing challenge at this stage as we look at the feasibility of including nesting beaches and foraging grounds as part of Protected Area Networks.

COMMUNICATION AND SOCIAL NETWORK TOOLS ARE NOT ENOUGH TO SAVE SEA TURTLES IN VIET NAM*

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Although Vietnam has made many efforts in management and conservation of sea turtles, the number of unique and important creatures has dramatically dropped over the years. The major causes of this are illegal exploitation of nesting females and eggs, fisheries by-catch, illegal trade and degradation of habitats. Among them, fisheries by-catch is the biggest challenge and needs more time and effort from both governmental agencies and conservation organizations. According to the research conducted by World Wildlife Fund and Research Institute of Marine Fisheries in 2014, up to 50% of observed offshore longline fishing vessels caught sea turtles (including Olive Ridley, Green and Hawksbill). Viet Nam currently has 28,700 off-shore fishing vessels (with an expected 30,000 by 2020), and it is estimated that 1,000 to 4,000 sea turtles are caught each year. Despite their precarious status in the wild, marine turtles continue to be killed and sold illegally in Vietnam. A recent marine turtle bust in Nha Trang, Khanh Hoa, Viet Nam in November 2014 was one of the largest cases of sea turtle trafficking in the world with an estimated 7,000 turtles, mainly hawksbills, found. Combatting this trafficking in sea turtles and their products has not been a priority of the government and the demand for these types of wildlife products is determined by consumer behaviors, which cannot be changed overnight. Communication and social networks are great tools for saving sea turtles on nesting beaches and in Vietnamese near-shore fisheries. Over the last ten years (from 2004 to 2015), IUCN Vietnam has cooperated with several government agencies and conducted more than 50 training and awareness raising workshops about conservation of sea turtles and their habitat protection needs in 10 coastal provinces from the North to the South, organized sea turtle volunteer programs for six main nesting locations (in Quang Ninh, Quang Tri, Quang Nam, Binh Dinh, Binh Thuan, Con Dao), and encouraged the participation of more than 1,000 volunteers. However, this program has only been successful in protecting nesting females on beaches but not at reducing bycatch and stopping the illegal trade in sea turtle products. To address the above issues, developing awareness of critical conservation issues within government institutions and the wider public should be continued. Attitudes towards conservation can be changed and this is essential to ensuring the success of conservation initiatives. Identifying key trade routes, harvest and trade volumes, uses, and "hot-spots" for trade is essential. Information on illegal international trade, such as smuggling methods and trade flows must be shared among neighboring countries to support sea turtle conservation efforts in Viet Nam. Awareness among fishermen and local authorities regarding the status of sea turtle populations must be raised, and existing laws and regulations need to be reinforced. We also need to continue to encourage fishermen to use fishing methods and technology that minimizes sea turtle bycatch. Finally, strengthening enforcement activities through implementation the Marine Turtle Conservation Action Plan (2015-2025) is also essential.

POOR PERFORMANCE AND ECONOMIC INSTABILITY THREATEN THE LARGEST NESTING HABITAT FOR LOGGERHEAD SEA TURTLES IN THE MEDITERRANEAN

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Laganas Bay, on Zakynthos Island, Greece, hosts the largest loggerhead nesting habitat in the Mediterranean with about 17% of the total loggerhead nesting effort in the Mediterranean. ARCHELON has operated a conservation project since the early 80's in Laganas Bay. Due to the significance of the nesting habitat, its imminent degradation from mass tourism and uncontrolled development, and following persistent national and international pressure from NGOs, the Council of Europe and the European Commission, the Greek State eventually issued a Presidential Decree (PD) in December 1999 that established the National Marine Park of Zakynthos (NMPZ) and few months later its Management Agency (MA). The PD includes zonation with varying general regulations on land and at sea. However, the more specific conservation and management measures, regarding both terrestrial and maritime areas, were to be included in the -foreseen by the PD- Management Plan, which regrettably was never drafted. Consequently, the majority of management requirements are not yet legally demarcated and vital conservation issues remain unresolved for more than 15 years since the Park's establishment. This legal deficiency compounded with inconsistent funding of the MA -recently exacerbated by the financial crisis in Greece- result in inadequate enforcement of the existing restrictions which lead to further degradation of the habitat and harassment of sea turtles. Specifically, due to inadequate wardening, human presence on nesting beaches during nighttime is a regular phenomenon while during daytime existing nests are threatened with trampling by the massive presence of tourists at the back of the beach and by horse-riding. The frequent presence of vehicles results in destruction of dunes and endangers incubating nests and emerging hatchlings. Existing restrictions regarding beach furniture -viz specific number per beach and stacking during nighttime- are not implemented and therefore significant parts of some nesting beaches are almost entirely occupied by sunbeds. Moreover, the lack of adequate marine wardening and the existence of only one MA patrol-boat, combined with the high number of tourist vessels (364 powered and non-powered boats during the 2015 season) have led to infringement of the maritime regulations and to severe disturbances of turtles during their inter-nesting period on a daily basis. Lastly, within the boundaries of the NMPZ exists an overused but still active landfill site which is a permanent toxic pollution threat to both the nearby nesting beaches and the marine area. The above-mentioned facts combined with the significant decline of nest numbers over the last few years make clear that national and international pressure is urgently needed, once again, to request the immediate approval of a Management Plan (including carrying capacity of vessels within the Bay), the enforcement of existing legislation and the regular financial support to the MA in order to improve the long-term conservation perspective of this important habitat.

CONSERVATION CHALLENGES FOR NESTING LOGGERHEAD TURTLES IN THE FACE OF COASTAL DEVELOPMENT IN SOUTHEASTERN BRAZIL*

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The loggerhead sea turtle (*Caretta caretta*) is the most abundant nester of the five nesting species known to visit the beaches of Brazil. Based on mtDNA analysis, the loggerhead population in Brazil is believed to be subdivided into three major lineages; a northern group which includes the rookeries of Sergipe and Bahia; and a southern group, which is subdivided into the rookeries of Espírito Santo and Rio de Janeiro state. Like many marine turtles, global declines of loggerhead nesting populations seriously threaten the sustainability of wild populations. The establishment of the Brazilian Sea Turtle Conservation program, Projeto Tamar, in the early 1980's has significantly improved the survival and recovery of sea turtles through the development of community based programs and protection of nests in main nesting areas using a variety necessary strategies or techniques. The beaches of the state of Rio de Janeiro, and to a lesser extent, beaches of Espírito Santo, are particularly important for the loggerhead populations in Brazil due to historically cooler nesting temperatures resulting in a preponderance of male hatchlings produced in these areas compared to other adjacent beaches. Although Brazilian law protects turtle nesting areas, this has not prevented the undertaking of large construction projects along the northern Rio de Janeiro coast, such as the building of the Açu Superport in 2008, and continued expansion of urban areas. The rapid and recent development of this region of Brazil has escalated the risk for loggerhead turtles through increased recreational activity, loss of nesting sites, light pollution, and dredging operations. Since 2011, Projeto Tamar and Fairfield University have engaged in a partnership of education and research. Together, we have examined the biological and conservation aspects of loggerhead populations within the state of Rio de Janeiro. Given the importance of these beaches for the viability of loggerhead populations and its continued urban development, we have focused our attention on 1) assessing the effects of light pollution on hatchling seaward orientation, 2) monitoring incubation temperatures of both in situ and translocated hatchery nests, 3) assessing orientation cues of hatchlings at sea, and 4) examining the effects of dredging operations on turtle strandings. One of the main objectives of this work is to use the information to aid in the assessment and development of environmental policies and guide current conservation management plans. Here we report our findings on the current state of loggerhead turtles in Rio de Janeiro state. Given the importance of these rookeries in maintaining loggerhead gender ratios, as well as the possibility that this particular loggerhead population is a unique genetic subgroup, we suggest that more effort must be devoted to this area in terms of conservation, research, education and policy implementation.

Eastern Pacific Sea Turtles: Special Session

THE MISSING HAWKSBILLS (*ERETMOCHELYS IMBRICATA*) FROM THE GUAYAQUIL GULF, ECUADOR

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Sea turtles in Ecuador are threatened by diverse anthropogenic stressors. The Guayaquil Gulf is the largest estuary along the Pacific coast of South America and commercial trade route in Ecuador. This bioregion seems to be an important foraging ground for hawksbill sea turtles (*Eretmochelys imbricata*), as well. Based on empirical data and information provided by secondary sources, we report two important sightings of hawksbills, including a juvenile (CCL= 40cm) and mature female (CCL = 74cm), observed in the Gulf of Guayaquil in 1999. These observations were the first records of this species in riverine mangroves and estuaries for Ecuador's mainland coast where the Gulf of Guayaquil constitutes a suitable ecosystem for hawksbills, which have managed to adapt as a response to the reduced availability of healthy habitats in their distribution area. These findings demonstrate the importance of estuarine habitats as feeding grounds for this threatened species and also illustrate the imperative need of conservation actions for this special area. Despite the limited knowledge available regarding about the ecological implications and protection measures needed to enhance the long-term conservation and resilience of hawksbills in this region, we claim that further research must address other dimensions of sea turtles conservation, including the management implications and social mobilization of local fishing communities and other coastal and marine areas users (e.g., ecotourism sector) as potential allies in the long-term sustainability of their living resources conservation of this species.

LIVING AT THE SOUTHERN TIP: CHARACTERIZATION OF THE MOST AUSTRAL EASTERN PACIFIC GREEN TURTLE (*CHELONIA MYDAS*) AGGREGATION AND ITS HABITAT IN BAHÍA SALADO, NORTHERN CHILE

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Bahía Salado, located in the middle of the Atacama Desert, is a habitat of high ecological value, particularly because of the presence of sea turtles (*Chelonia mydas*) and seagrasses. This bay also plays an important economic role for the Atacama Region, since it supports the economy of local coastal communities based on fisheries and algae extraction. Although, Bahía Salado has an ecological and economical relevance,

almost no information exists on the biological components of this ecosystem. Furthermore, little is known about Chilean feeding grounds for eastern Pacific green turtles, to which knowledge we contribute in the study presented herein. Between 2013 and 2015, we conducted seasonal monitoring of the local green turtle aggregation, where population and health parameters were determined (blood parameters, heavy metals determination and genetic analysis; n=7). Likewise, we performed a bathymetric and benthic macroinfauna characterization of the study area. Our results indicate that blood values of these turtles follow standard parameters. However, copper and lead concentrations show the highest values described for all sea turtle species around the world (2.259 µg/g and 1.105 µg/g, respectively). Additionally, analysis of 773 base pairs (bp) sequences of the mitochondrial control region indicate that Galápagos nesting stock is the principal source stock to this aggregation (43% carried haplotype CmP-4.6, 29% CmP-4.7, 14% CmP-4.1 and 14% CmP-15.1). Bahía Salado is a shallow bay (up to 8 m deep) characterized by a mixture of hard and soft substrates, with a high coverage of seagrass (*Zostera chilensis*) algae and invertebrates, on which these turtles most likely feed. In addition, our results show that *Z. chilensis* constitutes a key matrix for this ecosystem productivity and sustainability, harboring an important diversity of organisms in early onthogenic life stages (e.g. *Tagelus dombeii*, *Argopecten* sp, *Fissurella* sp. and *Cancer* sp). Our research on the southernmost feeding ground for eastern Pacific green turtles reinforces the high adaptability that this species exhibit in the dynamic Southeast Pacific. This work, also contributes to a better understanding of regional populations ecology and health status. Moreover, green turtles seem to play a key role in local ecosystem maintenance, which productivity and conservation is crucial as much for human sustainable development as for marine organisms' survival.

BUILDING THE BRIDGE: CONTRIBUTION OF EASTERN PACIFIC GREEN TURTLE STOCKS (*CHELONIA MYDAS AGASSIZII*) TO A CENTRAL AMERICAN FORAGING GROUND AT POZA DEL NANCE (PARQUE NACIONAL SIPACATE-NARANJO, ESCUINTLA, GUATEMALA) DETERMINED BY MITOCONDRIAL DNA ANALYSES*

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Quantifying the connectivity that exists between geographically separated habitats of migratory animals, such as sea turtles, is essential to define adequate conservation strategies on national and regional scales. Mixed Stock Analysis (MSA) using mitochondrial DNA sequences have proved useful to determine the links that exist between nesting and foraging habitats, allowing researchers to estimate patterns of dispersion, recruitment and migration throughout the species' distribution. Although major green turtle nesting stocks in the eastern Pacific have been genetically characterized, still little is known on their geographic range and the habitats that juveniles and adults occupy during non-reproductive life stages. Amongst these sites is the adult foraging ground at Poza del Nance in Guatemala. Central America has been

proposed as a bridge and point of convergence for north- and southeastern Pacific green turtles and it is our aim to test this hypothesis from a genetic point of view. Poza del Nance, located within the Sipacate-Naranjo National Park (Escuintla, Guatemala), is a saltwater pond surrounded by mangrove forest, where Eastern Pacific green turtles (*Chelonia mydas agassizii*) feed and mate. In the pond, adult sea turtles (CCL= 84cm on average) can be found and captured throughout all the seasons of the year. With the aim to determine natal origins and estimate possible migratory paths following the philopatric behavior of females, we analyzed 773 base pairs (bp) of the mitochondrial DNA control region (CR). Between May and August 2015, we undertook four trips to Poza del Nance. Using specially designed tangle nets, a total of 33 individuals were captured, of which three were males and thirty females. Thirty-one skin tissue samples were collected from those individuals and processed together with two additional samples collected in September 2014 for a total of 33 skin tissue samples obtained from different individuals. DNA was extracted from all samples and approximately 900 pb of the CR was amplified using the H950 and LCM15382 primers. The sequences will follow regional haplotype nomenclature and we will conduct a MSA, incorporating previously published and new haplotype frequencies from regional green turtle stocks. Our results will contribute to the knowledge of the migratory routes of the black turtles in the Eastern Pacific, Strengthen Guatemala's National Sea Turtle Conservation Strategy and initiate more scientific studies that can contribute to the management and conservation of the species and of the protected area.

LONG-TERM MONITORING OF AN OLIVE RIDLEY ROOKERY IN THE NORTHERN LIMIT OF NESTING IN EASTERN TROPICAL PACIFIC

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An assessment of the nesting of olive ridley rookery in Baja California Sur (BCS), Mexico is presented based on continuous monitoring through 20 seasons (1995-1996 to 2014-2015) in two protected beaches by ASUPMATOMA. This site represents the northernmost nesting area of olive ridley in the Eastern Tropical Pacific (ETP) and exhibits unusual environmental conditions (low rainfall and humidity) for the specie, which suggests high impact on embryo development and survival of the hatchlings. The long-term monitoring is an excellent opportunity to assess the success of the program of conservation and management actions in the area. The nests of the period 1999-2014 were analyzed for: 1) Determine the nesting trend 2) Assess reproductive success and 3) Estimate rookery size. An increasing trend was observed in the estimated number of nests per nesting season, from 252 nests in the 1999-00 season to 1732 nests in the 2014-2015 season, representing an increase of 6-fold in 16 years. A Mann-Kendall test indicated a positive trend over the period of monitoring (T = 0.786, p<0.001, N = 12742). Rookery size was defined as the average number of nests between 1999 and 2014, resulting in 634 nests.year^{-1} and corresponding to 211-422 nesting females.year^{-1}. Except for a few years with extreme weather events, percentages of hatching and emergence remained above 75% and 70% respectively, which highlights the importance of solitary nesting beaches as producer of hatchlings, because of the low rate of predation, little pollution and low density of nests. The environmental education programs implemented by ASUPMATOMA in the community, encourage the conservation of sea turtles and every year, more private and public organizations get involved in the program. The available data and biological knowledge of this rookery, suggest that long-

term monitoring at these beaches has contributed to the significant increase in olive ridley nesting in the northernmost limit. Little attention has been put to marginal nesting sites, but they can be key when operating as indicators of changes in the distribution of nesting. Although the number of nests and colony size is small compared other colonies of the ETP, the nesting colony of BCS, it was genetically identified as an independent Unit of Management. Therefore, knowing and monitor basic aspects of olive ridley nesting and management actions in this area is crucial, since the increase seen on these beaches is not only of regional importance, but also at the ETP level.

FIRST APPROACH OF BLACK TURTLE (*CHELONIA MYDAS*) TROPHIC ECOLOGY IN BAHÍA SALADO, NORTHERN CHILE, USING STABLE ISOTOPE ANALYSIS

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Bahía Salado is the southernmost foraging site known for the black turtle (*Chelonia mydas*) and also hosts an important seagrass ecosystem composed of *Zostera chilensis*, which is only known to occur at one other site along the 4300 km of Chilean coastline. Both of these marine species are classified as Endangered by the IUCN. Although in other parts of the world there is much scientific evidence for the dietary dependence on seagrass pastures by *C. mydas*, almost no information exists on their trophic relationships in the eastern and southeastern Pacific Ocean. Here we present preliminary data on the dietary components of *C. mydas* aggregated in the southernmost foraging habitat known for the Eastern Pacific population. Stable isotope analysis (SIA) is a minimally invasive technique that allows for the establishment of trophic relationships (prey-predator), distribution ranges, ontogenetic changes in diet and migratory movements. We investigated the composition of principal diet components by analyzing stable nitrogen and carbon ($\delta15N$ and $\delta13C$ respectively) proportions in blood, skin and carapace samples obtained from seven black turtles aggregated in Bahía Salado. Putative food items were also analyzed, including *Z. chilensis*, *Ulva* sp, *Macrocystis pyrifera*, *Asparagopsis armata*, *Ceramium* sp, *Chondrus acanaliculatu*s and *Anthothoe chilensis*. Residency and recruitment was also assessed using individual's stable isotope signatures compared to signatures of primary producers. Our results provide the first data on the ecological features of *C. mydas* and the southernmost known feeding ground in its regional distribution. The characterization of this unique habitat will help to understand black turtle ecology in the Southeast Pacific and highlights the plasticity this species has developed to flourish in regions outside the Pacific's' tropical and subtropical boundaries.

SILTING DYNAMICS AT THE MAIN FEEDING AREA OF *CHELONIA MYDAS* AGASSIZII IN NORTHERN CHILE – ARICA: CHINCHORRO BEACH

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The river San Jose of Arica: Northern Chile, provides water supply for agricultural purposes in the upper middle Azapa Valley and rises in the west limit of the Cordillera Central or Andean Highlands (JICA, 1995), leading to La Puntilla: Chinchorro Beach, a feeding ground of black turtle (*Chelonia mydas agassizii*). This river has a permanent, but small flow, only in its upper reaches. During the summer months (December-February), due to the Altiplano rainfalls, it reaches its lower course and even the sea, in the form of an alluvial stream (ephemeral river sensu Wetzel, 1975). Because of these alluvial downs, sediments, rocks and trash generate silting in the area around the river mouth, where during the dry season the algae meadow is used for feeding by the turtles. Because of this the impacts of the alluvial flow on the feeding area of the black turtles was assessed by monitoring the variation of the flooded surface and its space and time dynamics, georeferencing the flood area edge with a global positioning system (GPS) Garmin GPSMAP 78s. Silting maps were generated using the ARC-GIS 9.2 software by ESRI. The lowering of the San Jose River generates a catastrophic effect on the coastline around the mouth, involving the disappearance of the turtles in the sector, which is a temporary condition, followed by a gradual recovery of the original conditions of Puntilla sector and surroundings. The recovery of the initial conditions is given by high tides and normal processes of coastal currents in the sector. The material initially deposited by the river in the area of the mouth is carried by the mentioned actors above to the north, to Las Machas and El Chichorro beaches. The transport of sediment from south to north generates the outcrop of rocks of various sizes in the sector, which again allow attachment of algae and marine invertebrates, resulting in the recovery of the existing algae meadow before the descent of the river in time less than 10 months. Analyze the importance of silting generated in La Puntilla, where the dominant waves (from the west) face obliquely to the shoreline, generating a steady erosion and entrainment northward process of fine particulate matter (sand, silt and clay), and probably nutrients of lithosphaeric origin (Si, P, Fe). The clearing of stones and boulders generates a suitable substrate for the attachment of macroalgae (*Ulva* spp., *Enteromorpha* sp. and *Chondriocanthus chamissoi* as dominants), that develop aided by the gradually release of nutrients gradually associated with the drag of fine material.

CHARACTERIZATION OF FISHING GEAR THAT HAS AN IMPACT ON THE CAPTURE OF LEATHERBACKS TURTLES IN THE ARTISANAL FISHERIES OF CHILE

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The project will take place in the Eastern Pacific Ocean waters adjacent to Chile, and will take into consideration the vessels from major ports where the presence of sea turtles has been confirmed, such as Arica, Iquique, Tocopilla, Antofagasta, Caldera, Coquimbo, Valparaíso, San Antonio, Constitución, Tomé

and Lebu. The project's goal is to characterize the fishing operations and gear that incidentally capture leatherback turtles in the artisanal fisheries of Chile, through a detailed description of the design of the fishing gear currently used in artisanal fisheries in Chile, its operating system and type of fleet used, identifying the areas of greatest interaction as well as the type of interaction that occurs between fishing gear and methods of operation with leatherback turtles. The project also includes training fishermen in identifying species of turtles, handling leatherbacks onboard vessels with techniques on how to release turtles caught in fishing gear and the use of forms recommended by the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) to collect information on incidental capture. Strategic activities are linked to each objective and follow a standardized methodology defined in the project. Beneficiaries would be found at many levels, at the governmental level they would be able to meet commitments made under binding international agreements, artisanal fishermen would improve their knowledge to practice responsible and sustainable fishing, IAC Party countries could use this project's model to replicate locally, and in general countries sharing the eastern Pacific leatherback turtle population will be supported by Chilean fisheries bycatch mitigation. The size and power of the vessels involved, as well as description of the art of fishing of these is described in all fisheries. In terms of the operational regime of these fleets that make up the fisheries, it is variable, mainly by the alternation of the fisheries in the year, due to the seasonal nature of the resources, which affects its fishing gear changes. It is important to note that independent of the correct identification of the different species of sea turtles, in particular, the hard shell, this project has been established that there is a large presence of turtles in the coastal waters of the involved regions and that there is an interaction with the different art of fishing, especially the longline surface, which is operated by fleets in the more distant coastal area. In the case of the leatherback turtle (*Dermochelys coriacea*), as a species easy to identify, can say truthfully that it is present in the coastal zone and has interaction in most of the studied fishing gear.

NESTING POPULATION ORIGIN OF A GREEN TURTLE FORAGING AGGREGATION IN NORTHERN CHILE DETERMINED FROM MTDNA ANALYSIS; DRAWING NEW BOUNDARIES MANAGEMENT UNITS IN THE SOUTHEASTERN PACIFIC

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Developing an understanding of population structure is essential for informing conservation of marine turtle species. Recent mtDNA surveys of Pacific green turtle nesting populations have identified genetic stocks in the eastern, central and western Pacific and these studies now provide a baseline to evaluate the stock composition of green turtles foraging off Chile, which is considered the southern range for foraging green turtles in the eastern Pacific. The goal of this project is to define the connectivity between a green turtle foraging aggregation in Mejillones, northern Chile, and potential source (nesting) populations. To examine the stock origin and evaluate current life-history hypotheses, we 780 bp of the mitochondrial (mtDNA) control region sequences from 38 foraging green turtles (48-76 cm CCL) captured in nearshore waters off Mejillones and compared haplotypes with our reference database from 41 rookeries throughout the Pacific. Nine haplotypes were observed among the animals sampled, including 7 previously reported in eastern Pacific nesting populations and 2 new haplotypes that are new variants of eastern Pacific haplotypes. We carried out bayesian mixed stock analysis using the program BAYES based on the 5 potential eastern Pacific

nesting populations, or Management Units (MU); including Hawaii, Islas Revillagigedo (Mexico), Michoacan (Mexico), Costa Rica and Galapagos. Results indicated that the foraging aggregation in Chile belongs primarily to the Galapagos breeding population (or MU), with a mean estimate of 97% (SD=3.8%, CI= 86.3 – 98.0%) contribution from Galapagos and a potential 1% from Costa Rica (CI= 0-9%). Results are consistent with movements the 76cm CCL turtle that we satellite-tracked travelling north along the coast of Peru and then northwestward toward the Galapagos Islands before losing transmissions. These results indicate that the waters off Chile represent the southern extent of the distribution for the Galapagos breeding population (MU) in terms of resident foraging aggregations.

MARINE MAMMAL AND SEA TURTLE BYCATCH REDUCTION IN THE DRIFT GILLNET FISHERY IN CHILE*

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A number of strategies have been developed to reduce bycatch of marine mammals and sea turtles in pelagic longline fisheries while relatively few tools are available to reduce bycatch of these species in drift gillnet fisheries. We conducted a rapid survey assessment of the large mesh drift gillnet fishery operating out of Chilean ports and found reports of interactions with marine mammals and sea turtles, but primarily small cetaceans such as bottlenose dolphins (*Tursiops truncatus*), endangered sperm whales (*Physeter macrocephalus*), pinnipeds (fur seals and sea lions), and leatherback sea turtles (*Dermochelys coriacea*). The fishery is considered an artisanal fishery and targets swordfish, similar to the drift gillnet fishery operating out of California, USA. Fishing generally occurs from May through December, although most of the effort takes place through October. Vessels travel up to sixty miles offshore. Nets are approximately 1.5 kilometers long and 100 meters deep and are set at night. Trips may last up to around 20 days, with approximately 12-13 sets per trip. The U.S. drift gillnet fleet operating out of California is required to place acoustic pingers in a staggered pattern on both the floatline and the leadline to reduce marine mammal bycatch. This practice has been shown to result in a 50% reduction in the bycatch of small cetaceans and an apparent elimination of bycatch with beaked whales. Research on various colors and ultra-violet light-emitting diodes (LEDs) has shown significant reductions in sea turtle bycatch, without notable negative effects on target catch. We began trials in the 2015 fishing season to determine the effect of acoustic pingers and LEDs on gillnets in Chile during night-time fishing operations both with respect to target and bycatch species catch rates. Initial pilot trials involved capacity building and meetings with fishers to build trust and acceptance of new fishing gear modification. Information was collected on target catch and bycatch during 8 trips conducted between March and October 2015 by the artisanal vessel "Enriqueta" with various configurations of acoustic pingers and LEDs. Interviews with the fishers involved suggested a perceived reduction of bycatch associated with the use of the bycatch reduction technologies (BRT), particularly cetaceans, when compared to previous years. Although interactions with sea turtles are rare events, the fishers attitude toward the use of LEDs changed in positive ways after reporting sightings adjacent to nets of leatherbacks and hard shelled turtles during fishing operations without entanglement. We present results

from these initial trials and discuss potential for further expansion of monitoring and mitigation in the artisanal gillnet fleet in the next fishing season.

FIRST REPORT OF LOGGERHEAD TURTLE (*CARETTA CARETTA*) IN HEALTHY STATE IN NERITIC WATERS OF CENTRAL PERU, SEPTEMBER 2015

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From the seven species of sea turtles that exists worldwide, five have been reported in Peruvian waters: the black turtle (*Chelonia mydas agassizii*), olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*). The loggerhead has previously been reported in Peru by NGO's, however they were mainly founded in oceanic waters (mean 84 nautical miles offshore, N=299). Here we present new evidence of a healthy individual captured in shallow neritic waters. On September 22th during the sea turtle survey activities carried out by the regional lab of IMARPE (Instituto del Mar del Peru) in Pisco, the first capture of a healthy loggerhead in neritic waters took place, the individual was captured in the following position (13°51'10.6''S; 76°15´51.6´´W) in a 5.5 m depth and at 0.82 km (0.44 nm) from the shoreline, the SST were the animal was captured was 19.8°C (+2.5°C above the average of the last 4 years in the area). The animal was a juvenile, since the CCL of 62.2 cm was reported, since was less than 70 cm, the minimum size of nesting females in Queensland, Australia, a weight of 32.5 kg was reported. The reported body condition index was 2, meaning that the animal was in a healthy condition. Several epibionts from oceanic origin were as well reported in their different parts of its body: like the shark sucker (*Remora remora*) in the plastron, three flotsam crabs (*Planes cyaneus*) in the perianal area, 28 individuals of pelagic gooseneck barnacles (*Conchoderma virgatum*) in the plastron and head and seven individuals of duck barnacles (*Lepas anatifera*) in the head, in addition other unidentified pelagic barnacles were as well reported. The presence of this animal in coastal shallow waters could be a consequence of El Niño 2015.

ENVIRONMENTAL CONDITIONS OF THE HABITAT OF BLACK TURTLES (*CHELONIA MYDAS AGASSIZII*) IN CHINCHORRO BEACH, ARICA CHILE

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Arica constitutes together with other specific sectors of the north of Chile, a unit place of concentration of turtles. The turtles inhabiting Chinchorro beach are an interesting point of study because there is scarce information to establish if their presence is permanent or episodic, especially given their localized presence within the urban area. Within the Conservation Program of Sea Turtles in Arica, funded by the Regional Government of Arica y Parinacota, one of the main objectives of the program was to characterize the environmental conditions of the water column of the sector used by the turtles. The sampling area

corresponds to the Chinchorro beach, where two transects, one parallel to the coast (100 m offshore), and another perpendicular to the coast at 1, 3 and 5 nautical miles from the coast. From surface and bottom of the water column were taken samples with a Niskin bottle. In situ temperature, conductivity and pH were registered. Also, subsamples were taken for determinations of ammonia, nitrite, nitrate, total nitrogen, phosphate, total phosphorus, detergents, oils and fats, total suspended solids and total hydrocarbons. During the study period (between 2011 November and 2013 January, was carry out 10 sampling campaign) the reduction of hydrocarbons and detergents was observed. Unlike coliforms and total nitrogen levels increased significantly. The period with the worst environmental conditions was when the flood of the San José River occurred (January 2012). During this event the fecal coliforms was present in all station and depths (> 500 NMP / 100 mL). This event generated a significant modification of the coast, as well as environmental conditions of the water column, which was reflected in a marked decline in sightings and catch of turtles.

SEA TURTLES AT LOBOS DE TIERRA ISLAND, NORTHERN PERU, NEED FOCUSED CONSERVATION EFFORTS

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Lobos de Tierra Island (06°26'S, 80°51'W) is part of the Guano Islands, Islets and Capes National Reserve System (RNSIIPG), created in 2010. It is a 10.5 km long island, located 11.4 Km from an inhabited coast in the convergence zone between the Peruvian (Humboldt) Current and El Niño current, under the influence of subtropical surface waters from the west, which makes this island a special site for marine bio-diversity and conservation. Dispersed and sporadic from previous years, research indicates that Lobos de Tierra Island is a main feeding ground for juvenile sea turtles, mainly the Black Turtle (*Chelonia mydas agassizii*). In addition, Olive Ridley Turtle (*Lepydochelis olivacea*) has also been recorded. On the base of several visits to the island between 2004 and 2014 we describe the conservation status of sea turtles around Lobos de Tierra Island and will propose some conservation measures. Despite the lack of scientific information on sea turtles in this area, it is well known by local fishermen that sea turtles congregate around the Island in special hot spots, as protected bays and beaches for foraging and resting. This situation leads to direct catch and by-catch of sea turtles, most of them used for fishermen's consumption during their stay in the area and consumption in nearby localities. Direct captures occur by hand (at the beaches and by scallop harvesting divers) and using hand-thrown harpoons, suggesting the easy accessibility of turtles to people. By-catch occurs using medium to large mesh gill-nets for rays and other fish, although few line hooking cases have been recorded. Both, direct capture and by-catch has not been estimated, but could be considered high if pooled. Although Lobos de Tierra Island is part of a marine protected area (the RNSIIPG), the allocated personnel (normally 4 guards) for its management and control is not enough for its extension. Despite human impact on the inhabiting seabird species on land can be controlled due to the relatively inaccessible location of the island, fishery interactions must to be reduced and controlled with specific and

permanent measures to avoid illegal direct takes and by-catch. Special efforts must to be dedicated to the zonification of the island according to hot-spot detected in recent and future research and the creation of exclusion zones for fishery. However, these efforts will be futile if the control measures are not reinforced with more personnel and equipment allocated on and around the island. As part of a reserved area originally created to protect seabirds and guano production, it must be noted that Lobos de Tierra island, due to its extension and particular marine biodiversity, should be treated as an independent protected area from the other 21 small islands that are part of the RNSIIPG. Finally, although legal protection already exists for sea turtles in Peru, contradictory roles of authorities and legal procedures must to be solved.

ISOLATED IN THE PACIFIC: HANGA ROA, AN IMPORTANT HABITAT FOR SEA TURTLES IN EASTER ISLAND, CHILE

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Hanga Roa is one of the main areas for recreative diving, and it is also one of the most common places for sighting turtles at Easter Island. In this study, we performed diving touristic trips daily to Hanga Roa, between August 2013 and April 2015. In each, the number of encounters with sea turtles was recorded. Species and morphotypes were identified, according to morphological characteristics (number of scutes, shape of head and carapace, and carapace coloration). Individuals were differentiated by natural marks as well as scars located in head, flippers and shell. After species and individual identification was carried out, we compared photographs obtained between 2010 and 2012 in the same location, in order to examine the occurrence of each identified individual, as well as the presence of others turtles in the area. Twenty-seven different individuals of green turtle were identified in total, each specimen was sighted at least one time, and at most eleven times. From all green turtles sighted during this study, two had been observed in four different years; four turtles in three different years, five in two years and 16 had been sighted once. Additionally, we identified the presence of two different morphotypes of green turtle (yellow and black). Twenty turtles were classified as yellow morph and 7 as black morph. Two distinctive hawksbill turtles were observed in August 2013 and October 2014, respectively. Furthermore, one individual with hybrid morphological characteristics, from green and hawksbill turtles was also observed. Our results suggest that Hanga Roa represents an important habitat for sea turtles in Easter Island, since the high occurrence and potential fidelity to this site by turtles. These preliminary data highlight the need for further research, on these endangered species and their habitat in this isolated Pacific Island.

IN SITU DIFFERENTIATION AND PHOTO-IDENTIFICATION OF GREEN TURTLES (*CHELONIA MYDAS*) IN THE MOST ISOLATED PACIFIC ISLAND, EASTER ISLAND, CHILE

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Identification of individuals by natural marks and scale patterns is considered an alternative to traditional tagging in sea turtles. The advantages include being a noninvasive method that does not alter the animal's behavior and also the stability in time, a very important factor to consider in these long-lived species. In Hanga Roa (27.0850°S; 109.2604°W) located in the southwestern portion of the island, we recorded individuals of *C. mydas* through photographs between 2010 and 2015. Individuals were differentiated in situ by natural marks and scars located in their heads, flippers and shells. After individual identification, in order to confirm the effectiveness of this method, head photographs of each distinctive turtle were passed through P.I.T.MAR. software, which compares the pattern of cephalic scales. Thirty-three photographs were submitted to this platform corresponding to 18 different individuals identified in situ by natural marks and scars. Using the software, 18 turtles were identified as different individuals, however, two individuals corresponded to the same turtle and two other individuals registered originally as different turtles ended being the same individual. Our results show that in situ differentiation and photo-ID with P.I.T.MAR. could provide less reliable results when they are used separately because of observer/photographer bias. Nevertheless, the use of both techniques to individualize green turtles can provide robust results when they are used together, and their application can be particularly useful in locations where logistics difficult the capture of individuals in foraging habitats. Additionally, both quality and quantity of photographs are key factors to consider in the methods developed in this study.

SEA TURTLE CONSERVATION IN PERU: AT A CROSSROADS?

Coppelia Hays Branscheid

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Substantial progress has been made since the first publication in 1982 of the Status of Sea Turtles in the Southeast Pacific with emphasis on Peru. Nevertheless, we seem to be headed towards a crossroads where decisions on both national and international levels must be made. The conservation of sea turtles is a complex issue as they are a migratory species and the conservation and management of this shared resource involves a regional as well as international approach. The Pacific Ocean of Peru, nearshore and offshore, is primarily a foraging habitat for 5 species of sea turtles. Flipper tag returns, genetic analysis and satellite tracking studies indicate the following: green turtles in Peru originate from nesting rookeries in Galapagos and Mexico, olive ridleys come from Costa Rica, Colombia and Mexico, while leatherbacks are from eastern (Mexico and Costa Rica) and western Pacific (Papau New Guinea, Indonesia and Solomon Islands)

stocks and loggerheads migrate from Australia and New Caledonia nesting rookeries. Although data on hawksbills in Peru are limited, continental Ecuador provides the nearest known nesting beach. In 1979, the first olive ridley nest was documented in Tumbes and nesting was thought to be a sporatic activity. This has since changed as nesting activity has been increasing along the coast of Tumbes and Piura where olive ridleys and greens nest. EcOceanica has recorded 70 nests and nest emergences between Jan 2010 and Feb 2014. Fishery bycatch is recognized to be one of the major threats to sea turtle survival. There is a continuous growth of fisheries to meet the growing demand of national as well as international markets. In addition, small scale fisheries, causes an annual sea turtle bycatch estimated in Peru to be in the thousands. This has a significant impact on the green, loggerhead, and leatherback turtles. ProDelphinus is working closely with the fishing community to develop sustainable fishery practices while reducing bycatch. WWF is also working on mitigation of sea turtle bycatch. Since 1997, IMARPE has been conducting an onboard observer program, part of the efforts to reduce sea turtle mortality. Marine pollution is a threat to all species of sea turtles. A recent surge in plastic pollution is creating "garbage patches" and the Great Pacific Garbage Patch, about the size of Texas, continues to grow. As sea turtles are eating more plastic, this is bound to have a detrimental effect on the species in Peru and in the overall Pacific at large. After analyzing the literature regarding conservation of sea turtles in the eastern Pacific, it becomes apparent that this is not only a national task but rather an international responsibility. Peru has been a signatory to the Inter-American Convention for the Protection and Conservation of Sea Turtles since 1999. IMARPE, the Ocean Institute of Peru, provides an annual report. There is a strong dedicated body of NGO's working towards sea turtle conservation which incudes ProDelphinus, ecOceanica, Planeta Oceano, ACOREMA, WWF and APECO as well as various universities and government agencies. Together they are addressing the new management challenges in Peru for sea turtle conservation that have international repercussions for the Pacific basin.

WHERE DO ALL THESE TURTLES COME FROM? LOW GENETIC DIVERSITY OF EASTERN PACIFIC HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) FORAGING IN THE NORTHERN PACIFIC OF COSTA RICA DEMANDS NEW MOLECULAR APPROACHES TO DETERMINE ORIGINS OF JUVENILES AND ADULTS AT DIFFERENT HABITATS ALONG NORTHERN PACIFIC OF COSTA RICA*

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The eastern Pacific hawksbill turtle (*Eretmochelys imbricata*) has undergone significant population decrease and almost reached extinction. However, recent efforts to study and restore this emblematic population have shown that there are many more individuals in the water than are being found on the beach nesting. Only three major nesting grounds have been identified in the Eastern Pacific and are genetically characterized. However, the Northern Pacific of Costa Rica hosts a variety of different ecosystems that are occupied by different life stages of this emblematic species and which being characterized using 770 bp sequences of the mitochondrial DNA control region, combined with tag-recapture and satellite data. Five

foraging grounds where sampled in the Costa Rican Pacific, including Isla del Coco, Bahía Matapalito, Punta Coyote, Punta Pargos and the Gulf of Nicoya and a total of 43 hawksbill tissue samples were analyzed at the laboratory of the Centro de Investigación en Biología Celular y Molecular, at the Universidad de Costa Rica, where DNA was extracted, aprox. 770 pb of the mitochondrial DNA control region amplified and all samples successfully sequenced. We identified two dominant haplotypes with five putative new haplotypes. Haplotype diversity was overall low, and although genetic structure was not significantly different between sites, there was an apparent variation in haplotype diversity when considering sizes and sexes of the turtles sampled. Furthermore, the higher genetic diversity of small males residing at Punta Coyote compared with the lower diversity found in resident, small juveniles at Bahía Matapalito somewhat counters the dispersal-and natal homing theory and may suggest differential habitat preferences depending on origin, size and sex. Although small sample sizes do not warrant the conclusion yet, females seem to recruit to mangrove areas, meanwhile males reside at open, rocky reefs, being supported by additional tag-recapture and satellite data. Our results contribute significantly to the still poorly known eastern Pacific hawksbill population, but currently undergoing studies that aim to obtain a higher resolution from mitochondrial markers, particularly the highly variable Short Tandem Repeat area flanking the control region are necessary to conclude on origin-dependent segregation of eastern Pacific hawksbill turtles along the Northern Pacific in order to be incorporated into regional conservation measures of this critically endangered species.

SO CLOSE BUT YET SO DIFFERENT GREEN TURTLES: COMPARING THE OCEANIC FORAGING GROUND AT ISLA DEL COCO WITH COASTAL GOLFO DULCE, PACIFIC COSTA RICA, USING STABLE ISOTOPE ANALYSIS OF CARBON AND NITROGEN*

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The eastern Pacific is known for its highly dynamic ocean realm, in which green turtles (*Chelonia mydas*) forage following different strategies in a geographic range from the United States down to Chile. Stable Isotope Analysis (SIA) has been an informative tool to answer questions on dietary compositions and preferences, but recently has also been proven to reveal the geographic origins and migratory routes of individuals recruiting from one habitat to the other. Using SIA as a migratory tracer to determine habitat connections and life stage-specific aggregation at different foraging grounds is thus becoming the marker of choice. However, in order to complete the regional and Pacific-wide isoscapes, or isotopic variations, in order to determine accurate probabilities of origins, characterizations of major foraging grounds are necessary and the mechanisms of isotopic variations in or between years need to be understood. Here we present the isotopic characterization of two green turtle foraging grounds in the Pacific of Costa Rica. Isla

del Coco and Golfo Dulce are only 550km apart, but are dominated by completely different oceanographic processes that seem to model and vary their isotopic signatures by 2.5%0 in Carbon and 1.5%0 in Nitrogen. Meanwhile Isla del Coco, an oceanic island, is impacted by year-round strong trans-pacific currents and a deep Carbon pool, Golfo Dulce is a tropical fjord, partly surrounded by mangroves and shallow coastlines but reaching more than 200 meters in depth where the unique Anammox reaction occurs. Both of these sites represent the most important green turtle foraging grounds in the Costa Rican Pacific, where juveniles to males dominate Isla del Coco (mean CCL=73cm, n=86) and mostly females aggregate at Golfo Dulce (mean CCL=79cm, n=69). In order to determine site-specific isotopic signatures as well as habitat connections and origins of recruitment, we conducted cluster analysis and subsequently draw bayesian inferred convex hulls and standard ellipses as implemented in the packages SIAR and SIBER, using the program R. Our results indicate that green turtle foraging at Isla del Coco have a higher probability of being resident than at Golfo Dulce, where signatures vary greatly and are possibly the result of a higher rate of stop-overs and short residencies. Nonetheless, the overlap of both isotopic niches suggests a connection of these sites, where smaller individuals from Isla del Coco possibly recruit to Golfo Dulce once reaching larger sizes. Likewise, recruitment probabilities from other currently studied foraging grounds at Paracas, Peru, Isla Gorgona, Colombia, and Bahía Los Angeles, Baja California, are presented. The isotopic characterisation of green turtle foraging grounds represents an important cost-effective tool to estimate habitat connection, but also opens new interrogations on the ecosystemic plasticity that this species is capable to deal with when shifting between different habitats throughout the green turtles' life cycle. In this sense, our results contribute to the overall knowledge on eastern Pacific green turtle ecology and provides new information on the survival strategies they acquire in order to survive in a highly dynamic ocean. Furthermore, putative habitat connections using SIA will inform national but also regional conservation measures, focusing on the management needs of geographical dispatched habitats occupied by this migratory animal.

COMMERCIAL TESTOSTERONE ASSAYS SUGGEST UNUSUAL SEX BIAS IN GREEN TURTLES (*CHELONIA MYDAS*) AT GALÁPAGOS FORAGING SITES

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The study of demography and sex ratios among populations is essential to gauge a population's health, but reliably determining the sex of juvenile and subadult sea turtles in the field has been a challenge for researchers. Previous approaches have included laparoscopy, which requires invasive procedures, or DNA fingerprinting methods, which are costly and time-consuming. With the development of Radio Immuno Assays (RIA) to determine levels of testosterone, methods have become less invasive but remained expensive. The finding that commercially available, cost-effective ELISA (enzyme-linked immunosorbant assay) test kits can determine testosterone levels and identify the sex of immature green sea turtles has opened the door to studying demographics of free-ranging sea turtle populations. We used ELISA protocols

to study sex ratios of green sea turtles at five coastal foraging sites on three islands within the Galápagos Archipelago during the 3 non-nesting seasons between 2013 and 2015. Surprisingly, most of the sampled sea turtles (n=100) were found to have testosterone titers typical of males. This finding stands in sharp contrast to reported sex ratios of sea turtle populations in most locations around the world. Overall, we found mainly juvenile and subadult males, with only a few adult females, during the entire study. Previous studies in the Galápagos, many of which were conducted during the nesting season, reported an abundance of adult female turtles. It is possible, however, that these observations reflected the presence of turtles that had migrated to the islands to nest but departed afterward, rather than turtles that are resident throughout the year. Overall, the unique Galápagos case showcases the use of ELISA tests for the study of free-ranging sea turtle populations and underlines the need for regional conservation efforts due to the highly connected and dependent Eastern Tropical Pacific subpopulations. Acknowledgements: The authors would like to thank the Tortuga Negra-Galápagos project and all the people involved, the Galápagos Science Center, Universidad San Francisco de Quito, Parque Nacional Galápagos, Ecofondo, ICAPO, 36th Annual Symposium on Sea Turtle Biology and Conservation, and James Cook University.

HEMATOLOGICAL AND BIOCHEMICAL PROFILES OF AN EASTERN PACIFIC GREEN TURTLE POPULATION (*CHELONIA MYDAS*) IN THE GOLFO DULCE OF COSTA RICA

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The Eastern Pacific green turtle (EPGT) has been differentiating from the green turtle and is currently being considered as a separate population. In order to obtain reference values for hematology and biochemistry of the EPTG foraging population of the Golfo Dulce of Costa Rica (8°41'N 83°21'W) blood samples were collected from the cervical sinus of 100 free-ranging, apparently healthy individuals between 2010 and 2014. Samples for hematology were measured using manual methods, while biochemical metabolites were analyzed with automated and semi-automated spectrophotometry; also, four hormones were measured by an automated immunoassay. Approximate age was estimated measuring the curved carapace length. A cell description was prepared and measurements were taken from each cell type found in the slides. The average values were: hematocrit (38% ± 6.04), hemoglobin (11 g/dL ± 1.79) and mean corpuscular hemoglobin concentration (31 ± 3.79). The interval obtained for the white blood cell count was (124 – 3823 x 103 µL ± 649.06) and for the differential was: heterophils (42 – 3555 x 103µL ± 563.16), eosinophils (0 – 444 x 103µL ± 93.55), lymphocytes (15 – 1391 x 103µL ± 184.89), monocytes (0 – 154 x 103µL ± 32.27) and basophils (0 – 433 x 103µL ± 111.75). The metabolites' results were: total protein (4.42 g/dL ± 0.86), albumin (1.80 g/dL ± 0.37), globulin (2.59 g/dL ± 0.63), glucose (90.06 mg/dL ± 22.2), cholesterol (160.91 mg/dL ± 58.58), ureic nitrogen (4.64 mg/dL ± 3.53), creatinine (0.43 mg/dL ± 0.14), inorganic phosphorus (8.53 mg/dL ± 2.30), calcium (7.38 mg/dL ± 1.38), magnesium (8.84 mg/dL ± 1.79), uric acid (1.26 mg/dL ± 0.67), triglycerides (170.16 mg/dL ± 128.01), alanine aminotransferase (3.71 U/L ± 2.81), aspartate aminotransferase (186.30 U/L ± 45.27) and seric alkaline phosphatase (478.77 U/L ± 538.75). Some of the hormones' results were below or above the detection limit for the technique used. The interval obtained for each hormone was: estrogen (2200 ng/dL ± 206.56) and total thyroxin (<0.5 – 0.9 µg/dL ± 0.12). The results

APPLYING GENERALIZED LINEAR MODELS AS AN EXPLANATORY TOOL OF THE HEALTH STATE OF EAST PACIFIC GREEN SEA TURTELS (*CHELONIA MYDAS*)

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Deleterious effects of pollutants are difficult to detect in wildlife since many of the effects are evident after longer periods of time, when xenobiotics have already jeopardized the physiology, reproduction and/or survival of the organisms and populations. The synergic effect of multiple pollutants on sublethal health responses, such as blood biochemical alterations, in free-living sea turtles is unknown. The goals of this work were to evaluate the relationship of clinical parameters (e.g. triglycerides, total proteins, cholesterol, glucose), exogenous factors (season, study site, year) and the simultaneous effect of concentration of xenobiotics (trace elements and organochlorine pesticides, OC) to the biochemical, physiological and morphological biomarkers measured in immature ($\leq$77.3 straight carapace length) East Pacific green turtles (*Chelonia mydas*) inhabiting in the occidental coast of Baja California Peninsula. Generalized lineal models (GLM) were fit for each clinical parameter (alkaline phosphatase, aspartate aminotransferase (AST), alanine aminotransferase (ALT)), indicators of oxidative stress (catalase (CAT), glutathione S–transferase (GST) and TBARS), endocrine disruption biomarkers (sex steroids, thyroxine (T4) and vitellogenin (Vtg)) and body condition. The effects of the xenobiotics and clinical parameters to the response variables were evaluated in separately GLM analyses. Statistical models explained biologically plausible metabolic relationships between blood biochemistry parameters (e.g. proteins, glucose, and cholesterol) and concentration of hormones and Vtg. The synergic contribution of multiple xenobiotics affecting clinical parameters (ALT, AST, alkaline phosphatase, <44% variance explained) and oxidative stress indicators (CAT, GST <52% variance explained) suggest acute biochemical and health responses of free-living green turtles exposed to habitat degradation. However, clinical parameters explained a larger amount of the variability in physiological responses (levels of sex steroids and Vtg) and body condition (33–80% of variance explained) than those models including levels of xenobiotics as explicative variables (14–39% of variance explained), implying that xenobiotic exposure has not been reflected as oxidative damage (TBARS), endocrine disruption (Vtg), nor at the physiological (sex steroids, T4) and morphological (body condition) level. Differences in health parameters between season and study sites explained by the models coincided with specific nutritional state and chemical exposure differences related to the specific habitat conditions. GLM is a useful novel approach to study ecotoxicological aspects by using green turtle as

sentinel species. This multivariate statistical tool not only allows for identifying and evaluating the synergic effects and contribution of the factors (e.g. concentration of xenobiotics) associated to biomarker (biochemical and physiological) responses but also for understanding regional and temporal differences in health responses of East Pacific green turtles by the inclusion of categorical variables such as season and study site. Phenotypic plasticity observed in East Pacific green turtle confers this species with the potential to characterize particular habitat conditions and to identify habitat perturbation by the evaluation and monitoring of its health state.

MOVING SOUTH: TREND OF SEA TURTLE STRANDINGS IN CHILE

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Chile is an important feeding habitat for sea turtles in the Southeastern Pacific, harboring five of the seven extant species globally. From the 90's decade, sea turtle strandings have been recorded along the continental Chilean coast and its oceanic islands. Between 1990 and 2014, 170 stranding cases, including all the five species of sea turtle recorded for the country, were registered by formal (government authorities) and informal (citizen and press) sources. Most of the strandings are represented by two species; olive ridley (*Lepidochelys olivacea*) and green turtle (*Chelonia mydas*), and they occurred mostly in northern and central Chile (55% and 40% respectively). The seasons with a higher number of cases were spring (34.55%) and summer (28.18%). Furthermore, in the mentioned period only 34, 1% of the alive stranded turtles underwent through a rehabilitation process. In this study, we present sea turtle`s stranding data for this period in comparison to the data obtained during 2015 for the country, all this following the same methodology described above. During 2015 fifteen strandings have been recorded, ten of them belonging to green turtle, four to olive ridley and one to leatherback (*Dermochelys coriacea*). Loggerhead (*Caretta caretta*) and hawksbill (*Eretmochelys imbricata*) strandings were not recorded. Most of the events took place in southern Chile (n=7) and during the winter season (n=11). Additionally, most of the cases (n=9) went through a rehabilitation process. Although during this year green and olive ridley turtles continue to be the most common species stranded on the Chilean coast, differences appear between the location and season in which the strandings occurred. In the previous years (1990-2014) most of the stranding events took place in northern Chile; however, in 2015 the cases were concentrated on the south coast of the country. In the same way, the occurrence of strandings in the previous period was higher during spring season, while in 2015 the majority of the cases were registered during winter. Additionally, during 2015 81, 9% (n=9) of the cases underwent a rehabilitation process, in contrast to previous period in which only 34, 1% (n=58) of the cases were assisted. These differences related to the location and season of stranding events, could be due to the increase of sea surface temperature associated to ENSO, which could affect migration from nesting beaches to foraging habitats or between foraging grounds. This oceanographic event could be encouraging displacements to higher latitudes and turtles could now have access to foraging grounds not used before, increasing the probability of strandings in these areas. Furthermore, it is probable that due to the ectothermic condition of sea turtles, the increased ocean temperature has elevated their activity in periods of "winter dormancy", which could be associated to higher exposition to anthropic threats such as plastic ingestion and bycatch. This higher susceptibility could also increase the probability of stranding. In

addition, the higher percentage of turtles that go through a rehabilitation process, could suggest a higher awareness by the governmental institutions, increased funding for this cause, and also more interest in informing and registering cases related to these threatened species in Chile.

A METANALYSIS ON THE CONSERVATION STATUS OF SEA TURTLES IN GALAPAGOS AND CONTINENTAL COASTS OF SOUTHERN COLOMBIA, ECUADOR, AND NORTHERN PERU

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Sea turtles are highly migratory and all species have been attributed a conservation and/or threatened category under either CITES or IUCN. The distribution and population status of sea turtles in the Southeastern Pacific has scarcely been documented in recent times despite nesting and foraging grounds and migration routes are affected by anthropogenic activities and environmental and physical factors arising from natural variability and climate change. From a meta-analysis perspective, using descriptive statistics following the PRISMA structure, a literature review of publications from both the indexed peer-reviewed journals and grey literature from the Pacific coasts of Colombia, Ecuador (including the Galapagos Islands) and northern Peru was conducted. A list with an analysis and evaluation of the literature was quantified, detailing research studies conducted and identifying species relatively assessed. Major topics include sightings, nesting, strandings, population ecology, movements, fisheries interactions and conservation, among others. Preliminary results show at least 238 references, of which 39.8% are refereed documents and 60.2% grey information, mainly focused on sighting records documenting nesting and foraging by sea turtles around La Plata Island and the Galapagos Islands (Ecuador) since 1697. While there are still gaps on the bio-ecology of sea turtle populations, especially lack of data on their population sizes and dynamics in the region, the evolution of research on marine turtles has progressed dramatically since the early 70's, when the sea turtle research started with observations and empirical work of nesting sites in Galapagos and Ecuador's mainland coast. Recent research has continued with the innovation of new techniques and field approaches relying on the use of satellite technology and telemetry devices to investigate and track local displacements and migration of *Chelonia mydas* in the Galapagos, *Dermochelys coriacea* in the Tropical Eastern Pacific, and *Eretmochelys imbricata* in the Gulf of Guayaquil. Secondary topics include the assessment of anthropogenic impacts (fisheries interactions) and the imperative need of conservation and management actions, which have been implemented or are being fostered in some nesting sites of the region assessed.

CHARACTERIZING ENVIRONMENTAL AND SPATIAL VARIABLES ASSOCIATED WITH INCIDENTAL CATCH OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) IN THE EASTERN TROPICAL PACIFIC PURSE-SEINE FISHERY

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In the Eastern Tropical Pacific (ETP), a region of high fishing activity, olive ridley (*Lepidochelys olivacea*) and other sea turtles are accidentally caught in fishing nets with tuna and other animals. To date, the interaction between fishing activity, ocean conditions, and sea turtle incidental catch in the ETP has been described and quantified, but the factors leading to the interaction of olive ridleys and fishing activity are not well understood. This information is essential for the development of future management strategies that avoid bycatch and incidental captures of sea turtles. We used Generalized Additive Models to analyze the relationship between olive ridley incidental capture per unit effort (iCPUE) in the ETP purse-seine fisheries and environmental conditions, geographic extent, and fishing set type (associated with dolphins, floating objects, or in free swimming tuna schools). Our results suggest that water temperature, set type and geographic location (latitude, longitude and distance to nesting beaches) are the most important predictor variables to describe the probability of a capture event, with highest iCPUE observed in sets made over floating objects. With the environmental predictors used, sea surface temperatures of 26 - 30ºC and chlorophyll-a concentrations.

RELEASING LEATHERBACKS: A COLLABORATIVE CONSERVATION INITIATIVE AMONG FISHERMEN AND RESEARCHERS IN PERU

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Due to the critical situation of leatherback turtles (*Dermochelys coriacea*) in Peruvian waters, on 2006 we launched a conservation initiative to encourage leatherback conservation among artisanal fishermen and personnel from governmental agencies. Work involves collecting biological information and samples from stranded and by-caught leatherback turtles in coastal Peruvian waters. Since its first stages, valuable information on biology, presence, distribution, capture areas, interaction with fisheries and trade of sea turtle products has been compiled. Two main scenarios have been identified: Incidental capture with sea

turtle releases and bycatch with sea turtle retention for sale or for own consumption. Emphasis has been made in the ports and fishing villages where leatherback turtles retention (that lead to mortality) have been identified; an additional criteria for locality selection was the lack of previous conservation activities. These localities included La Cruz (03°37' S, 80°37' W) and Puerto Pizarro (03°29' S, 80°28' W), both at the tropical Tumbes region, and Tambo de Mora (13° 30' S, 76°11' W) and San Andrés (13° 43' S, 76°13' W) in the southern coast, influenced by the Peru current. For data collection, we surveyed beaches, fish markets and landing places of ports, inlets and fishing villages, looking for sea turtle strandings or evidences of fishery interaction, and sea turtle meat for sale. The increasing information comes from the support of fishermen that had become important allies and voluntarily collected data for the present project. They recorded: Date, location, type of interaction (hooked, entanglement, sighting), measurement (CCL in cm), skin samples and fate (released, released with injuries, with hook or nets, retained, butchered, etc. Accessing fishermen's confidence and at the same time to compromise their cooperation is a hard, long‑term effort, through which mutual respect for the work of both fishermen and researchers is being achieved. Obviously, the process is particularly difficult in communities where fishermen see turtles just as an economic resource. Nevertheless, fishermen volunteer collaboration has been the cornerstone of the present project, making possible the release of leatherback turtles in locations where historically are retained and used for food. Total leatherback turtle records for the periods July – November 2006 and June 2010 – August 2015 is 207, including bycatch, sightings and strandings. The driftnet ray fishery accounted for the highest records; other fisheries reported were the longline fishery, and artisanal driftnets for tuna, together with the 3.5"-4" artisanal driftnet for a variety of fish species. In addition, nylon bottom set nets, industrial and artisanal purse seiners and floating lines from shellfish marine cultures were also involved in incidents with leatherbacks. The strategies implemented during the present project could be valuable in places like Peru, when no large amount of data is available for knowing leatherbacks space/time distributions, and when funds are scarce and no continuous trough the time.

GRAB A SHELL DUDE! TRANSPACIFIC RECRUITMENT AND REGIONAL CONNECTIVITY OF PACIFIC GREEN TURTLE (*CHELONIA MYDAS*) POPULATIONS AGGREGATED AT TWO ECUADORIAN FORAGING GROUNDS*

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Understanding the relationships between breeding and foraging populations of migratory marine species is vital for their conservation. Mixed Stock Analysis (MSA) using molecular techniques has proved to be an effective alternative to estimate the origin of sea turtles sampled away from their nesting sites. However,

little is known about population dynamics in the foraging green turtle aggregations of the Eastern Pacific. In this study, we used 773 base pairs from the mitochondrial DNA control region in order to trace back the origin of green turtles (*Chelonia mydas*) from two foraging grounds of Ecuador: the Galapagos Islands (GFG; n=61) and Machalilla National Park (MNP; n=43). We used published data from potential source rookeries in the Eastern, Central and Western Pacific, complemented with genetic composition data of nesting females (n=29) from MNP. Comparing the MNP rookery with previously published data of other nesting stocks from the central and eastern Pacific, no significant difference was found with the Galapagos stock, therefore these two areas were pooled into a single Galapagos-Machalilla stock for subsequent analyses. The MSA results indicate a high Galapagos-Machalilla contribution for both foraging grounds with average contributions of 93.8% (CI: 74.7-99.8%) to GFG and 94.1% (CI: 72.9-99.9%) to MNP. Costa Rica and Michoacán (México) show minimal contributions of 3.9% and 1.3% respectively to the GFG, and for MNP we have the first report of one individual with a haplotype found only at Western Pacific rookeries (CmP22.1). Further evidence for transpacific recruitment is provided by high numbers of the "orphan" haplotype CmP-97.1, which is phylogenetically related to western Pacific rookeries and was found in 13% of GFG and in 2% of the MNP aggregation. Although the source rookery for this haplotype still remains unknown and prevents us from accurately estimating its contribution, a trans-Pacific connection seems evident and might be stronger than previously believed. The Galápagos-Machalilla stock is the main source population for both foraging grounds, and the low contribution from northern Eastern-Pacific rookeries may indicate minimum migratory connectivity between north and southeastern-Pacific green turtle populations. Acknowledgments: The authors would like to thank Pontificia Univesidad Católica del Ecuador, Equilibrio Azul, Galapagos Science Center, Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesquería and World Wildlife Fund.

GOOD SUSTAINABILITY PRACTICES: SENSIBILIZATION, OBSERVATION TURTLES RELEASE IN PURSE SEINING IN PERU*

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During fishing seasons of anchovy, jack mackerel and horse mackerel; fishing vessels TECNOLOGICA DE ALIMENTOS S.A. (TASA); performs a georeferenced and continuously recording of environmental conditions and sightings of marine top predators. TASA has a fleet of 50 vessels with near one thousand fishermen working on them. Fishermen known as "our sustainable agents" are constantly trained in sustainable fisheries as part of the program "Best Practices for fisheries sustainability". The program began in 2008 and continues to date, and aims to monitor and care of marine biodiversity, focusing on marine top predators. As part of this initiative, the addition of the training program "Correct identification and release of the main species of marine top predators" conducted with the support of the NGO Pro Delphinus, allowed the improvement of data collection. Furthermore, the employment of a "Sustainable kit", as part of the equipment of the 50 vessels, have enhanced the detection and identification of top marine predators such as sea turtles. Number of sightings increased by 69% going from 1,200 in 2012 to 4,090 sightings in 2014.Among these, the most important sightings are: seabirds, dolphins, sea lions, whales and sea turtles. In the case of sea turtles, we have been able to identify, measure and release different sea turtle species, being the most common the green turtle (*Chelonia mydas*).

POPULATION CHARACTERIZATION AND PHOTO-IDENTIFICATION OF BLACK TURTLE (*CHELONIA MYDAS*) AGGREGATION AT BAHÍA SALADO, NORTHERN CHILE

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Bahía Salado, located at the Atacama Desert, is one of the few natural foraging areas for black turtle (*Chelonia mydas*) in Chile, and it is the southernmost foraging ground for this species in the Southeastern Pacific. Although this feeding site was discovered in the early ´80s, and this species is listed as Endangered by IUCN, to date there is little information available about the current status of this foraging colony. In this study, a morphological characterization of this black turtle aggregation was performed, which allowed us to determine the age and sex ratio. A population size estimate was also carried out, using capture-mark-recapture and the Schnabel (1938) methods. Photo-identification as a complementary technique to traditional tagging was evaluated using the software P.I.T.MAR. All data were obtained between 2013 and 2015. Since 2013 we have captured and tagged 9 individuals, of which 2 were juveniles (CCL<60.7) and 7 were adults (CCL ≥ 60.7). Furthermore, all of the adult turtles were females. Results on the population estimation indicated that this aggregation is composed of at least 10 individuals. Using capture-mark-recapture technique proved that at least two individuals presented some degree of fidelity to Bahía Salado, since they were recaptured in two and three field campaigns respectively, between 2013 and 2015. Our study did not provide enough evidence to conclude that photo-identification can replace traditional tagging, in order to identify black turtle individuals at Chilean coasts. Thus, is essential to conduct further studies with larger sample sizes at the study area. The information collected in this study provides a basis for the development and implementation, of management and conservation strategies, of this endangered species at Bahía Salado. Acknowledgments: the authors would like to thank the National Oceanic and Atmospheric Administration (NOAA), the Chilean Environmental Protection Fund, the Rufford Small Grants for Nature Conservation and the Idea Wild grant.

BYCATCH OF SEA TURLTES IN THE ARTISANAL GILLNET FISHERY IN SECHURA BAY, PIURA, PERU, 2013 – 2014

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Gillnets are recognized globally as one of the fishing gears with the highest levels of bycatch and mortality of sea turtles. Through onboard observer monitoring, from July 2013 to June 2014, we assessed the bycatch of sea turtles in the Sechura Bay, Peru artisanal gillnet fishery. One hundred four sea turtles were

incidentally caught in 53 observed fishing sets. The observed species composition of bycatch was *Chelonia mydas*, green turtles (n=100), *Eretmochelys imbricata*, hawksbill turtles (n=3) and *Lepidochelys olivacea*, olive Ridley turtles (n=1). Bycatch occurred in 62.3% of the monitored sets, with an average of 1.96 turtles caught per set. For all sea turtles combined, 28.8% of individuals were dead and 71.2% were alive at the time of retrieval. Live individuals were released after sampling and tagging. The majority of individuals caught were classified as juveniles and sub-adults, with an average carapace length (CCL) and width (ACC) of 57.3 + 0.9 cm and 56.3 + 0.8 cm, respectively for green turtles; and 40.2 + 2.4 cm and 36.0 + 2.2 cm for hawksbills. The catch per unit effort (CPUE) of sea turtles varied significantly between seasons with a CPUE of 1.94 + 1.59 turtles / (km.12h) in winter, 1.14 + 0.52 turtles / (km.12h) in autumn, 0.89 + 0.73 turtles / (km.12h) in spring, and 0.46 + 0.05 turtles / (km.12h) in summer. These results indicate that Sechura Bay is an important foraging area and developmental habitat for juvenile and sub-adult green turtles and also an important foraging site for hawksbill turtles. The development of monitoring programs, local awareness-raising, and enhanced management and protection of this critical area foraging and developmental habitat is recommended.

THE BLACK SEA TURTLE (*CHELONIA MYDAS AGASSIZII*) AT LOBOS DE TIERRA ISLAND, NORTHERN PERÚ: HIGH DENSITIES IN SMALL AREAS

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Preliminary findings regarding black turtle (*Chelonia mydas agassizii*) occurrence in Lobos de Tierra Island, Northern Perú showed that black turtles are highly aggregated in the east coast of the island. Black sea turtle mean CCL for live individuals was 55.4±5.8 (range: 43.8−73.8 cm; N=97); for dead ones was 59.5±7.5 (range: 26−74.4 cm; N=103); and the overall mean CCL was 57.5±7 (range: 26−74.4 cm; N=199). A very high percentage 95% (N=189) were considered juveniles, CCL: 56.7±6.4 (range: 26−68.8 cm) and 5% (N=10) as sub-adults, CCL: 71.6±1.6 (69−74.4 cm), no adults were registered. The total mean sighting index (N° sightings/0.5 h) was 114.7±165 (range: 0−545; N=12). The total sighted area of the 12 locations was 0.065 km2. The mean N° of turtles per sighted area was 11.7±15.1 (range: 46.1−0). An overall total density of 180.4 turtles / km2 was calculated considering the 12 spots together. The highest densities were founded found in sandy bays and inlets located in the southeast, like El Ñopo, Bahia Grande and some other nameless inlets. Inshore densities in shallow waters (<1.5 m) were almost one order of magnitude greater than offshore at ~1.5 km. In addition, based on structured qualitative interviews with fishermen, sea turtle capture and consumption still exists in the island, though occasional and sporadic. Jellyfish (*Chrysaora plocamia*) and green algae (*Ulva* sp.) consumption plays an important role in black turtle aggregations in the island, where densities are quite high compared to other feeding grounds elsewhere. We conclude that

Lobos de Tierra constitutes an important Peruvian feeding ground, with high black turtle aggregations, close to the northern limit of the cold Humboldt Current.

BLACK TURTLE POPULATION DYNAMICS IN PARACAS, PERU DURING A SIX YEAR IN-WATER MONITORING*

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During a six year (2010-2015) monitoring program, 30 in-water surveys were carried out in "La Aguada" (13°51'S; 76°15'W), an inlet located in the southeastern part of Bahia Paracas, which is located within the cold-water upwelling system in the central Peruvian coast. A net of approximately 1 km length and a mesh size of 60 cm was employed, the parameters analyzed were as follows: length structure, weight, residence time, growth rates and body condition index. A total of 314 black turtles (*Chelonia mydas agassizii*) were captured, with an average of 10.5 individuals per survey (range: 1-49), the mean number of new captures and recaptures was 8.1 and 1.2 turtles respectively, of the total captured individuals 243 were unique individuals, 33 were captured twice and two individuals three times. The total mean recapture date was 11.2%, the mean recapture interval was 204.1 days (range: 29-708, N=35). In addition, one olive ridley (*Lepidochelys olivacea*) and one loggerhead (*Caretta caretta*) were captured as well. The mean size was 58.5±8 cm CCL (range: 40.9-84.5) and the mean weight was 27.7±12 kg (range: 7.2-96), from those 88.9% (N=279) were juveniles (<69 cm CCL); 11.1% (N=35) were sub-adults (≤69 and <85 cm CCL) and no adults (≥85 cm CCL) were reported. The mean size for juveniles was 56.4±5.8 (range: 40.9-68.6) and for sub-adults was 74.4±4.3 (range: 69-84.5). From 35 recapture individuals, 32 juveniles and 3 sub-adults, we used 20 records with recapture intervals equal or higher than 170 days, the mean growth rate was estimated at 7.3±2.4 cm year-1 (range: 2-10.8), this is the highest growth rates reported for this species in the whole Pacific Ocean. Regarding the Body condition index (BCI) the total mean for the six years was 1.52±0.06, with highest values in juveniles (1.52) compared to sub-adults (1.46), the lowest BCI exhibited per year and stage was for sub-adults in 2015 (1.40) and the highest for juveniles in 2013 (1.64). The total BCI increase gradually from 2010 up to 2013 then a decrease was reported in 2014-2015, even though the values reported here are the highest in the East Pacific. The mean size of turtles in the Paracas temperate feeding ground is among the smallest. It is known that green turtles grow faster at smaller sizes. In addition, turtles in temperate waters grows faster than their tropical counterparts. Moreover, great abundance of food may be conductive to faster growth and health, this is exemplified with the high jellyfish (*Chrysaora plocamia*) abundances reported (27.1±27.2 kg jellyfish/100m/hour; range: 0.5-84.6 Kg, N=16) in the area. This jellyfish is one of the main black turtle diet items in the area (FO=70%). We hypothesize that a synergy of small size ranges, low temperatures and high prey availability ended up in a healthy population in the area.

ILEGAL CAPTURES OF SEA TURTLES AND BLACK MARKET USING INFORMATION FROM DUMPSITES AND STRANDINGS IN SAN ANDRES, PISCO, PERU*

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San Andrés, is a fishing village located in central-southern Peru (13°44´S; 76°13´W), is close to an important feeding ground for the endangered black sea turtles *Chelonia mydas agassizii*, 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 (97.3%) and strandings (2.7%) during a biweekly sampling in a five-year period (2009-2014). For each carapace, we determine the species and recorded date, Curved carapace length (CCL), Decomposition stage, and interaction if possible. Moreover, evidence of the demand for different sea turtle products, their illegal commerce and consumption was reported. A total of 953 carapaces were reported, from those: 92.2% (N=898) were black turtles (*Chelonia mydas agassizii);* 4.3% (N=41) were olive ridleys (*Lepidochelys olivacea*); 1.4% (N=13) were leatherbacks (*Dermochelys coriacea*) and 0.1% (N=1) was a hawksbill (*Eretmochelys imbricata*). Regarding sizes, mean black turtle size was 59.2 ± 9.5 cm CCL (range: 34.2-90.9, N=610); olive ridley mean was 60.4 cm CCL (range: 39.6-69.7, N=38); leatherbacks mean 113.0 cm CCL (range: 80-135, N=10). Regarding blacks, 83% were juveniles, 15.4% sub-adults and only 1.6 % adults; from olive ridleys, 84.2% were juveniles and 15.8% adults, finally 70% of the leatherbacks were juveniles, 30% sub-adults and there were no adults. All the carapaces found on the dump sites corresponded to turtles used for meat, sea turtle meat was observed being sold in the Pisco and Chincha market at a price between 7 and 10 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 when the artisanal fisheries diminish. On the other hand, and complementary, when the captures of Eastern Pacific Bonito (*Sarda sarda chilensis*) and flying fish eggs (*Cypselurus sp.*) increases the pressure on sea turtles diminishes. The lack of effective control and management measures and also the poverty in the area influence fisherman to take turtles not only for subsistence but also for trade. The presented information should be used to improve management measures and effective control that should be linked with the government scale, in order to better succeed in the proper conservation off this endangered species.

LEATHERBACK (*DERMOCHELYS CORIACEA*) NESTING TREND ON THE VERACRUZ BEACH ON THE RÍO ESCALANTE CHACOCENTE WILDLIFE REFUGE, NICARAGUA BETWEEN 2002 – 2014

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Veracruz de Acayo beach, in the Rio Escalante - Chacocente Wildlife Refuge, is one of the three most important leatherback (*Dermochelys coriacea*) nesting beaches on the Pacific coast of Nicaragua. Since 2002 we have been conducting a monitoring and conservation project at Veracruz focusing specially on this species of sea turtle. The project was developed in response to the critical condition of this turtle's population in the region, as well as the intense egg poaching pressure existing in Nicaragua. During each nesting season a team made of ten community assistants (many of them ex-poachers) and a biologist, carry out night patrols; gather morphometric data and tag females using PITs. The nests are relocated and protected in hatcheries until they hatch, and then the hatchlings are released immediately; subsequently the remainder of each clutch is excavated. Between 2002 and 2014, we have recorded 340 nests and have protected 93.5% of them (89.7% in hatchery and 3.8% in situ). In this same period, we have tagged 45 individual females, from which 44% nested in at least two different seasons. The number of nests per season shows a downward trend in the same time span. However, as a sign of hope, during the 2014-2015 season the number of nests increased up to 23, after five seasons with less than 20 nests per year. This recovery, although generating optimism, cannot be interpreted as evidence of a reversal in the downward trend of previous years. The project has demonstrated efficacy in reducing egg poaching, however other threats could impact leatherbacks in Veracruz if further conservation actions are not taken. Among these emerging threats, we notice the establishment of tourism- focused coastal developments that do not comply with the requirements of existing management plans. In addition, climatic factors, such as high temperatures and drought, reduce hatch success and therefore the capacity of this rookery to recover. This presentation aims to describe results of 13 years of monitoring and protection in Veracruz de Acayo, as well as discuss our perspectives regarding the emergence of new threats and their implications for the future of this species at this key nesting site in Nicaragua.

CONSERVATION PROGRAM OF BLACK TURTLES (*CHELONIA MYDAS AGASSIZII*) IN NORTHERN CHILE: LA PUNTILLA, CHINCHORRO BEACH, ARICA

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Four species of sea turtles inhabit the Chilean coast: *Chelonia mydas agassizii*, *Caretta caretta*, *Dermochelys coracea*, and *Lepidochelys olivacea*, which use this area as a feeding area. The main threats on Chilean sea turtles include industrial and agricultural discharges, destructive practices by the artisanal fisheries, oil pollution from the vessels, habitat destruction and other forms of marine pollution, including trash of prolonged persistence (Eckert. 2000). The Chinchorro beach: Port of Arica is together with other sectors of northern Chile (Chipana Bay: I Region of Tarapaca, the ports of Antofagasta and Mejillones: II Region of Antofagasta and Salado Bay: III Region of Atacama), a feeding ground of *C. mydas agassizii*, being the place with the highest concentration of black turtles in the country. The local populations of these sites have been affected by diverse actions, including incidental capture (Salinas & Sielfeld 2007) and in the particular the case of Playa Chinchorro, the extension of the urban edge to the feeding area, represents an additional factor of danger for the local turtle population. Because of its conservation status (endangered), the lack of biological, demographic and ecological background of the local population of Arica, it was found necessary in 2011, to create a Sea Turtle Conservation Program at Chinchorro Beach, where they meadow green, red and brown algae associated with the mouth of the San Jose River. At the date 112 individuals have been captured and marked (shell length 47 - 108 cm) and a weight between 12-181 kg. Only 2 males were captured, with the remaining all adult females. A third male was photographically recorded in the sector. All specimens were robust, with few epibionts and only 7% of the captured specimens showed injuries. 8 dead specimens were also found. The generated information was delivered to the Regional Sea Turtle Program of Arica, providing background for the protection of the feeding area through a municipal ordinance and a future Marine Reserve.

ARTISANAL FISHERMEN RELEASE SEA TURTLES: AMIGOS DE LA NATURALEZA

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Amigos de la Naturaleza (ADLA) is a NGO comprised of fishermen and scientists from Chiclayo and other parts of Peru. Its main goal is to promote sustainable fishing, focusing the work on decreasing bycatch of endangered species, collaboration with scientific research and promotion of marine conservation within the local society. In the present study, we describe fishery and vessels (members of ADLA and others) and owners who have being working for the conservation of marine turtles. Fishermen have worked with scientists in order to share experiences and learn release methods to avoid mortalities of marine turtles. The gillnet fishery of 27 boats operating during March and October 2015, is described. Twenty-six boats have

caught at least one marine turtle during the study. *Chelonia mydas* was the species with the most catches per unit effort (CPUE) followed by *Caretta caretta* and *Dermochelys coriacea*. Every marine turtle was released alive.

TROPHIC ECOLOGY OF GREEN SEA TURTLES ACROSS THE EASTERN PACIFIC OCEAN: INSIGHTS FROM BULK TISSUE AND COMPOUND SPECIFIC STABLE ISOTOPE ANALYSIS*

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Effective conservation strategies for endangered species must incorporate information about trophic niche width and diet in high-use foraging areas. However, the inherent challenges of directly monitoring these factors call for creative research approaches and innovative application of existing tools. Green sea turtles (*Chelonia mydas*) are present throughout many coastal areas in the eastern Pacific Ocean. Historical paradigms suggest that adult green turtles are obligate herbivores with diets largely consisting of seagrasses and/or marine algae. However, recent empirical diet data (i.e. stomach content analysis) indicate that green turtles in this region opportunistically consume a much broader variety of foods, depending on the particular habitat occupied. Here we use bulk tissue stable-carbon ($\delta13C$) and -nitrogen ($\delta15N$) isotope analysis to describe the trophic status of 815 green turtles distributed among 16 foraging areas from the US to Chile. We combine these data with results from compound-specific isotope analysis of amino acids to decipher the baseline influence on bulk nitrogen values at each site. We found disparate bulk tissue values among sites, with a nearly 12ppt range in mean $\delta15N$ values among sites. Compound specific results indicate some of this variability is due to local baseline differences, influenced by broad-scale nitrogen cycling patterns as well as local-scale anthropogenic nitrogen loading. Nevertheless, that largest portion of the $\delta15N$ variation owes to differences in local diet intake patterns, supporting that green sea turtles are opportunistic omnivores whose diets adapt to local prey bases. This work is the culmination of nearly 20 years of stable isotope research on green turtles in the eastern Pacific Ocean. To our knowledge, this is the largest dataset of stable isotope values ever assembled for any species within a marine region, in this case the eastern

Pacific. Our study underscores the power of broad individual and institutional collaboration across multiple countries to decipher regional ecological trends in protected species; our study will hopefully provide an example for others to follow around the world.

IMPACTS OF EL NIÑO ON THE EARLY LIFE HISTORY OF EASTERN PACIFIC LEATHERBACK TURTLES*

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Here we investigate the early life history of leatherback hatchlings using passive and active Lagrangian particle dynamics within a Regional Ocean Modeling System (ROMS). We hypothesize that the dispersion statistics of eastern Pacific leatherback turtles are strongly sensitive to changes in the eastern pacific El Niño Southern Oscillation (EP-ENSO). During the EP-ENSO, peak positive anomalies in temperature and sea level located along the South America coastline excite large-scale waves that propagate this signal along the coast of North and South America. These coastal waves are thought to be important drivers of the offshore eddy-pathways that facilitate the dispersion of turtles from nesting beaches into the open ocean. With a reduction of this type of EP-ENSO and an increase in the CP-ENSO, which does not excite these coastal waves, the probability of hatchlings being dispersed offshore may decrease significantly and have a negative impact on the overall population. We performed a set of calculations of particle dispersions during strong EP-ENSO periods and during moderate to strong La Niña periods. To diagnose the role of physical circulation in the dispersion statistics, we conducted these simulations without active turtle behaviors. We found that during EP-ENSO periods, particles were less dispersed and more likely to be found in the North (> 10□N). In contrast, during La Niña periods they were more dispersed and more likely to be found to the south (< 5□S). These experiments suggest that in the absence of swimming behavior, turtle trajectories are very sensitive to climate variability. We added active behaviors within the sensitivity experiments to understand how behavioral dynamics influence the turtle trajectories. While the dynamics of swim behavior require further investigation and sensitivity analysis, small behavioral changes may strongly influence hatchling ability to overcome the effects of changing circulation associated with different Pacific climate states.

MOVEMENT PATTERNS OF JUVENIL AND SUB-ADULT HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN MANGROVE ESTUARIES ALONG THE PACIFIC COAST OF EL SALVADOR AND NICARAGUA*

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The hawksbill turtle was considered nearly extirpated in the eastern Pacific Ocean. However, recent efforts have discovered important nesting levels in the region, where the species is strongly associated with estuarine habitats, particularly in El Salvador and Nicaragua. Although the species has been studied worldwide, knowledge on habitat use, development areas and foraging in the eastern Pacific is scarce and mostly focused on satellite telemetry of post-nesting adults to establish migratory routes. The importance of mangroves and estuary habitats to its pre-adult development is still unknown, representing a significant obstacle to coastal conservation programs relevant to the recovery of this species and its habitats. To understand the movement patterns of immature hawksbills in mangrove areas of Bahía de Jiquilisco (Bahía) in El Salvador and Estero Padre Ramos (Padre Ramos) in Nicaragua, we used commercial hand-held GPS devices inside floats, as well as a novel, effective and economical tracking tool based on open-source microprocessors to register GPS locations, store data, send summaries via SMS and maintain battery power with solar panels. We used qGIS for spatial analyses. Mark-recapture, biometry and remote tracking generated information on abundance, size composition and dynamics of displacement in time and space for the first time in these estuaries. From May–December 2014 and August, September and December 2014 in Bahía and Padre Ramos, respectively, we captured a total of 176 different individuals with 52 recaptures, most of which were immature (88.6%), representing the highest number of in-water captures for the species in estuarine habitats of the eastern Pacific. We identified zones with a higher concentration of young turtles, which were primarily in the 40 cm to 60 cm size classes (averages: Bahía LCC 50.9 + 13.1 cm, 41.7 + 10.7 cm, weight 14.9 + 14.1 kg; Padre Ramos LCC 52.9 ± 14.8 cm, ACC 44 ± 11.9 cm, weight 17.8 ± 17.1 kg). Tracks from 12 juveniles exhibited different spatial patterns where trajectories and speeds were correlated with turtles' alignment with the tide direction, moving short distances (0.2–2.0 km), showing a higher speed in the same direction of the tide, moving mostly along the edges of channels, and actively avoiding channel mouths. The high-use of channel edges is a strategy likely employed to facilitate less resistance to currents while swimming, which would also likely save energy during displacement. Within the periods of mark-recapture there was no exchange of turtles between channels. Therefore, the movement of juveniles and sub-adults appears to be restricted, with selection of specific sites and taking advantage of the tide changes for your displacement, probably to benefit their feeding and resting. Based on our findings, hawksbills in

the eastern Pacific not only use the estuaries as nesting habitat but also as developmental habitat for juveniles and sub-adults of the species, where they demonstrate high site fidelity and intra-channel movements that exploit tidal fluctuations. These results provide a valuable baseline on habitat use in these critical developmental environments that should aid regional management and conservation planning at key estuarine sites in the region.

PHYLOGEOGRAPHY OF GREEN TURTLES (*CHELONIA MYDAS*) IN THE PACIFIC: POPULATION STRUCTURE, CONNECTIVITY AND COLONIZATION PATTERNS IN ECUADOREAN POPULATIONS*

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There is a lack of knowledge about green sea turtle genetic composition in foraging and nesting habitats in Ecuadorean territory; however, little importance has been given to *Chelonia mydas* population dynamics in foraging and nesting habitats from Galápagos and mainland Ecuador. In order to ensure Ecuadorean green sea turtle populations viability and migratory individuals on routes protection, it is important to maintain genetic structure research to date and Eastern Pacific MU's delimitations. One step toward this goal is the use of genetic analysis to investigate connectivity and spatial distribution over vast geographic areas. We sequenced 841pb of mtDNA control region of 132 green sea turtle (*Chelonia mydas*) populations from three foraging aggregations (Puerto López-Machalilla, Isla de La Plata and Galápagos) and two rookeries (Machalilla and Isla de la Plata). These sequences with previously reported frequencies and sequences of green turtle mtDNA haplotypes from Galapagos rookeries and four Eastern Pacific MU´s were implemented to i) define Ecuadorean genetic structure and inter-population connectivity between mainland Ecuador coast-Machalilla National Park (MNP) and Galápagos Islands (GPS), and ii) generate a broad scale exploration of Eastern Pacific population structure, phylogeography and historic colonization patterns between Ecuadorean aggregations with previously reported reference haplotypes of foraging and nesting aggregations from the Pacific. Genetic analysis identified 15 previously defined haplotypes found in Ecuador (MNP+GPS) and two new haplotypes to be reported, little significant differentiation found among MNP-GSP rookeries and foraging aggregations. Analysis of Molecular Variance (AMOVA) reported high connectivity between GPS-MNS rookeries and aggregations, which suggest that Ecuadorean rookeries represent a single stock and supports the presence of five different stocks in Central/eastern Pacific. GPS-MNS rookeries and aggregations were characterized by high haplotypic diversity resulting from the presence of individuals from multiple geographic origins. That is, Ecuadorian haplotypes corresponded to

different clades from Eastern Tropical Pacific populations, associated with different time periods of clade formation. So, we suggest that the processes of colonization in the Pacific occurred through different routes (Western Pacific AGE: 0.8460 Mya and Central/eastern Pacific 1.8913Mya). We conclude that *C. mydas* populations from Ecuador represents an important pool of diversity in the Eastern Tropical Pacific therefore highlighting the importance of Ecuadorian populations to maintain the genetic diversity for this group. We recommend further exploration of large-scale phylogenetic studies to improve conservation of key Ecuadorean green sea turtle populations as an important management unit of the Eastern Tropical Pacific.

TAGGING PROGRAM OF OLIVE RIDLEY SEA TURTLE, *LEPIDOCHELYS OLIVACEA*, AT OSTIONAL WILDLIFE REFUGE, COSTA RICA FROM 2009-2015

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During the period from 2009–2015, we studied inter-nesting interval and the post-nesting movements of solitary and arribada nesting Eastern Pacific olive ridley sea turtles, *Lepidochelys olivacea*, in Ostional, Costa Rica using inconel metal tags. During this period, we tagged a total of 10,018 ridley turtles in Ostional, Costa Rica and encountered 637 previously tagged turtles. Of the 637 tagged turtles, 541 were recaptures tagged in Ostional and 96 were tagged on other beaches. Origins of tags included turtles from other nesting beaches such as Nancite, Camaronal, PRETOMA, ASVO, NOAA, and in-water studies, all of which are located on the Eastern Pacific coast of Costa Rica. The mean interesting interval observed was 24.5 days (SD=8.6). We observed a total of 36 females that successfully nested during two consecutive seasons, exhibiting a remigration period of 359.4 days (SD=35.2), which supports previous studies that olive ridleys may nest in consecutive years. We found 166 females nesting solitarily and during arribadas, which suggests that at least part of the Ostional ridley population is capable of nesting in a mixed strategy. In addition, 25 females were observed nesting during at least three different nesting events at Ostional beach, demonstrating high nesting site fidelity among this population. Our findings also revealed that olive ridleys are capable of utilizing different beaches during their nesting period. However, in order to gain more accurate information on the interesting and remigration behaviors of olive ridleys, it is important that tag information is shared more openly amongst sea turtle projects in the Eastern Pacific because with incomplete information, we lack the knowledge to accurately manage the Eastern Pacific olive ridley sea turtle population. Acknowledgements: FW gratefully acknowledges travel support provided through the Symposium Travel Committee.

ESTIMATES OF SEA TURTLE BYCATCH IN CHILEAN SWORDFISH FISHERIES*

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There is great concern over declining populations of sea turtles in the Pacific and the extent to which fishing activities contribute to these continued. In Chile, sea turtle species commonly recorded as bycatch in the swordfish fisheries are loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*) and olive ridley (*Lepidochelys olivacea*). They are listed as vulnerable or endangered species on the 2015 IUCN Red List of Threatened Species (IUCN). Swordfish fisheries included industrial and artisanal longline, gillnets and artisanal espinel. Previous research done from 2001- 2005 revealed a very low mortality of bycatch sea turtle in longline fisheries and suggested potentially reduced harmful effects of this fishery in the future. Here we present information on incidental capture of sea turtles by industrial and artisanal longlines, gillnets and artisanal espinel fisheries targeting swordfish in Chile over an 8-year period (2006-2014). We present sea turtle bycatch relative to fishing effort, catch rate for each fleet and year and compared longline fishing interaction from our study to previous period (2001-2005) as well. A total of 348 turtles were caught during study period by all fleets. Leatherbacks (n = 182) and loggerheads (n = 89) were the most common species captured. Fleets had a different capture rate over the entire study period with 44% of turtles caught in industrial longline, 28% in artisanal espinel, 17% in gillnets and a 11% in artisanal longline. Fishing effort was examined based on the number of fishing trips with scientific observers onboard and changes within each fleet were observed among our study period and the previous one (2001-2005). Whereas a notable reduction in the number of fishing trips was observed in the industrial longline fleet, the number of fishing trips increased in the artisanal longline, espinel and gillnets fleets during our study period compared to 2001-2005. One important aspect to consider when interpreting these results is related to the effective observer coverage of each fleet. While coverage of industrial and longline fleet has been in general very high (>70% of total fishing trips), the monitoring coverage of artisanal espinel and gillnets fleet has been very low (< 3% of total fishing trips). In this sense, the results presented here on sea turtle bycatch in swordfish fisheries in Chile could be well considered as minimum values. It is important to mention that while a decreasing pattern has been observed in the number of industrial and artisanal longline boats from 12 in 2001 to 3 in 2014, the number of artisanal espinel and gillnets boats have remained similar (~90). Given the extent of leatherback and loggerhead bycatch observed in our study, we recommend the adoption and further development of fishing techniques and the improvement of observer coverage to obtain a more comprehensive understanding of the spatial distribution of fishing effort and corresponding sea turtle interactions with this fishery in the region.

Education, Outreach and Advocacy

MIGRATION FESTIVAL: A FESTIVAL TO LEARN TO LIVE IN PEACE WITH NATURE

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The department of Chocó on the Pacific coast of Colombia is rich in biodiversity and natural resources, but for the last two decades, the internal armed conflict and violence have profoundly affected Chocó. This department is inhabited principally by Afro-Colombians (80%), indigenous peoples (10%) and Mestizo communities (10%). Whales, seabirds and sea turtles arrive each year to the Pacific coast of Colombia from July to November. However, the main threat here for sea turtles is nest predation, reaching 100% and the capture of adults in the sea by fishermen throughout the coast, in large part due to lack of environmental awareness and the local belief that marine resources are inexhaustible. Making use of the attractive migratory flagship qualities of species like olive ridley turtles and humpback whales, we captured the attention of children, youths and adults to improve the overall relationship between people and their environment. Therefore, Mano Cambiada (local NGO), in collaboration with others NGOs, like Fundacion Tortugas del Mar, directs resources to support strategies for social cohesion through the realization of the Pacific Migration Festival. The event promotes environmental education and the strengthening of cultural values through music groups, dance, theater, photography, painting and leadership to change the logic of relationship with the natural environment in children and young people. In 2015, more than 600 children and youths participated in the different activities, to learn to live in peace with nature. We consider that continuous interdisciplinary education efforts directed at members of the local community produced greater environmental awareness. Our goal is to progressively increase the number of community members, NGOs, private enterprise and staff of environmental authorities involved in our grassroots conservation project, the Pacific Migration Festival.

USING ONLINE TOOLS TO ASSESS THE LONG-TERM EDUCATIONAL AND BEHAVIORAL IMPACTS OF MARINE TURTLE-BASED ECO-TOURISM*

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Marine turtles have historically contributed to societies through harvests for food, tools, and decorative objects but have recently began to fill other roles benefiting humans through fiscal income and education, through eco-tourism activities. Aside from generating sizeable amounts of gross income, often exceeding those produced from traditional consumptive uses, educational-based uses of marine turtles can also make significant impacts on guests' willingness to conserve these species. While marine turtle-based eco-tourism has existed in Florida for 25 years, no data have been published regarding the long-term educational and behavioral impacts on participants of these activities. Brevard and Indian River Counties, located on the east central coast of Florida, are known primarily for their dense loggerhead (*Caretta caretta*) nesting and

the Archie Carr National Wildlife Refuge (ACNWR), one of the highest density loggerhead nesting beaches in the western hemisphere. The demand for turtle-related educational tourism (i.e. turtle walks) has dramatically increased around the ACNWR (41% increase in attendance from 2001 to 2014) benefiting the local economy, but straining the ability of eco-tourism organizations to both meet demand and comply with management regulations. Although some studies of marine turtle eco-tourism have explored short term impacts of educational tourism activities on guest attitude towards conservation and knowledge level about threats to survival, few studies have examined the long-term impacts. Using an online social surveying tool, we examined the long-term educational and behavioral impacts of marine turtle eco-tourism around the ACNWR. Economic impact surveys were distributed at six turtle walk locations around the ACNWR during the 2014 turtle walk season to determine guests' socio-demographic status and financial contribution to the region. Guests' left their contact information on survey if willing to participate in a follow-up survey. Six months after all turtle walks were completed, 503 guests were emailed online follow-up surveys, with a response rate of 56% (n=283). Results indicated that guests were not only extremely satisfied with their guided tour, but rated themselves as has having an extensive level of knowledge about the impacts to marine turtles, and being extremely concerned about these impacts. Additionally, guests reported having a significant change in their perception of threats marine turtles face, were extremely willing to partake in activities which could help protect marine turtles, and 94% reported changes in their behavior to protect marine turtles after attending a turtle walk. These data can be used to support and enhance current marine turtle-based eco-tourism activities, to improve our understanding of the long-term impacts these educational interactive activities, and can be used to promote the creation of new educational tourism opportunities to meet the demands of the growing eco-tourism market.

LOGGERHEAD MARINELIFE CENTER'S PROJECT SHIELD: GLOBAL PARTNERSHIPS FOR RESPONSIBLE TOURISM

Tommy Cutt and Demi Fox

Loggerhead Marinelife Center, FL, USA

The chance to view sea turtles in their natural habitat is often a once in a lifetime experience. In recent years, as the tourism industry has expanded, so too have the number of people boating, snorkeling, and diving in vital sea turtle habitats. While this increase in human presence can have negative effects on sea turtle populations, it also serves as an opportunity to expand awareness and participation in marine conservation. Loggerhead Marinelife Center (LMC), a non-profit organization in Juno Beach, Florida, has created several Conservation Initiatives. These initiatives allow LMC staff to partner with various organizations around the world and form relationships with stakeholders who utilize the ocean and its resources every day. The fishing, boating, diving, and tourism communities are crucial participants in marine conservation. By placing the necessary knowledge and tools into the hands of people on the ground, we are able to change perceptions, address societal challenges, and work toward a common goal – sea turtle and ecosystem conservation. The most recently developed initiative, Project SHIELD, is a multi-faceted program that provides conservation solutions to areas in need including: fishing piers, marinas, resorts and hotels, beach access points, fishing charter operators, and snorkel and SCUBA operators, as well as pollution prevention projects at various sites. Workshops, educational signage, recycling containers, and hotel rack cards are among the resources offered to LMC's partners. Their businesses are advertised on LMC's website and social media pages, of which more than 30,000 people follow. Additional staff trainings

and replacement supplies are always available to partners. Project SHIELD has provided LMC staff with a platform to reach hundreds of tourists each year. We are able to proactively address potentially harmful wildlife interactions and create lasting lessons of human responsibility for the health of the marine environment. By working collaboratively with the tourism community, we have developed a novel approach to sea turtle conservation and are excited to continue to expand our efforts worldwide.

RESPONSIBLE PIER INITIATIVE: PARTNERING SEA TURTLE ORGANIZATIONS WITH RECREATIONAL ANGLERS

Tommy Cutt and Demi Fox

Loggerhead Marinelife Center, FL, USA

Fishing piers are home to an elevated number of interactions between sea turtles and recreational anglers. To mitigate the effects of incidental capture and entanglements, Loggerhead Marinelife Center (LMC), a non-profit organization in Juno Beach, Florida, implemented the Responsible Pier Initiative (RPI) as a pilot program at the Juno Beach Pier in 2013. The Initiative is designed to provide anglers and pier managers with the appropriate action steps to follow in the event a sea turtle is accidentally hooked on a fishing pier. The RPI consists of the following four components: (1) Educational signage displayed on participating fishing piers (2) First Responder workshops conducted on site for anglers and pier management (3) Underwater cleaning of participating piers and surrounding areas (4) Pollution prevention methods Since its inception, the RPI has expanded to 31 piers in Florida, six piers in Virginia, five piers in Texas, and one pier each in North Carolina and Puerto Rico. LMC staff have conducted 19 First Responder Workshops across the Southeastern United States. The RPI has facilitated the successful rescue of more than 100 reported sea turtles of four different species and the removal of more than 5,000 pounds of debris from areas surrounding the recognized piers. Much of the success of the RPI can be attributed to the establishment of successful partnerships with like-minded organizations, both governmental and NGOs, in targeted areas. For each participating fishing pier, we identify and collaborate with the organization responsible for conducting sea turtle stranding and salvage activities. These partnerships help us gain an understanding of the individual needs and unique challenges presented with each participating fishing pier. By working collaboratively with the recreational fishing community, we are gathering spatial and temporal data on sea turtle interactions, types and severity of injuries, rehabilitation time, and effective methods for education and awareness across large geographical areas. Each pier manager is contacted by LMC staff once a month for a report on sea turtle strandings on their respective piers. Not only is this helping to inform us of sea turtle interactions, it is closing the perceived gap between the fishing community and conservation organizations. With the RPI, both parties are working together toward a common goal.

EDUCATIONAL PROGRAMS AT THE GOLDRING-GUND MARINE BIOLOGY STATIONREY

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The Leatherback Trust (TLT) has been committed to sea turtle conservation since 2000. In 2004, to further strengthen their impact on conservation of the IUCN critically endangered Eastern Pacific population of leatherback sea turtles (*Dermochelys coriacea*), TLT acquired the Goldring-Gund Marine Biology Station in Playa Grande, Guanacaste, Costa Rica. We have now expanded our operation to also include an environmental education component. This includes a course in Tropical Marine Biology for large school groups of 30-80 students between the ages of 11-23. Being housed at the Goldring-Gund Marine Biology Station, students are able to take part in active research projects, share traditional Costa Rican meals and housing with the resident biologists. Upon their arrival, students are immersed in ecological research, being able to explore our neighboring environments through various educational activities. These activities include dry forest ecological hikes, a boat cruise of the Tamarindo Estuary, snorkeling at the neighboring black sand beach and helping biologists measure and monitor the endemic and endangered populations of sea turtles. Additional programs, such as biodiversity laboratories have been added and tailored to fit the needs of the varying age groups. Currently, we host programs to several schools across the United States including Bishop Dwenger High School, Bullis Charter School, Nueva High School, Western Connecticut State University and Western Kentucky University. While the Leatherback Trust is devoted to conservation, we encourage future biologists to conservation in the next generations. We would like to thank Jack W. Schrey Distinguished Professorship, The Leatherback Trust, and Goldring Family Foundation for research support, as well as the Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria, and World Wildlife Fund for support through International Sea Turtle Society travel funds.

BREAKING DOWN BARRIERS – BRINGING TOGETHER COMMUNITIES AND GOVERNMENTAL ORGANISATIONS THROUGH TURTLE CONSERVATION

Neil Richard Davis

Bahari Karuna and Wildseas, Ghana

In Western Ghana, up until recently there has been a severe lack of cooperation, education, or indeed, action to protect sea turtles and their habitats. Bahari Karuna has been working extremely hard over the last four years to bring people closer together with the ultimate goal of protecting the species and environments they rely on for sustenance. Illegal and over fishing, lack of regulations and law enforcement together with a lack of understanding on how ecosystems work has led to the near collapse of many local fisheries and

subsequent unemployment. To combat this, we have held many lengthy discussions with village elders and fishermen, expanded our sea turtle safe release program from one town to five, continued an education program within numerous schools in the Western Region and held art competitions, based on marine conservation in rural coastal communities. Further staff have been employed in villages and towns that we are expanding into and more fishermen than ever before have signed up to the program. A big part of our ethos is the empowering of locals and thankfully we are now able to leave the majority of field work in the hands of our local coordinators and field staff. Along with this we have just held an important workshop with members of the Ghana Wildlife Division, Marine Police and Government Environmental officials in the Capital, Accra. This served to both strengthen the networks among the various government stakeholders and ourselves. There was a general consensus among the attendees that the workshop had been badly needed and that more are required into the future to progress sea turtle conservation along the Ghanaian coast. The Wildlife Division and the Marine Police are now fully committed to helping out wherever possible and have even suggested the desire to establish a rescue centre and also push the use of turtle excluder devices. Despite TED legislation having been passed in 2010 their introduction to trawl fleets across the country is still non-existent and none of the fisherman we spoke to had even heard of a turtle excluder device prior to our meetings. Something we hope to change over the next few seasons.

CONSIDERATIONS ON THE FIRST SEASON OF *CARETTA CARETTA* CONSERVATION PROJECTS IN CAMPOMARINO OF MARUGGIO, TARANTO, ITALY

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The loggerhead of the Mediterranean exhibits limited gene flow with those in the Atlantic and represents a Regional Management Unit for conservation. Italy represents the most western nesting site in the basin and a recent review suggested that nesting in Italy should considered a regular event, rather than just an occasional one. Many potential nesting sites have not been adequately monitored, as demonstrated by the case of Calabria, where the most important nesting area currently known in Italy was only discovered when a proper monitoring programme was launched. In Puglia, there are potentially suitable coasts for sea turtle nesting, and nests have occasionally been reported there by tourists or local people, however the actual nesting level and distribution is not well understood. In 2011 and 2014, two nesting cases were discovered within a 300 m area located along the coastline of Maruggio, (Italy). This area is ecologically significant due to the presence of a dune habitat but it maintains a strong human presence and is subject to constant human disturbance. As a result of the efforts of WWF Taranto, two projects have been funded to raise awareness of the loggerhead nesting sites in Maruggio, and to help educate the local population on how to reduce human pressures and protect the sites. We established the Turtland project to increase awareness and education among students of Maruggio and it involved a total of 245 children. The program included lessons and workshops within the classroom and excursions to the dune habitat. The students were also invited to participate in the monitoring of the beaches and help raise awareness among adults. The Turtle Guardians project enabled for daily beach patrols of the nesting sites to take place. These monitoring events also helped to inform the public and raise awareness among tourists. During the project, seminars for

university students have been made. The seminars provided training on the biology and ecology of sea turtles, the main threats and conservation measures and how to carry out a monitoring program. A total of 107 volunteers were successfully trained and recruited to participate in the beach patrol. The beach patrol was conducted from the beginning of June 2015 through the first week of August 2015. During this period, 10 km of coastline were monitored daily, divided into two transects of 5 km. During the season a potential track was found on a beach and it was reported by a citizen. In the following days, for the possibility of further nesting of the same turtle a few kilometers from the first site, it was decided to increase the daily mileage involving a great deal of human and economic resources. It is necessary to continue the monitoring programme and essential to expand the length of coast monitored in order to better understand the occasional discovery of the sea turtle nests. Turtle Guardians demonstrated an effective tool to connect scientists and students to achieve at different levels education and awareness. Unfortunately, it has also demonstrated how expensive in terms of financial and human resources it is to undertake intensive turtle nest monitoring along the coast of the Ionian Sea. Given the experience this year, it seems important to try to increase the mileage and collaboration with a local university could be a possible starting point. However, the main priority is to achieve a greater information campaign in order to ensure any possible sightings are reported.

SEA TURTLE NESTING BEACH AND TOURIST DESTINATION, WORKING TOGETHER FOR CONSERVATION

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On the coast of Venezuela, the tourist beaches of Puipuy and Siete Mares become, from March to August, the site of the spawning of the leatherback sea turtle (*Dermochelys coriacea*), only in the first locality, and in smaller numbers the loggerhead sea turtle (*Caretta caretta*) and the green sea turtle (*Chelonia mydas*), on both beaches. Puipuy is situated on the northeast of the Paria Peninsula, in Sucre state, and is strongly affected by tourism development and the fishing industry, while Siete Mares is a group of small beaches separated by rocky formations, occasionally visited by illegal hunters or fishermen, in the locality of Osma, Vargas state. The Ecoposadas del Mar are committed to nature conservation and have recently started a sea turtle project, whose chief aim is to encourage conservation of these species and their environment, including environmental education in the study programs of local community schools and in ecotourism, through basic workshops on biology, species identification, ecological roles, population status, threat reduction, and monitoring of sea turtle nesting beaches, among other subjects. These workshops are addressed to teachers, park wardens, turtle conservation activists from other districts, tourism promoters, the mayor´s office, local councils, children and tourists. The program was carried out continuously throughout the nesting season, with the distribution of informative material, presentation of short educational videos and digital information, and with meetings for talks on the biology and conservation of the turtles. Beaches were cleaned and baby turtles freed to the sea. Cultural activities associated with sea turtles were carried out with school children and tourists, such as plays, dances, poetry, songs, poster design

and crafts using waste material, thus encouraging recycling. The work was complemented by night and day patrols to protect the nesting females and their nests on the beaches, and subsequent data collection. Publication on different social networks of the activities of protection during the nesting season, increased the participation of tourists in the work of conservation, promoting sustainable economic development in the community. There was greater community collaboration in night patrols, school tasks and talks. Thirteen schools in both states were initiated in the subject. A working network to protect sea turtles in Vargas State was formalized. A total of more than 600 people were sensitized, 8 volunteers trained, and two people from the Puipuy community and all the staff of the Posada Siete Mares were assimilated into the work of turtle protection, all motivated by the sole purpose of saving sea turtles from extinction, strengthening the sense of belonging and extending the knowledge acquired in the future.

PARTICIPATORY STRATEGIES FOR SEA TURTLE EDUCATION AND OUTREACH IN NORTHERN PERU*

Kerstin Forsberg

Planeta Oceano, Peru

Five species of sea turtles are found in Peru: the leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), green turtle (*Chelonia mydas*), loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*). Threats to these species in the Tumbes and Piura regions (northernmost Peruvian regions) include interaction with incidental and targeted fisheries, carapace ornamental use and increasing perturbation through unregulated tourism, among others. Establishing innovative formal and non-formal education approaches are thus vital to build community engagement and ownership for sea turtle conservation. This presentation describes the community-based educational strategies that Planeta Océano (PO) has carried out since 2007, in order to strengthen marine education among schools and highlight sea turtles as flagship species. These are participatory, game-based, nature-based and science-based innovative strategies that include: (1) Forming a 'Marine Educator's Network' -a collaborative network of over 50 local schools- and building capacity among local teachers, in order to ensure self-sustained outreach and education, (2) Empowering youth-lead community projects focused on sea turtle and environmental conservation, and (3) Developing a game-based education module (PO's 'Ocean Explorers' Program) that can be diffused throughout the regular school curricula. We describe how a wide array of stakeholders (K-12 students, teachers, fishermen, business representatives, media, authorities) have been engaged for these strategies, as well as the key activities, impacts and lessons learnt for each strategy. As a Key Partner of UNESCO's Global Action Programme on Education for Sustainable Development, we will also describe how these actions contribute to global frameworks and strategies. To date, >1500 teachers and >9000 students have been reached. Student and teacher surveys have documented increase in knowledge and awareness regarding sea turtles and marine environments. Youth-lead community initiatives have included student-lead campaigns to reduce sea turtle carapace ornamental use, recognizing and showcasing responsible fishermen and contributing to monitor sea turtle strandings. Local governmental commitment has also been engaged. These education and outreach strategies have thus provided self-sustaining mechanisms that can generate multiplier effects for environmental awareness, supporting the continuous delivery of conservation messages for the long-term. This work thus exemplifies a successful case study and model that can be adapted for sea turtle and biodiversity education in other geographical areas. Furthermore, following an ecosystem-based approach, it highlights the value of developing sea turtle

outreach and awareness as part of broader, marine education, Ocean literacy and Education for Sustainable Development efforts.

RECOVERING PROCESS OF THE MARINE TURTLE, *LEPIDOCHELYS KEMPII* IN TECOLUTLA, VERACRUZ, MEXICO

Irma E. Galvan Tejada and Manuel F. Manzano Cervantes

Vida Milenaria, A.C., Mexico

Tecolutla, is a small place in Veracruz State, Mexico, its population is 7000 habitants. There, marine turtles come to lay their eggs every year, but in 1974 some people realized that turtles didn't come anymore to lay their eggs. So, Fernando Manzano from Tecolutla, got inspired in a documentary of Jacques Cousteau, so he started his recovery work without any knowledge about the *Lepidochelys kempii* species, which is the endemic species from Mexico and the only one in the world that has diurnal habits. Walking more than 30 kms per day, in 1974 Fernando could release 500 turtle hatchlings to the sea (in 2013, more than 84,000 were released), without any help, only his own conscience and his love for nature. Year by year he worked on raising awareness in the population and little by little he developed protection techniques to recover this very endangered species. In 2000, "Vida Milenaria", the non-governmental organization was legally established, to continue working and in the same year the protected area was extended. Thirty-five kilometers of the beach are protected, and during these years people from Tecolutla were trained in this issue: volunteers visit different schools in the coastal community as well as Tecolutla municipality, to raise awareness in the whole community. Many schools from Mexico visit us and we offer them workshops about environmental education and those children take with them the message of taking care of the turtles as well as other species of flora and fauna. After four decades of great effort protecting marine turtles, the objective was reached with a simple formula: inspection + protection + education every single day, "Vida Milenaria", is open to all the people that visit us to take with them the message of protecting this species which is so threatened. In 2013, we released more than 84,000 turtle hatchlings, especially the lora turtle (*Lepidochelys kempii*), as well as the green and white ones (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata*). At the moment, 12 men and women are working together to protect the turtles that are threatened in Tecolutla, Veracruz, Mexico.

GREEN TURTLE RELEASES IN URUGUAYAN COASTS: EDUCATIONAL WORKDAYS

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Karumbé, Montevideo, Uruguay

Since 1999 the Karumbé NGO has been dedicated to the rehabilitation of sea turtles that stranded on the coast of Uruguay. Every year green turtles (*Chelonia mydas*) appear stranded alive with different injuries along the Uruguayan coast. These individuals are brought to the organization's rehabilitation center to

perform the corresponding veterinary procedures. Turtles that succeed in this recovery process are returned to the sea and public releases are held whenever possible. Since 2006 this activity has been developed at various points in the Uruguayan coast in order to inform population about biology, ecology and threats facing green turtles. In addition to that, the importance of the Uruguayan coast as a feeding and developmental area for green turtles in the Southwestern Atlantic is shown to the local community and tourists. These activities consisted of exhibitions and talks on the biology and issues affecting marine turtles, their conservation, marine debris collection from the beach and lastly, prior to liberation, songs and games with children and adults present. Through education and outreach activities year after year we managed to inform and raise awareness among a large number of people who lacked knowledge about the presence of marine turtles in Uruguayan waters and even more of the problems these turtles are facing. Our idea is to continue with these activities in the coming years and reach more and more public in Uruguay.

COLLABORATIVE PARTNERSHIPS FOR SEA TURTLE CONSERVATION IN THE TURKS AND CAICOS ISLANDS

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The Turks and Caicos Islands Turtle Project (TCITP) has been operating since 2008 and has achieved great success through its collaborative, multi-disciplinary approach to sea turtle conservation. Through multiple stakeholder engagement, the TCITP is working towards increased community stewardship of sea turtles and their environment in the TCI. The project is a collaboration between the the TCI Government, the Marine Conservation Society (MCS), the University of Exeter, Duke University, local fishers, the Amanyara resort, the School for Field Studies, watersports companies, and local volunteers. This broad range of stakeholder involvement in sea turtle conservation ensures that all sectors of the community are reached, including fishers, local residents, expatriates and visitors to the TCI. TCITP biological research includes an extensive mark-recapture study throughout the archipelago, satellite tagging of sub-adult and adult sea turtles, and genetic research with both green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) sea turtles. The most successful project collaboration with a private-sector partner is with Amanyara, an exclusive resort in the TCI. Resort guests who opt to participate in the Amanyara Sea Turtle Initiative are taken out with local sea turtle fishers and given the opportunity to catch, flipper tag and release green and hawksbill sea turtles in their foraging grounds. This collaboration with a luxury resort has proved beneficial in a number of ways: scientific data at turtle foraging sites is collected during the trips run by Amanyara staff, who engage a broader range of stakeholders with the project and sea turtle conservation in the TCI. In turn, Amanyara is able to offer a unique opportunity to their guests, allowing them to participate in research on a local and international scale, while also interacting with local fishers and gaining a deeper insight and understanding into life in the TCI. Participation in one-day tagging trips inspired a deeper interest in the project in some cases, with guests choosing to become more involved by sponsoring satellite transmitters. Since these trips began in 2012, Amanyara has run more than 60 flipper tagging trips, involving 200 guests and has flipper-tagged over 250 turtles. In addition, seven satellite transmitters supported by the Amanyara Sea Turtle Initiative and guests of the resort have been deployed, contributing

important information regarding the migration patterns of sub-adult green turtles in and around the TCI. The local sea turtle fishers involved with the trips have generated significant income as an alternative to that generated from fishing as a result of the initiative. Developing relationships that both engage and benefit the local fishing community is an important component of the Amanyara Sea Turtle Initiative. The multi-stakeholder approach that the TCITP has developed along with the Amanyara Sea Turtle Initiative has potential to be applied to other islands in the TCI and further afield. Involvement in this project provides an alternative source of income for fishers through the non-consumptive use of sea turtles, which has potential positive impacts on the legal sea turtle fishery in the TCI. Beyond local relationships, community involvement and beneficial data contributions used to guide regulatory changes, the TCITP has also generated positive publicity in the TCI and abroad through media exposure and live tracking of tagged turtles.

HPA/NOAA: A SUCCESSFUL COLLABORATIVE MARINE TURTLE PROGRAM SPANNING TWENTY-NINE YEARS

Laura Jim, Anna Sorensen, and Julia Ann Salvador

Hawai'i Preparatory Academy, Kamuela, Hawai'i, USA

In 1987, students from the Hawai'i Preparatory Academy (HPA) joined George Balazs of the National Oceanic and Atmospheric Administration (NOAA) at Kiholo Bay on Hawai'i Island for the inaugural trip to ocean-capture, measure, and tag green turtles (honu). This trip was the launch of a very successful cooperative relationship between a secondary educational institution and a formal government agency that has spanned 29 years with positive impacts on the honu and people in Hawai'i and around the Pacific. The work has been conducted primarily on the west coast of Hawai'i Island with approximately 2200 HPA students participating. There have been 249 tagging trips on the island with over 3900 honu captured and released. In addition to flipper tagging, numerous ARGOS satellite tags and time-depth recorders have been deployed. Other ocean-capture tagging events have occurred on the other Hawaiian Islands. HPA students and teachers have volunteered to educate the public at community events. Additionally, HPA has run a turtle stranding rescue program for the west side of Hawai'i Island for over 15 years, assisting sick or injured turtles and collecting dead turtles for necropsy by NOAA scientists. In addition to efforts in the State of Hawai'i, the program has worked internationally, including New Caledonia, Japan, Rose Atoll, Midway Atoll, etc. During these trips, HPA students and educators have assisted NOAA scientists and cooperating research organizations in the deployment of over 300 satellite tags on juvenile and sub-adult sea turtles. Thirteen HPA students have completed independent projects and presented them at annual International Sea Turtle Symposia. The students of HPA have benefited by participating in applied science in action with a number of experts from around the world. The scientific results coming from the HPA/NOAA program have resulted in 75 publications and reports and a website highlighting program accomplishments (www.hpa.edu/turtle). The robust population return of the honu in the Hawaiian Islands can be partially attributed to the HPA/NOAA program and its efforts to enhance scientific knowledge about the honu. For many students, their career paths and subsequent contributions towards science and conservation have been influenced by their experiences working with Hawaiian sea turtles. Why has this cooperative program continued to grow and thrive over the last three decades? People make partnerships and throughout the 29 years the program has involved two essential members, NOAA scientist George Balazs and HPA educator and scientist Marc Rice. While these two leaders will accept little praise, their

achievements towards sustaining the honu and educating the people of Hawai'i and the world are examples of effective cooperation that can be applied to any initiative. Both leaders have enlisted the support of their institutions, networked with researchers, stayed relevant and innovative in the area of technology, and recognized then harnessed the energy, enthusiasm and potential of student scientists. It is our belief that cooperative projects will be successful if they have appropriate needs, effective leaders, and support from their respective institutions and the community.

INTERINSTITUTIONAL PARTNERSHIPS FORMED FOR SEA TURTLE'S CONSERVATION IN CEARÁ STATE, BRAZIL

Eduardo H.S.M. Lima and Maria Thereza D. Melo

Fundação Pró-TAMAR, Brazil

In recent years, Projeto TAMAR has defined priority regions in 8.000 Km of Brazilian coast for a sea turtle protection and monitoring program in feeding and nesting areas, developing different activities and campaigns with the central theme in conservation involving communities and society as well. In addition, TAMAR supports external initiative with partners potentially interested in contributing to the protection of sea turtles in not monitored areas, but that present significant occurrences. Since 1993, Projeto TAMAR has a Protection and Research Station in Almofala, a small village in the West Coast of Ceará State, to protect sea turtles in this important feeding and development area. This Station operates in six fishing communities that extend over 40Km of coastline, where there are five species of sea turtles that can be captured incidentally in local fisheries. In the remaining 520Km of coastline there is no effective project performance. In the year of 2014, the Station of Projeto TAMAR based in Almofala, Ceará, started a Lecture Series with discussions whose main theme is Sea Turtle's Conservation and the challenges to be faced. Questions as Incidental fishing, situation of Sea turtle's occurring areas, Review of species records and Exchange of experiences are discussed in such debates. In parallel, there are some courses to the participating groups directed to procedures for rescue of stranded animals and necropsies to identify the cause of death of the rescued individuals that did not survived. The guests groups also conduct explanations about activities and future claims. At this time, there were three Lecture Series with six Debates and two Classes of Sea Turtle's Rescue and Necropsies with 81 attending persons from different institutions such as universities, environmental departments of the state and city, non-governmental organizations and environmental police. The results so far are encouraging since we have formed stimulated and interested partners to collect standardized information, following the same procedures and presenting progress in activities, which reverts to the best conservation of Sea turtles in Ceará's Coast. Projeto TAMAR, a conservation program of the Brazilian Ministry of the Environment, is affiliated with the Chico Mendes Institute for Biodiversity Conservation (ICMBio), is comanaged by Fundacão Pro´-TAMAR, and officially sponsored by Petrobras.

"NETS CATCH MORE THAN JUST FISH" – THEATER AS A TOOL TO INVOLVE FISHERMEN IN SEA TURTLE CONSERVATION IN ALMOFALA, CEARÁ, BRAZIL

Eduardo H.S.M. Lima and Maria Thereza D. Melo

Fundação Pró-TAMAR/Brazil

The Projeto TAMAR station at Almofala, on the western coast of the State of Ceará, northeastern Brazil, was established in 1993 to protect sea turtles in feeding areas. Prior to the establishment of the station, all sea turtles captured in fish weirs (in Portuguese: "currais de pesca"), a regional fishing method developed by the Tremembé indigenous community, were killed and their meat and other parts were sold locally. Some of the station's first actions were environmental education activities in local schools, the development of conservation-related income-generating activities for local communities, and the campaign "Nets catch more than just fish" ("Nem tudo o que cai na rede é peixe"), focused on the involvement of fishermen in the protection of sea turtles. The campaign comprises discussions with fishermen about problems observed in the local artisanal fisheries and possible solutions, watching movies about environmentally responsible fishing, breakfasts with the fishermen titled "Coffee with the turtles" ("Café com as tartarugas"), the release into the sea of rehabilitated turtles that had been rescued by the local fishermen, and talks about sea turtle biology and conservation. In 2014, TAMAR created a theater play that teaches fishermen some procedures to rehabilitate sea turtles incidentally caught in fish weirs. Up to October 2015, the play has been staged eight times to 392 fishermen who currently support the sea turtle conservation work carried out by TAMAR. The play has been a hit with the local fishing community, since the rehabilitation procedures and other conservation information are presented in an amusing and entertaining manner. The play provides the fishermen with an opportunity to understand that it is indeed possible to save turtles that have been incidentally caught by their fishing gear, and represents a significant tool to reduce the impact that the local fisheries cause on the sea turtles that feed and rest at Almofala. Projeto TAMAR, a conservation program of the Brazilian Ministry of the Environment, is affiliated with the Chico Mendes Institute for Biodiversity Conservation (ICMBio), is comanaged by Fundacão Pro´-TAMAR, and officially sponsored by Petrobras.

SOLICITING CITIZEN REPORTS OF SEA TURTLE SIGHTINGS TO IMPROVE UNDERSTANDING OF SEA TURTLE PRESENCE OFF OF THE U.S. WEST COAST

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Understanding sea turtle presence and distribution in coastal and offshore waters is often difficult due to resources and time associated with conducting dedicated surveys in an extensive spatial scale. Based on seasonal monitoring efforts, strandings, and reported sightings, sea turtles have been documented along the U.S. West Coast year-round, but our understanding of their presence and potential drivers for seasonal shifts in distribution are less understood. To improve our knowledge of sea turtle presence in near and offshore waters, in late 2013 we reached out to local communities, soliciting citizen reports of sea turtle sightings.

The response has been overwhelmingly positive over the past 2 years. Data collected to date have come from recreational swimmers, snorkelers, SCUBA divers, boaters, sport and commercial fishermen, and scientists participating in research cruises. Virtually all accounts were from respondents that were undertaking non-turtle related activities. The level of data reported varies, but typically includes the date, species identification, latitude/longitude or general location, size, general description of the turtle and activity, and sometimes, visual information such as photographs and videos. Data are submitted via email to a dedicated address SWFSC.turtle-sightings@noaa.gov and recorded in a dedicated database. Upon entry, data are validated, often through reaching out to the original respondent to solicit additional details of the sighting. Since October 2013 we have documented over 250 sea turtle sightings in near and offshore waters along the California coast; the majority of reports were of loggerhead turtles in Southern California. We believe this is due to elevated sea surface temperatures / El Niño conditions that provide a suitable habitat for loggerheads in the Southern California Bight. Awareness of our desire to document sea turtle presence has also increased from education and outreach efforts aimed at the recreational water user community. The data collected so far have been useful to guide aerial surveys and in-water capture of loggerheads in the Southern California Bight. These citizen-reported data will also add value to a variety of sea turtle management decisions. Future steps include enhancing outreach efforts and the possible development of a sighting reporting app. The information gained and collaborations that have blossomed show that engaging the public in data collection can help improve our understanding of sea turtles along the coast.

FROM NULL TO FULL PROTECTION - CHALLENGES AND OPPORTUNITIES IN IMPLEMENTING NEW LEGISLATION IN WESTERN AFRICA*

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São Tomé and Príncipe is a breeding place for four of the seven known species of marine turtles in the world, including the most important nesting population of the critically endangered Eastern Atlantic hawksbill. In a country characterized by poverty and high unemployment rates, sea turtle exploitation and trade of turtle derived products (meat, eggs and tortoiseshell) are traditional practices that represent an important source of income to the local population. The NGO Marapa has been running Program "Tatô" (local name given to the Olive Ridley sea turtle) since 2003, and is dedicated to the protection, conservation and research of the sea turtle populations occurring in São Tomé and Príncipe. The program has been leading awareness and conservation activities since then, being partially successful in halting sea turtle harvesting and nest loss due to anthropogenic threats on 15 km of nesting beaches. However, without adequate legal framework, mortality rates ranged from 67 - 89% of nesting females each year. Intense campaigning and negotiation with the São Tomé and Príncipe government for nearly a decade finally gave rise to the first legislation for the full protection of sea turtles in São Tomé in June 2014. This has posed new challenges and problems to the NGO that partnered with the Portuguese NGO ATM in order to strengthen its conservation and research program, and develop an intense public outreach campaign and environmental education program. With novel approaches and a solid participatory approach to law

implementation, the NGOs present the results and shares their experiences of the first two years of new protective framework.

AN OVERVIEW ON THE FIRST 20 YEARS OF LAMPEDUSA SEA TURTLE RESCUE CENTRE ACTIVITIES

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Lampedusa Sea Turtle Rescue Centre, Sicily, Italy

Lampedusa, thanks to its strategic location, separates the Western portion of the Mediterranean Sea from the East one, and the Northern part from the Southern one: the role of this small platform in the middle of the sea has motivated the activities of the 25-years Sea Turtle Conservation Project in collaboration with WWF Italy and various universities. The main interest of the project has been fishermen sensitization, mainly from trawlers and longlines, which often use Lampedusa's harbour. The great number of turtles delivered every year represents the result of this continuous sensibilization effort carried out by thousands of volunteers. In few years, the rescue centre has been established, a facility where to check and take care of recovered turtles. Between 1996 and 2015, in the hospital over 5500 turtles were admitted to the rescue center, and more than 2500 surgeries were carried by the vet team. We compare the different activities carried out by the rescue centre and the practical results obtained: new surgical techniques were carried out, and better care and convalescence technique were developed, moreover different researches were carried out by Biology and Veterinary graduate and PhD students, leading to several published papers. Since 2009 vet seminars were planned, developing a close cooperation between the Mediterranean rehab centres and associations. This collaboration allowed planning a project, funded by the European Community, for training young vets, in order to standardize medical management for emergencies and treatments of sea turtles. Since 2010, with the precious support of the Mediterranean colleagues, the rescue centre coordinates the Medicine and Health Workshops during ISTS Annual Symposia, expanding the rescue centres network. This can be considered an opportunity for conservation, thanks to awareness and research activities. The effort of hundreds of volunteers represents the great and precious added value, making the difference! Marine turtles cross the borders, as a way of communication that combines incredibly. Sea turtles become the reason for people joining Lampedusa rehab efforts, coming from different countries and making relations. All around the rescue centre people work to make the world a little better than they found it, and with passion and interest they are sure that one more turtle in the sea is one more hopeful future of peace!

PROTECTING THE GREEN SEA TURTLE (*CHELONIA MYDAS*) THROUGH ENVIRONMENTAL EDUCATION IN A PUBLIC SITE ON SANTA CRUZ - GALAPAGOS ISLANDS)

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The Galapagos Islands are recognized as one of the most important nesting sites of the green sea turtle (*C. mydas*) in the eastern Pacific. The Galapagos National Park (GNP) and the Charles Darwin Foundation (CDF) have made efforts for the conservation of the green sea turtle through their monitoring program at the most important nesting sites: Quinta Playa and Bahia Barahona, located south of Isabela and Las Bachas on Santa Cruz Island. However, it is fundamental to involve the local community in the protection of this emblematic species through environmental education programs that raise awareness on the efforts made to protect this species worldwide. In addition, environmental education is an important tool for the conservation of the species, since it enables the expansion of knowledge about animal ecology and also promotes favorable attitudes towards environmental conservation actions. Although the GNP and Marine Reserve have protected the Galapagos green sea turtles, several threats remain important to acknowledge. Wild cats regularly frequent nesting beaches to feed on hatchlings. In addition, activities such as tourism, traffic and fishing vessels on important foraging and nesting sites post a threat to this particular species. In 2013, the GNP and Charles Darwin Foundation (CDF) together with Ecology Project International (EPI), through its Ecology Club Mola Mola, conducted for the first time an environmental education program to protect green sea turtles (*C. mydas*) on a public site (Tortuga Bay) located on Santa Cruz Island. The aim of this program was to promote local community participation on conservation efforts, particularly concerning green sea turtle nest protection, through an environmental education program. The green sea turtle environmental program raised awareness on green sea turtle conservation with a total of 14 local students in 2014 and 33 in 2015. In 2014, a total of 52 nests were identified, of the total number of nest identified 23% (n=18) were reach by the tide and 5% (n=4) showed signs of human disturbance. In 2015, a total of 46 nests were identified, 81% (n=35) of the nests were reach by the tide, 14% (n=6) presented signs of feral cats and 5% showed signs of ants around the nest. In addition to the nest identification activity, clean ups were carried out along the beach. A total of 68% of the garbage collected was plastics sized less than 2.5 cm in diameter, 18% was plastic lids and 9% was fishing materials such as pieces of string and nylon; the remaining percentage was personal hygiene, clothing, paper, metal and cigarette butts. Tortuga Bay is still an important public nesting site for the green sea turtle. Therefore, it is important to protect this site from human disturbance and raise local awareness of the importance of Tortuga Bay for nesting green sea turtles. Acknowledgements: I wish to thank Ecology Project International, Galapagos National Park, Charles Darwin Foundation, US. Fish and Wildlife Service, Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesquería and World Wildlife Fund, which contributed in some way to my participation in the symposium through travel grants.

ECOMUSEUM: VISITOR CENTER FOR SEA TURTLE CONSERVATION IN EQUATORIAL GUINEA

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The Ecomuseum has a key role in outreach and environmental education for the TOMAGE Project (Sea turtles of Equatorial Guinea) of Equatorial Guinea's Institute for Forestry Development and Protected Area Management (INDEFOR). It was installed with local support in 2009 in Tika, a coastal community in the Rio Campo Natural Reserve. The Ecomuseum was decorated with panels and information about sea turtle biology, threats and conservation efforts. There is also a taxonomic collection of carapaces and bone parts of the four sea turtle species that occur in the region. As part of the education program, there are murals representing the sea turtle life cycle, and life size paintings of the four species encountered in the region. Near the museum is a hatchery, used to protect relocated sea turtle nests, and as a tool for environmental education and awareness-raising, illustrating information on the sea turtle life cycle and the possible threats to eggs and hatchlings. During the past six years, the Ecomuseum was visited by the local population and tourists - national and foreign, of more than 30 nationalities - that visit Tika as a weekend getaway destination. During the nesting season the visitors find project staff providing explanations about sea turtle biology and TOMAGE's project activities. Tourists and locals are involved in numerous activities such as: sea turtle hatchling releases, night monitoring walks and morning beach surveys. In addition, the local children and adult villagers often frequent the Ecomuseum as a meeting place and for educational or recreational activities. We also promote beach cleaning as a way to raise awareness of the pollution issue on Equatorial Guinea's beaches. Rising ecotourism development in Equatorial Guinea highlights the importance of the Tika Ecomuseum as an environmental education and conservation center.

EFFORTS OF ACOREMA FOR THE CONSERVATION OF SEA TURTLES AT THE PISCO AREA, SOUTHERN PERU

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Currently, five sea turtle species are reported from the Pisco area, southern Peru: *Dermochelys coriacea, Lepidochelys olivacea, Chelonia mydas, Eretmochelys imbricata and Caretta caretta*. Main threats to these species include direct capture, bycatch, trade of meat and other products, and habitat degradation. Historically, San Andrés port (13°43'S) accounts for the highest sea turtle captures along the Peruvian coast, reported since the late 1970s. Studies by ACOREMA between July 1999 and June 2000 estimated that 202 sea turtles were taken at San Andrés, while for the same locality IMARPE reported finding more

than 600 sea turtle carapaces between November 2009 and March 2013. Previous conservation efforts involved monitoring of fishing activity, awareness raising actions with several publics, including control operations at local markets and restaurants. Recently, however, new places for disposal of sea turtle remains and confirmation of the continued trade of turtle meat at some restaurants pointed to the need for a longer-term effort. Since 2011, ACOREMA has been working on specific actions towards sea turtle conservation directed to key actors, such as the fishermen; some of them already provided information about new sea turtle remains disposal sites, and participated in inspections carried out by city authorities. Sea turtle conservation work is also underway together with the three marine reserves with territory in the Ica region. The work comprises research and monitoring of fishing activities and their interaction with sea turtles, training of both volunteer and official rangers, and strengthening of education and awareness activities to diverse publics. An important component is the inclusion of children from the San Andrés coastal community in the awareness activities, as they usually help their fisher parents and relatives at the port. Thus, since 2011 a workshop including sea turtle conservation has been implemented for children whose parents are fishermen or work at the fishing market of San Andrés. Lectures, games and educational materials have been designed to be used by the children during these workshops that covers sea turtle biology, ecology and threats, and reached already 200 children. In total, an estimate 15,000 people have been sensitized through a wide range of activities: workshops, lectures, puppet shows, parades, public exhibitions, videos presented at public plazas, etc. Among the impacted publics are students and teachers from 11 local schools. The environmental education and awareness raising program of ACOREMA seeks to establish a sustainable experience where the target publics become aware of the values of sea turtles and the need to conserve these species as important elements of this particularly reach marine ecosystem. Environmental education activities detailed in this work and made by ACOREMA have been conducted with the support of Sphenisco (Germany).

LINKING COMMUNITY OUTREACH AND LEATHERBACK CONSERVATION: LEARNING FROM ABUN DISTRICT, WEST PAPUA, INDONESIA*

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Jamursba Medi (JM) and Wermon beaches support 75% of leatherback nesting in western Pacific region annually. Leatherbacks are no longer exploited in JM and Wermon, but low hatchling output has considerably impeded the recovery of this population. Local communities, of Saubeba, Warmandi, Wau, and Weyaf living near these nesting beaches, legally own the beach, and the persistence and success of conservation and management measures to reverse declines ultimately lies in gaining support from these communities. Our community program aims to promote effective and sustainable leatherback conservation efforts in the Bird's Head region through comprehensive and sustained engagement with local stakeholders. In particular, we strengthen conservation efforts by empowering and building the capacity of communities living near critical leatherback nesting habitats. In exchange for building their capacities, the communities

would increase their support and participation in leatherback conservation. In a socioeconomic survey in 2010 community members indicated better education and agricultural extension workers as two things that will improve their life. In this we saw an opportunity to change community's perception and promote community-supported marine turtle conservation. In 2013, we placed two community workers in Saubeba village for six months, focusing on two areas: agriculture and elementary education. We expanded our effort in 2014 by placing more workers in the three others villages. In 2014, our community workers lived and worked alongside the communities for 10 months. During these ten months, they lead activities that build community members capacities in these areas: agriculture, animal husbandry, economy, education, and environment. Over the years, we have seen the livelihood and quality of life of community members improving, and the relationship between our conservation program the communities strengthening. Implementation of better vegetable and chicken farming techniques, better bookkeeping, and improvements in reading, writing, and math skills showed we are succeeding in building their capacities. Gaining more support from the communities to leatherback conservation in exchange to the capacity building we provided remains challenging. Hence, a holistic strategy needs to be developed to ensure the sustainability of leatherback conservation effort in the long-term.

CREATIVE METHODOLOGY FOR ENVIRONMENTAL EDUCATION RELATED TO THE CONSERVATION OF SEA TURTLES

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In many places around the world, where sea turtles share their habitats with people, conservation programs cannot be successfully implemented without the involvement and awareness of local communities. Even though environmental education plays a key role in shaping attitudes and consciousness, it is also greatly undermine. Ecuador is home to four species of sea turtles. Machalilla National Park in the central coast has been identified as the most important nesting and aggregation area for black sea turtles (*Chelonia mydas*) and hawksbills (*Eretmochelys imbricata*) in continental Ecuador, and one of the most important areas for hawksbills in the Eastern Pacific. Despite being protected within the national park, sea turtles continuously face numerous threats as the human population is unaware of the importance of these species with which they share their home. In response to this we aimed to develop an environmental education initiative that would provide children with an opportunity to gain knowledge of the importance of marine ecosystems through a multidisciplinary approach. In the year 2008 the ecological club ¨Guardianes de la Naturaleza¨ was formed with 25 children ages 6 to 14 from Puerto López, a coastal fishing and tourism based community in the heart of Machalilla National Park. The ecological club keeps running, with the participation of around 120 kids in these seven years of existence. Following the success obtained with the ecological club, we decided to replicate it in Portete, a small community in northern Ecuador of great importance for nesting olive ridleys (*Lepidochelys olivacea*). The ecological club there is running for 4 years now with the participation of around 40 kids. The teaching methodology we use differs greatly from formal education, and is based in Piaget´s theory that suggests that the source of knowledge lies in the interaction between subject and object, and it is through this interaction that assimilation of the outside elements occurs. Meeting an average of 3 hours a week this was a space to discover the surrounding marine ecosystem through a real participation in sea turtle research and conservation together with field trips,

documentaries, plays, art and games. Great emphasis was placed on developing the creativity and natural curiosity of children in order to set bases for observation and making inferences about natural processes. Sea turtles and garbage management have been the key topic in the lessons. Children have benefited tremendously from this initiative as they have acquired knowledge of ecological processes through a creative and fun method. Even though the number of participants has been somewhat small due to the personal nature of the program and restrictive funding, it has been an important step in creating a successful model of environmental education which can be repeated in other communities as a way to guarantee greater sustainability of the efforts towards sea turtle conservation.

GTTM-LUZ: A NEW PERSPECTIVE OF SEA TURTLE BIOLOGY AND CONSERVATION AT LA UNIVERSIDAD DEL ZULIA

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Since the founding of an organization for the research and conservation of sea turtles in the Gulf of Venezuela, the job of educating new sea turtler generations has been one of the most important objectives. With the support of the Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV) a strategic alliance with La Universidad del Zulia (LUZ) has been established through an outreach project: Grupo de Trabajo en Tortugas Marinas de la Universidad del Zulia (GTTM-LUZ). The campus is a center of convergence between different points of view which ensures a constant flow of knowledge and ideas. GTTM-LUZ has been embracing this intellectual encounter in favor of the education and training of young leaders from all the semesters of the school of biology and for the subsequent integration of students and university staff from other faculties. Our educational strategies are designed to promote a sense of personal and collective responsibility towards the reality of sea turtles (ST) and the communities that interact with them. Training efforts have focused on our three lines of action: environmental education, research and networking, such training has been carried out through education modules, courses, workshops and mentoring by members of the GTTM-GV and field professionals. Among our activities, we have recruited a considerable number of volunteers (N=20) that have participated and organized small and medium scale events in our state as vacation plans (Plan Vacacional Tortuguero at Zapara Island), bazaars and exhibitions (Expo Tortuguero 2013), talks and fundraising events (Camina TU Planeta), have authored and co-authored scientific works on ST and their ecosystems in national academic events and attended courses on biology and conservation of sea turtles and marine wildlife. Despite being a recent project, the establishment of GTTM-LUZ has satisfied the needs of young people to be part of a collective action against environmental

conflicts adopting sea turtles as their emblem. Our members and volunteers have become spokespersons of our mission and vision.

DESIGN ON SEA TURTLES INFORMATIVE MATERIAL FOR CHILDREN WITH VISUAL IMPAIRMENT

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In Colombia, according to the census of the Ministry of Health and Social Protection in 2014, there are about 147,708 visually impaired children (total blindness or low irreversible vision) between 0 and 6 years old, i.e. preschool stage or readiness, for which there are no stories or publications such as booklets that allow them to know the marine fauna of the country and how to help protect them. Tourtugas Foundation is a non-profit organization working for marine turtles in Colombia through environmental education, industrial design and dissemination of knowledge about the species organization. It has designed a book for the population of visually impaired children inspired by the leatherback turtle *Dermochelys coriacea*. Categorized by the IUCN (International Union for Conservation of Nature) as critically endangered, with its soft shell and seven keels; it was chosen to be the protagonist of the short story for blind and irreversible low vision children, "LILA: History of a sea turtle" story. It was printed by the National Institute for the Blind-INCI ink-braille and presented to the public by Tourtugas Foundation, with the help of a puppet replica *Dermochelys coriacea*, it allows children to know some characteristics of this species, such as food, physiognomy plus some recommendations about care for the marine ecosystem and suggestions about how to help protect sea turtles in general. This project will promote awareness about sea turtles in Colombia, and facilitate the process of readiness for braille literacy necessary for children with visual disabilities, while learning about marine life. The story about the Sea Turtle Lute caught the attention of National Institute for the Blind - INCI, the official agency of the Colombian government for the visually impaired, so it was revised and included in its forthcoming annual production plan, with which it expects to cover 1000 institutions with blind and irreversible low vision students enrolled, plus in libraries and civil society. The story "LILA: History of a sea turtle" by Foundation Tourtugas, aims to generate a situation of knowledge sharing and knowledge about sea turtles in Colombia, contributing to its protection by sharing information in a manner accessible to all children, applying our slogan "Turtles for all".

AGENTS OF CHANGE FOR SEA TURTLE BYCATCH MITIGATION IN THE EASTERN PACIFIC OCEAN*

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The main elements for the successful implementation of education and participative programs with fishermen, in order to change attitudes are described, considering the experience developed by 250 fishery

observers and 35 scientific technicians who have participated as agents of change in the eastern Pacific program to reduce sea turtle mortality. Among the key elements to consider are: volunteer observer programs; introduction workshops with communities, associations and fishing leaders; direct dialogue with these stakeholders; development of educational materials tailored to fishermen and research programs. These strategies seek to convert fishermen into agents of change as well. Fishing observers, in addition to playing the traditional role of collecting the required information, contribute significantly in generating awareness strategies for fishers through communication strategies and exchange of experiences and knowledge of the fisheries and the marine ecosystem. In addition, the role of the technicians is critical to establish a bond of trust and good communication strategy to ensure collaboration and active participation of fishermen from the beginning of program implementation. The workshops organized by technicians in order to receive feedback from fishermen to adapt the program to the needs and perceptions of the different communities are part of an approach strategy and process of trust building to introduce observers to the usual tasks of the fishermen. At the same time, meetings and continued dialogue with fishing communities and leaders, are a way to find solutions, transfer local knowledge from fishermen to observers, and exchange experiences and practices in fishing operations, to generate new ideas that improve the fishing technologies proposed to reduce sea turtle mortality and to improve new techniques and/or procedures for handling these species onboard. Moreover, it is essential to recognize the importance of the involvement of fishermen in the implementation of research studies and sea turtle tagging programs on board fishing vessels to generate interest in the protection of these species, and a feeling of ownership and pride. All these strategies, and the fishermen, observers and technicians as the agents of change, lead to a change in attitude by the fishermen about the environmental services of marine ecosystems in a sustainable manner. Therefore, it is necessary to continue the transfer of knowledge and training of technicians and observers involved in education and awareness raising of fishermen.

THE TRIP OF A LIFETIME FOR A MORE ENVIRONMENTALLY-CONSCIOUS GENERATION IN GUATEMALA

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Of the 8 species of sea turtles, 6 species have been documented in Guatemala, with the olive ridley (*Lepidochelys olivacea*) being reported more frequently. The conservation of sea turtles in Guatemala focuses primarily on the implementation of hatcheries on both the Pacific and Atlantic coasts of the country. ARCAS is a conservation organization with one headquarters on the southern coast of Guatemala called Hawaii Park. At Hawaii Park, the main project focuses on the conservation of sea turtles. This park was founded in 1994 and manages the country's most productive hatchery with the highest success rate of egg recovery, which increases annually. Besides the hatchery of Hawaii, ARCAS also manages another hatchery at El Rosario, another village nearby. In addition to working on sea turtle conservation, ARCAS implements various programs within the community such as environmental education, rehabilitation and reintroduction of yellow nape parrots, reforestation, and conservation of mangrove ecosystems. ARCAS works with schools of 6 different local communities. The program in which we stress the most importance on within these communities is related to environmental education. Teaching environmental education is particularly imperative because educating this generation allows for a brighter and more environmentally

conscious future. To successfully achieve our goals as a conservation organization, involvement from the people of local communities is essential. Implementing a community development strategy is the first phase of the project in order to attain the most sustainable, long-term efforts. In 2013 and 2014, one of the most effective and popular educational programs carried out in 5 of the surrounding villages was Rally Parlama. This program encouraged local children to donate sea turtle eggs to our hatcheries and the first students to give the donation won an all-inclusive trip to visit other national parks and protected areas within the country. In 2013, we took 35 students and 13 adults to the department of Petén and in 2014 we took 30 students and 13 adults to Lake Atitlán in the department of Sololá. Also, with this participation by the students in Rally Parlama, our hatcheries were able to receive 3240 eggs in 2013 and 3360 in 2014, all of which contribute to sea turtle conservation. The Rally Parlama program was a huge success for ARCAS because it allowed the surrounding community members to support sea turtle conservation and visit some of Guatemala's most beautiful, natural, and iconic sites. Year after year, our hope is to continue encouraging younger generations to get involved in conservation efforts with programs like Rally Parlama.

EVALUATING THE EFFECT OF A GUIDED SEA TURTLE WATCH PROGRAM ON CONSERVATION ATTITUDES AND BEHAVIOR IN PARTICIPANTS*

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Sea turtle ecotourism is global in scope and covers a wide range of activities. Many ecotourism programs capitalize on opportunities to promote conservation behavior in participants through education, which can address many of the most important threats faced by sea turtle populations. We present a comprehensive evaluation of a guided turtle watch program conducted at Disney's Vero Beach Resort® in southeastern Florida designed to encourage conservation behaviors in program participants. We evaluated the impact our program had on the following variables; 1) interest in nature and conservation, 2) knowledge of sea turtle information, and 3) likelihood of engaging in conservation behaviors. Results of our study found that turtle watch participants were likely to have had prior interest in nature programs and to have attended similar programs in the past, suggesting that the program targets a specific segment of the general population. Participant knowledge of sea turtle life history and conservation information increased after viewing an interpretive presentation administered prior to the turtle watch on the beach. Following the turtle watch, a majority of participants indicated they were likely to engage in a suite of conservation behaviors that benefit sea turtles and six months later, 73% of willing participants contacted by phone stated that they had engaged in conservation behaviors that benefit sea turtles since attending the turtle watch program. We concluded that there were several successful attributes of our program that contributed to changes in participant conservation behavior (namely, an engaging interpretive presentation and the ability to personally connect with the staff) that apply to other sea turtle ecotourism activities that seek to build a conservation constituency. Furthermore, the likelihood of engaging in conservation behaviors following the program did not differ significantly between those participants that were able to view a turtle and those who were not, suggesting that expansion of these programs into regions with less turtle nesting would still have influence and conservation value.

"TARTALAB AND LA BIBLIOVALIGIA", AN EDUCATIONAL MOBILE UNIT

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Education plays an important role in nature and threatened species conservation and it can be greatly facilitated by using attractive tools. Sea turtles are an effective source in the creation of such instruments, due to their special physiological adaptations and their ancient origins. Rarovet is an association which works with biodiversity conservation, whereas LabLib is more focused on educational activities. Jointly, the two associations have organized an educational project "TartaLAB and La Bibliovaligia" with the main goal of enhancing awareness of sea turtles and marine life conservation through interactive and creative workshops. It is commonly known that students learn better by doing than by watching, therefore the project is always very dynamic, with collective readings, creative workshops and interactive games. All the activities are focused on sea turtles: their biological and physical adaptations to the environment, threats to survival and conservation efforts. The innovation of the project is its mobility. Indeed, we can easily move our workshop in different places and this flexibility allows us to reach also those places where it's urgent to make people aware on sea turtle preservation, but there isn't any specific project yet. The project includes a library, a science lab, a manual printing lab, several games and display information panels and gadgets. During the years 2014 and 2015 we arranged the project in 3 Regions in Italy (Puglia, Calabria and Sicilia) in different contexts like young summer camp, sea turtles rescue centers and other public events on chelonian. The "TartaLab and Bibliovaligia" is suitable for small or big groups and until now it has been attended by 15-40 children of different ages (3-12 years old) each time. Our approach still represents a work in progress on possible educational strategies for a correct and effective development of knowledge. In fact, we believe that only a constant exchange of experiences with other organizations can sharpen and improve our methodology.

SEA TURTLE EDUCATION PROGRAM DEVELOPMENT, IMPLEMENTATION, AND OUTCOME ASSESSMENT IN ST. KITTS, WEST INDIES*

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St. Kitts has recorded four species of sea turtles in the area nesting and/or foraging and these include the leatherback, green, hawksbill, and loggerhead. An open fishing season for sea turtles is active in St. Kitts

and Nevis from October 1st through February 28th annually and in addition to this harvest, all species face a number of other threats including but not limited to sand mining, vehicular traffic, and development on nesting beaches. In order to address some of the threats facing sea turtles in St. Kitts, the SKSTMN has initiated a number of programs including work with sea turtle fishermen to develop non-consumable sources of income primarily in the form of Leatherback Ecotourism; a Turtle Friendly Certification Process for establishments within close proximity to sea turtle nesting beaches, and Sea Turtle Camp to increase public awareness of the importance of sea turtles to the environment. The Sea Turtle Camp program was initiated in 2007. The focus of this environmentally themed camp is to introduce campers to the different types of endangered sea turtles that live and nest in and around St. Kitts. Using the Sun, Sand and Sea Turtles curriculum developed by the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) combined with a combination of arts and crafts, educational activities, games, and hands-on experience, participants learn about sea turtles and the importance of preserving them. Over 500 children have participated since the initiation of this program, many of which return in subsequent years which has emphasized the need to develop additional curriculum to build on the initial experience. In 2015 and 2016, the SKSTMN performed an outcome assessment of this education program which included pre- and post-tests for each of the 2015 participants and a survey using the Qualtrics platform of parents of participants as well as participants who are now over the age of 18 to determine if this program has positively affected participants and perceptions regarding sea turtles and conservation; strengths and weaknesses of the program; and areas that could be further developed. The SKSTMN is using this assessment to work with consultants to adjust and implement the changes determined necessary following the outcome assessment and to develop an additional camp curriculum. Acknowledgements: The authors would like to thank volunteers from the SKSTMN for their assistance in survey administration. The authors would also like to thank the St. Kitts Department of Marine Resources (DMR) for their permission to work with sea turtles in St. Kitts and for their support of this research project and the Global Environmental Facility-Small Grants Program (GEF-SGP), SKSTMN, Georgia Sea Turtle Center (GSTC), and Ross University School of Veterinary Medicine (RUSVM) for their financial contributions and technical support.

FISHER LEARNING EXCHANGES AND SEA TURTLE CONSERVATION: AN EFFORT BETWEEN MEXICO, CUBA AND THE U.S. TO ENGAGE CUBAN COASTAL COMMUNITIES IN NON-CONSUMPTIVE ALTERNATIVE BEHAVIORS*

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This presentation will describe fisher learning exchanges as tools for sea turtle conservation through close examination of the Third International Workshop on Sea Turtle Conservation and Fishers' Exchange that took place from Apr 22-30, 2009 on Cuba's Isle of Youth. A group of 28 fishers, conservationists, marine scientists and fisheries managers from Cuba, Mexico and the US gathered at Siguanea Bay off the island's remote southwest coast. The goals of the exchange were to provide a forum for sea turtle experts and

communities in the three bordering countries to share experiences on conservation activities, expand livelihoods for Cuban fishers, and develop the scientific basis for future conservation in this highly productive region of Cuba. During the exchange, participants spoke with local Cuban fishers about the challenges of preserving sea turtle populations while maintaining their way of life. Key outcomes for the exchange include an improved understanding of turtle bycatch off the Isle of Youth, enhanced collaboration among the three nations in turtle conservation, and increased motivation by fishers to participate in sea turtle research and conservation. As a direct result of this exchange, the community of Cocodrilo on the Isle of Youth hosted multiple sea turtle festivals, which have continued to help increase support for turtle conservation efforts by the local community. This presentation will also describe the town of Cocodrilo and The Ocean Foundation's future plans to collaborate with community members.

QUICK GUIDE TO THE SEA TURTLES OF MEXICO

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Sea turtles have been swimming in the oceans of the world for more than 150 million years. The coasts and seas of Mexico are inhabited by six of the seven species of sea turtles of the world and all are classified as endangered. Baja California Sur is home to five species: leatherback, olive ridley and black that nest on its beaches and hawksbill and loggerhead that only come to feed in its waters. Sea turtles use tropical beaches for reproduction but only females come out of the sea to deposit their eggs in the sand. Survivability from hatchling to adult is very low due to natural predation and threats – direct and indirect - caused by humans. It has been estimated that only one of a thousand hatchlings will survive to reach adulthood. Sea turtles are threatened by man through consumption of their eggs, meat and oils, the use of their skin and shell for manufactured goods; direct fishing (all of them illegal in Mexico) and incidental bycatch; loss of nesting habitat by badly planned developments in coastal zones; irregular tourist activities in nesting beaches like vehicle and horse traffic on the beach; consumption of trash and pollution in the sea, among many others. Each species of sea turtle looks and behaves distinctly. Their shells consist in different scute patterns in the upper part (carapace) and the lower section (plastron). Hard scales (scutes) cover all but the leatherback turtle, and the number and arrangement of these scutes can be used to identify each species. They do not have teeth, but their jaws have modified "beaks" suited to their particular diet. Only females come ashore to nest; males rarely return to land after crawling into the sea as hatchlings. Most females return to nest on the beach where they were born (natal beach). Nesting seasons occur at different times around the world, generally during the warm spring and summer months. Most females nest at least twice during each season; some may nest up to ten times in a season. A female will not nest in consecutive years, typically skipping one or two years. This quick guide presents six species and one subspecies of sea turtles found in Mexico and describe their diagnostic characteristics through illustrations of the shell, plastron and skull of each species. The characteristics of weight, curved carapace length, distribution, diet, nesting and incubation are included. Certainly interesting, the track characteristics of each species are described and illustrated. Finally, you can find a brief guide about how YOU CAN HELP IN THEIR CONSERVATION. The guide is the result of the partnership of Defenders of Wildlife, Teyeliz, A.C., Organización para la Sustentabilidad y Conservación del Medio Ambiente, A.C. with the Government State of Baja California Sur and the H.

XII Municipality of Los Cabos, BCS through its Sea Turtle Protection Program to promote sea turtle watching and conservation in Mexico.

ZAPATILLA, THE SEA TURTLE: THE THEATRE AS A TOOL FOR ENVIRONMENTAL EDUCATION

Antonio Trujillo and Lucia Rosher

Ayotzintli AC, México

Zapatilla is a sea turtle that like all of its kind, has to overcome many dangers to survive. As peculiar as its name, Zapatilla shows exceptional courage and solidarity to become the lead exemplary friend of children, fish, cows and dogs. Together they face dangerous exploits and fun adventures that teach us all the importance of environmental conservation and the conservation of sea turtles. This staging is an interdisciplinary effort that Ayotzintli AC in collaboration with professional actors made possible for two important purposes: to create awareness about the plight of sea turtles in Mexico and the world, and secondly, to bring a cultural option to the communities associated with beaches of sea turtles through theater. This work premiered on May 24th and was supported by the wings and roots project which is a major cultural project in Mexico to create artistic projects. In this way the issue of the conservation of sea turtles has transcended beyond the beaches or environmental projects. Until today, it has been presented 45 times in schools, theaters and public spaces in the cities of the country and 25 times in various coastal communities of the Pacific; these presentations have worked with approximately 4,000 adults and 3000 young people besides reaching more than 10,000 people through electronic media designed for broadcast on social networks and the internet. The project has collected more than 50,000 Mexican pesos that have directly supported five community projects on sea turtle conservation in the states of Oaxaca and Guerrero.

RED DE AVISO OPORTUNO (RAO): AN EFFICIENT SEA TURTLE COMMUNITY CONSERVATION STRATEGY*

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Margarita Island is located off the northeastern coast of Venezuela in the Caribbean Sea and is one of the most important nesting sites in the country for the leatherback turtle (*Dermochelys coriacea*). Overexploitation of eggs and females on nesting beaches, as well as intentional take in fisheries and degradation of nesting habitats were among the major threats for this species on the island. For a long time, fishermen and the general public considered turtles in terms of meat value and the best way to prepare them, openly to the authorities. This situation was confronted by a small team of three enthusiastic people with limited resources implementing "Red de Aviso Oportuno" (RAO), in English "early warning network", a conservation network that was to become the driver of an integrated conservation project based on working

on the conservation of the leatherback turtles with community participation and active volunteers. The main RAO strategy was awareness raising and training, and conducting workshops and courses for all educational levels. Coastal and fishing communities throughout the state were involved, offering direct participation in conservation activities, establishing responsibilities to protect the endangered species and their habitats. The project also engaged governments and non-governmental institution at all levels. After 13 years of activity, the project has achieved the participation of 3,661 volunteers on all nesting beaches, fishing ports, educational institutions and public offices. Thiry-nine taining courses and workshops were given to 632 people in the community and students between 18 and 79 years and of all genders, beliefs and educational status. They were given 783 talks and awareness-raising events attended by 7,058 people and 4,220 elementary school children, which in many cases participated in more than one activity, including beach patrols. 2,351 nests of leatherback turtles and 293 of other species were found during this time period. 1,024 were monitored and more than 35,785 hatchlings released. Also, 122 stranding were attended and 82 turtles were clinically recovered and reintroduced into the sea. As the most important results, nest poaching for consumption or trade decreased from 83% in 1999 to 12% between 2002 and 2006 to reach 5% from 2007 until today. RAO has proven to be so successful and efficient a sea turtle conservation network that it has been used in other sea turtle conservation projects in Venezuela.

THE KEY ROLE OF ENVIRONMENTAL EDUCATION IN A SEA TURTLE CONSERVATION PROJECT: TWO CASES AT NESTING BEACHES IN THE CENTRAL-AMERICAN CARIBBEAN*

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Sea turtles play a major ecological role by transferring nutrients to nesting beaches, helping maintain species diversity in the ocean and providing an indication of water quality, among others. But their tremendous expedition doesn't end here. They also represent one of the most charismatic species in the ocean, providing the motivation for countless environmental movements and campaigns and, acting as emblems and community symbols. From a more educational perspective, sea turtles, prehistoric animals with strong survival skills, capable of dealing with anything evolution has put in their way, can also help conservationists to reach and enhance people's environmental consciousness. Sea turtles have the power to change people's attitudes towards the environment; thus, it is incredibly valuable to use them as stewards of marine ecosystems. Sea turtle research and conservation projects have existed since Dr. Archie Carr first landed in Tortuguero, Costa Rica, where the main focus was learning more about them, protecting endangered populations and avoiding large scale massacres through data collection and analysis, with the involvement of local communities. More recently, a positive addition has been made to the equation: sea turtle projects have started including environmental education programs in their agendas, trying to achieve the perfect formula towards their conservation. And it is certainly a correct path to follow, not only at nesting beaches where people live in direct contact with the resource but at any site where humans might have an impact on marine life, basically everywhere. Thus, sea turtles are key species to incorporate into the design and development of an environmental education program. In the present case, an environmental education program being developed at different nesting beaches located in the Central-American Caribbean will be presented. The paper will focus on the importance of a well-established, consistent and professional environmental education program, as a way of acquiring formality and trust within the community;

therefore, achieving better results in conservationist terms. The case will be concentrated on two main nesting areas of the Caribbean where an educational program is being conducted as part of the monitoring and conservation programs of Sea Turtle Conservancy: Tortuguero, Costa Rica, a major nesting area for *Chelonia mydas*, and Bocas del Toro, Panamá, an important region for *Eretmochelys imbricata* and *Dermochelys coriacea* sea turtles. Methodologies and innovative approaches will be discussed, based on the environmentalist premise of "education for action". A critical review of program activities will be included, highlighting those that have been successful and unsuccessful, to help other projects plan effective education programs. The program presented is designed for Caribbean communities living in nesting areas but might be also adapted to anyone who has a potential negative impact on sea turtles. Acknowledgements: The authors would like to thank: Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria and World Wildlife Fund for their help and support.

Emerging Threats: Climate Change, Oil Spill and Plastic Pollution: Special Session

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BIASES AND BEST APPROACHES FOR ASSESSING DEBRIS INGESTION BY SEA TURTLES: A CASE STUDY IN THE CENTRAL MEDITERRANEAN

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The impact of anthropogenic debris on sea turtles is still uncertain and an increasing number of studies are investigating this potential threat. Turtles have also been proposed as indicators of the occurrence of plastic in the environment. Methods to approach the topic differ from one study to another and the availability of samples is often limited and opportunistic. In order to contribute to the current knowledge about debris ingestion as well as to the methods, we collected and analysed a sample of 639 loggerhead turtles (*Caretta caretta*) in the central Mediterranean. To our knowledge, this is the largest sample collected by a single study so far, and this allowed us to ascribe turtles to different sources and to test different approaches. Results indicate that: (i) the apparent occurrence of plastic (% turtles) is affected by several covariates (e.g. zone, year, necropsy/feces, type of finding, duration of the captive period), therefore (ii) data stratification is needed and mixed dataset provide results which are biased, not comparable, and ultimately of questionable value, (iii) plastic ingestion mainly occurs at sea surface where most plastic probably accumulates, (iv) plastic debris may remain in the digestive tract for much longer than normal digestion time, (v) lethal effects of plastic ingestion are probably rare. Occurrence of plastic categories (Ospar protocol), size and color are presented. Intrinsic biases associated to methods used in such studies are discussed, with suggestion of best approaches.

ASSESSMENT OF PLASTIC INGESTION AND PERSISTENT ORGANIC POLLUTANTS IN SEA TURTLES ACROSS THE PACIFIC OCEAN*

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Plastic debris is a growing concern for many marine organisms due to entanglement, ingestion, and exposure to toxic chemicals. We hypothesized that ingestion of plastic debris is a potential source of exposure of persistent organic pollutants (POP) to threatened pelagic Pacific sea turtles. We necropsied 38

sea turtles [3 leatherback (*Dermochelys coriacea*), 3 loggerhead (*Caretta caretta*), 6 green (*Chelonia mydas*) and 26 olive ridley (*Lepidochelys olivacea*) sea turtles] that were incidentally captured in Hawaiian and American Samoan longline fisheries and quantified the amounts, types, sizes, and colors of ingested plastics in their gastrointestinal tracts. Ingested plastic was found in 87% (n = 33) of the turtles, with no plastic found in the 3 leatherback turtles, in 1 adult loggerhead, and in 1 juvenile green turtle. Mean mass of ingested plastic in all turtles sampled was 9.68 g with a range of 0.0185 g to 64.2 g amongst turtles that ingested plastic. The percentage of individual total gut contents comprised of plastic ranged from 0.00113% to 8.16% amongst turtles with ingested plastic and a mean of 1.01% in all turtles sampled. Juvenile green turtles ingested significantly more plastic than other species. Adipose samples from 25 of the turtles (2 loggerhead, 6 green, 17 olive ridley), were analyzed by gas chromatography/mass spectrometry for 83 polychlorinated biphenyls (PCBs), 20 organochlorine pesticides, 32 brominated flame-retardants and by liquid chromatography tandem mass spectrometry for hexabromocyclododecane (HBCD). Our study is one of the first to measure POPs in these species from this location. We analyzed differences among species, sex, and correlations with turtle length and capture locations. Total dichlorodiphenyltrichloroethanes (DDTs) were the predominant POP in both loggerhead (mean = 18.3 ng/g wet mass) and olive ridley (15.8 ng/g wet mass) turtles, and the second highest POP class in green turtles (1.80 ng/g wet mass). Total PCBs were the predominant POP in green turtles (2.71 ng/g wet mass), yet they had lower total PCB concentrations than loggerhead (4.92 ng/g wet mass) and olive ridley (3.95 ng/g wet mass) turtles. Green turtles had the highest concentrations of α-HBCD (1.46 ng/g wet mass), which was the only detected HBCD isomer. Among olive ridley turtles, few sex differences were seen in POP concentrations, likely because sampled turtles were mainly juvenile. Concentrations of several POPs increased with straight carapace length of olive ridleys, suggesting bioaccumulation through age. A geographic gradient was observed with concentrations of several POPs increasing with capture latitude. Plastic ingestion is extremely common in sea turtles and effects of toxic chemicals could have detrimental effects on their health and survival. Amounts of ingested plastic were unrelated to POP concentrations, suggesting that sea turtle exposure to POPs is predominately through their natural food chain rather than from ingested plastics. Additionally, our data provide important baseline POP concentrations for Pacific sea turtles, as this area has not been extensively monitored. Funding was provided by the U.S. Pacific Islands Program of the NIST Marine Environmental Specimen Bank.

SEA TURTLES EXPOSURE TO MARINE DEBRIS IN FRENCH WATERS

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Anthropogenic debris, mostly composed of plastics from land sources, is ubiquitous and a growing concern for marine ecosystems. Light and persistent, it passively drifts with the currents, posing a threat to the marine wildlife using the upper water column. More than 660 species are known to be affected by debris and all sea turtle species are impacted through entanglement, ingestion or pollution of their feeding and breeding habitats, directly or indirectly decreasing their chance of survival and reproduction. The European Marine Strategy Framework Directive (MSFD) aims to achieve the good environmental status (GES) of the marine environment, defined for Descriptor 10 (D10), as the level of debris which does not cause harm to the coastal and marine environment. Given the extent of population distribution and the dispersion of individuals, the loggerhead turtle *Caretta caretta* was proposed as an indicator of ingestion (indicator 10.2.1) for D10, in order to assess debris level and impact in coastal and marine habitats. To better guide sea turtle conservation policies and evaluate the terms of use of the indicator, a better understanding of the risks posed to turtles by exposure to marine debris is crucial. In this study, we evaluated the extent exposure of sea turtles to marine debris in the Atlantic and Mediterranean French waters. Firstly, in order to assess ingestion rates and the quantities of debris ingested by loggerhead turtles, we analyzed debris found in the digestive contents of autopsied individuals by the French Atlantic and Mediterranean stranding networks and in the feces excreted by live individuals observed in the French Atlantic (CESTM -Aquarium La Rochelle) and Mediterranean (CESTMed) rehabilitation centers, before and after the establishment of the standard protocols suggested by the MSFD. Secondly, we analyzed the location data collected during aerial surveys of the marine megafauna carried out in winter 2011 and summer 2012 in the French Exclusive Economic Zone, in order to assess the risk of exposure of sea turtles to marine debris at sea. This study confirms the propensity of loggerhead turtles to ingest debris and shows the significant probability of encountering marine debris at sea during their displacement, particularly in the Mediterranean. This highlights that marine debris represents a major threat to be considered in sea turtle conservation programs. In-depth studies, requiring empirical data on debris ingestion and simultaneous censuses of debris and turtles' spatial distributions, are crucial.

NESTING HABITAT LOSS SCENARIOS BY SEA LEVEL RISE ON THE MAIN BLACK TURTLE NESTING BEACH IN MICHOACAN, MEXICO

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Global warming is a new threat to sea turtles that will impact in the short, medium and long term species of sea turtle populations around the world mainly in two ways: 1) the sex ratio of the offspring produced in nesting beaches (where it is estimated that the production of females will rise sharply to remove the segment of males, and 2) Loss of nesting habitat by rising in sea level, suggesting that the beaches nesting island in the tropical zone of the planet will suffer a greater loss of habitat due to flooding. Against this background, the scenario modeling flooding due to rising sea levels is a key tool in studies of conservation of nesting grounds of sea turtles. Colola beach in Michoacan, Mexico, is the main nesting area for the black sea turtle (*Chelonia mydas agassizii*) listed as an endangered species (IUCN). To assess the impact of rising sea levels due to global warming in black turtle nesting areas we conducted a detailed survey of beach Colola to generate flood models in three different scenarios of sea level rise (0.5m, 1.40m and 5m) using a geographic information system (GIS) and a digital elevation model. The results showed that in scenarios of sea level rise of 0.5 to 1.40 m preferred nesting sites for turtles are not affected. While simulating sea level rise of 5m shows a dramatic change with the loss of the nesting area almost completely, leaving the study area without a nesting area for sea turtles. The results of the different scenarios of sea level changes and the loss of nesting areas allow us to predict the future of sea turtle populations in Michoacan and create conservation strategies to mitigate this new threat to sea turtles in Michoacán.

IMPACTS OF BEACH DEBRIS ON SAND TEMPERATURES AND POST-HATCHING MIGRATIONS OF HAWKSBILL HATCHLINGS

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The issue of marine debris is one of growing concern because of its impacts on marine fauna around the globe. Much work has been presented on the impacts of marine plastic pollution on sea turtles through ingestion, entanglement, and direct injury in the water. Additionally, work has been done regarding plastic pollution deposited on nesting beaches that can impede the ability of female turtles to navigate the shore to nest. In contrast, little work has been undertaken to measure the impacts of beach debris on sea turtle hatchlings during their critically important post-hatching movements toward the sea. Still less work has been done on linking debris to sand temperatures, which have been shown to influence hatchling movements. In 2013, we measured the running speed of hatchlings in four corridors of different densities of beach debris collected along the nesting beach at Pumpkin Hill on Utila, Honduras. A wide range of plastic and natural materials were arranged in corridors representing low density, medium density, high density, and control. We further categorized pollution materials within each corridor into four threat categories (low, medium, high, and very high) and quantified the amount of materials in each category in each corridor. Because sand temperature can influence hatchling metabolism and thus, running speed, we set up the debris corridors again in 2015 and measured sand temperatures within each corridor during two time periods throughout the day (5am – 8am, 12pm – 5pm) and one time period throughout the night (6pm – 3am). The number of items of different threat levels increased with increasing debris density. We also found significantly lower running rates of hatchlings in high density corridors compared with control corridors ($p < 0.0001$). There were no significant differences in sand temperatures during 5am – 8am. Between 12 pm – 5pm, there were significant differences in the sand temperature across the four debris corridors ($p < 0.0001$). Dunn's post hoc analysis indicated the low debris corridor had a significantly higher median sand temperature (40.9°C) when compared to the medium (37.4°C) and higher (38.4°C) debris corridors. The control corridor had a significantly higher median sand temperature (38.7°C) than the medium pollution corridor (37.4°C). Our results suggest that different densities and threat levels of debris on nesting beaches can directly impair hatchling running speed by entrapping and entangling hatchlings. This may increase the risks of prolonged shoreward migration, disorientation, predation on the beach, and the potential for heat death while entrapped in high threat pollution. However, in the conditions of this study, debris density does not appear to correlate with sand temperatures. Therefore, where beach cleanups can be accomplished, they should be done prior to the nesting season and throughout the hatching season.

In uninhabited areas where nesting occurs, studies should be undertaken to investigate rates of hatchling losses due to beach debris and the potential impacts to turtle populations as a result of such losses.

HIGH LEVELS OF PLASTIC DEBRIS INGESTION REVEAL MAJOR THREAT FOR MARINE TURTLES IN THE SOUTH WEST INDIAN OCEAN*

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Anthropogenic debris including plastic, defined as solid and persistent material originating from land-based transformed or manufactured products discarded or lost in the marine environment, have become a critical issue in marine ecosystems worldwide, affecting a wide range of living organisms from zooplankton to megafauna. Since the 1950's, plastic debris abundance and spatial distribution have continuously increased at an alarming rate. This pollution constitutes a growing threat for marine wildlife, directly induced by human activity both on land and at sea. As a component of marine megafauna and as species of particular conservation concern, marine turtles are also impacted by plastic debris throughout the oceans. They are known to ingest or get entangled in marine debris resulting in a large range of injuries, from lacerations to intestinal blockages or internal damage. Consequences are therefore dramatic and may result in various health problems (i.e. sub-lethal effects) and sometimes leading to death. As marine turtles occur in every ocean and are highly susceptible to debris ingestion, they appear to be reliable indicators of plastic debris pollution and its impact on marine wildlife. The Marine Strategy Framework Directive recently identified *Caretta caretta* as an indicator for debris ingestion to evaluate the good ecological status (descriptor 10 that focuses on marine litter) for the marine waters for Member States and to make regional assessments of French waters. In the Southwest Indian Ocean, the protocol was extended to all the marine turtle species encountered around Reunion Island to survey plastic debris impact in oceanic and coastal habitats. Ingestion of plastic debris has been surveyed from 2007 to 2015 in four marine turtle species – *Caretta caretta* (N=131), *Chelonia mydas* (N=49), *Eretmochelys imbricata* (N=21), *Lepidochelys olivacea* (N=21) – rescued after stranding or bycatch from fishing activities operating in the French and Malagassy EEZ. More than 53% of individuals from the four species contained plastic debris in faeces or gut contents from both oceanic and coastal individuals over the study period. More than 89% of *Caretta caretta* rescued in 2014 and 2015 had ingested plastic items, with the higher quantity collected from a stomach content of (a female subadult) loggerhead that did not survive following the ingestion of 217g of debris. While oceanic life stage individuals predominantly ingested domestic plastic debris (hard and soft, with a majority of bottle caps), coastal individuals mostly ingested fishing items such as various types of fishing lines and ropes. For

instance, one *E. imbricata* found in a coastal habitat in 2012 ingested dozens of meters of nylon ropes and pieces of hard plastics, before dying from intestinal blockage. We also observed an increase in the number of individuals affected by plastic over the study period (from 14% in 2007 to 70% in 2015) and in the amount of debris per turtle. These results confirm the alarming situation of marine debris ingestion by marine turtles in the Southwest Indian Ocean, and highlight the need to further analyse debris location and dispersion in this oceanic basin to adequately address conservation issues for sea turtles.

THREATENED BY OIL, KILLED BY THE RESPONSE: PROTECTING SEA TURTLES DURING OIL SPILL CLEAN- UPS*

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In June 2010, in the heat of the Deepwater Horizon clean-up response, a decision was made to initiate in situ burning. Unfortunately, sea turtles caught in the area corralled by the oil booms were not rescued before the area was set on fire. Only after a lawsuit was launched, BP officials and the U.S. Coast Guard agreed to stop this practice and take steps to collect trapped sea turtles. Another worrying aspect of the Deepwater Horizon clean-up response was the series of decisions that resulted in the use of record amounts of dispersants in the absence of adequate knowledge of their effects on the Gulf ecosystem in general and sea turtles specifically. Considering these events, how do we ensure in the future that sea turtles, already traumatized by oil spills, are not killed by our attempt to clean them up? To answer this question, this paper reviews oil-spill response plans in place in the U.S. at the time of the blow-up with an emphasis on decision-making and lines of communication between various actors, as well as U.S. national and international obligations to protect sea turtles. It then looks at government and academic reports analyzing the response to the disaster in order to identify points in the response where short-term and long-term effects of the clean-up methods on sea turtles, as well the precautionary principle, could have been better incorporated into the decision-making process. Since the U.S. is a signatory to the Oil Spill Protocol of the Cartagena Convention, it is the position of this paper that lessons learned from the Deepwater Horizon clean-up response can be useful to the response plans developed at the RAC/REMPEITC- Caribe. This paper examines these plans, as well as regional instruments imposing obligations to protect sea turtles, such as the SPAW Protocol and the IAC, and offers recommendations on how to ensure that sea turtles are protected during oil spill clean-ups in the future.

MICROPLASTICS PRESENCE IN SEA TURTLES. FIRST STUDIES

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ADS Biodiversidad

Marine pollution is one of the main threats for marine ecosystems. Plastic pollution in the oceans has been widely reported, and several studies have been performed to analyze plastic presence or problems derived from plastic to marine fauna, such as plastic ingestion by marine mammals, seabirds and marine turtles.

More recently, focus has moved to microplastics contamination, and numerous studies have been done, mainly in the water column, sea floor and filter organisms. In this study, microplastics presence in marine turtles has been reported for the first time. Microplastic presence was analyzed in feces of both live captive and wild turtles. Captive turtles were fed with marked food, and feces from this food were collected. In wild turtles, first feces after arrival to the Recuperation Center were collected. To collect feces, a handmade siphoning system was developed to pull out feces from tankbottom. Samples were weighted and microplastics were separated flooding samples with hipersaline water (35grNaCl/100 ml filtered H2O, 3 rounds), filtered and identified under a Zeiss Stemi DV4 stereomicroscope. Microplastics were classified according to Marine Litter Guidance categories, observing three types of microplastics: (filaments, spheruloid pellets or plastic fragments). Results showed no significant effect of turtle fitness (weight and minimum curve carapace length) in microplastics per feces gram. Similarly, no significant differences were founded between wild or captive turtles in microplastics per feces gram, despite the fact that macroplastics were founded only in feces become from wild turtles. These results suggest that microplastics present in feces came from the food, not from the degradation of macroplastics ingestion. According to these results, microplastics presence was demonstrated for marine turtles. Also, the developed methodology demonstrated to be useful to determinate microplsatics presence/absence in marine turtles, even though it should be improved upon to collect all feces remains, and further studies are needed to increase sample size. Finally, these results showed that marine turtles could be a Good Environmental Status indicator due to their migratory nature are their widespread along the food chain feeding activity.

CHANGES IN THE FORAGING STRATEGY OF KEMP'S RIDLEY (*LEPIDOCHELYS KEMPII*) IN THE NORTHERN GULF POST DEEPWATER HORIZON SPILL*

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On April 20th 2010 the Northern Gulf of Mexico became the site of the largest oil spill on record for the area. The spill began with an explosion at the Deepwater Horizon well and continued for 87 days, spilling an estimated amount of 4.2 million barrels of crude oil. Kemp's ridley (*Lepidochelys kempii* [Lk]), the most endangered species of sea turtles, has a long-established record of using habitats in and around the vicinity of the well as primary foraging grounds. Resulting negative impacts, both short and long term, on sea turtles have the potential to induce changes in the health and fitness of the Kemp's ridley population. We know that the oil penetrated the foraging areas. Stable isotope signatures of carbon and nitrogen from oil spewed from Deepwater Horizon should be reflected in the food web and in the tissues of organisms such as sea turtles. In order to evaluate effects of the oil on the Kemp's ridley population, we measured ratios of carbon and nitrogen of satellite tagged individuals to 1) assess changes in foraging strategies of nesting Kemp's ridley turtles sampled in 2010 (the year of the Deepwater Horizon Spill) and two subsequent post-spill

years; and 2) estimate the proportion of untagged females that were inside the area affected by the oil spill via discriminant analysis. Scute samples were collected at a long-term study site on the Lower Texas Coast (Padre Island National Seashore) and on the Upper Texas Coast (Galveston Island to Surfside Beach). Kemp's ridley turtles included in this study were sampled only once. δ13C values in scutes obtained from 2011 and 2012 turtles were depleted (F3,96=4.76, p=0.004) compared to samples of 2010. The depleted carbon values correlate with the depleted carbon values of the Deepwater Horizon spilled oil. Samples that were collected in 2010 provide pre-spill comparison values indicative of the carbon values of turtles foraging in the habitat prior to 20 April 2010. This difference indicates a change in the foraging habitat from 2010 to 2011 and 2012. There were no significant differences in the δ15N isotope values between these years, suggesting no appreciable change in trophic feeding level. The distinctive isotope values of the satellite tagged females provided data subsequently used to identify turtles that were inside the oil spill area, even when satellite data were not available.

PROJECTIONS FOR THE EFFECTS OF RISING SEA LEVELS ON THE REPRODUCTIVE SUCCESS OF SEA TURTLES, BRAZIL

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In Brazil, data regarding the vulnerability of sea turtle species to climate change are scarce. Pioneering studies on climate change have been conducted in breeding areas on the Brazilian coast. The present study has analyzed two scenarios of sea level rise on the nesting beaches and their consequences to the reproductive success of three species of sea turtles (*Caretta caretta*, *Eretmochelys imbricata* and *Dermochelys coriacea*) in four nesting areas of the Brazilian coastline. During the incubation and hatching periods, 223 nests were monitored over the 2013/2014 reproductive season in the Brazilian States of Espírito Santo, Bahia and Piauí. Data of the following environmental variables were collected: foreshore slope, nest locations and width of available area for nesting and characterization of the sediment from the foreshore. These data were correlated with the incubation period and emergence success. Foreshore slopes were measured to classify the beach in terms of morphodynamic stages and severity of rising sea level impact on each area. Slopes were measured based on the communicating vessels principle; this method proved to be inexpensive, easy to handle, and efficient for data collection. Three projections of rising in sea level were used, as proposed by the Intergovernmental Panel on Climate Change (IPCC). The nest locations, as regards their distance from the high tide line, did not influence the emergence success or the incubation period for any of the studied species. The studied beaches had different characteristics, especially in terms of foreshore inclination. *C. caretta* and *E. imbricata* had the largest emergence success rates in the vegetation zone, which is a beach area that will be most protected from sea level rise and will only be reached by the sea in the most extreme projected scenarios. The beach with a dissipative profile was noted to be the most harmed by rising sea levels. During this study, only *E. imbricata* presented regular clutches

on the beach with this morphodynamic. *C. caretta* and *D. coriacea* nests on a beach with a reflective profile will be protected unless hit with the most extreme rise in sea level. No *E. imbricata* nests were observed in a beach with a reflective profile. Beaches with an intermediate profile, in which all three species were observed, will be subject to different impacts from each projection of sea level rising, which is mainly dependent on the width and slope of the beach. Strategies to preserve nesting areas will be specific to each region and will depend on the intensity of the climatic impact. Field research on the impacts of climate change should be incorporated into conservation planning for sea turtle species in Brazilian coastline. Acknowledgments: We would like to thank all the involved partners, the Tamar Project, the Companheiros do Txai Institute and the Biomade Project. With thanks also to the Post Graduate Program in Zoology at the State University of Santa Cruz – Ilhéus/BA, and to the Brazilian Coordination for the Improvement of Higher Education Personnel (CAPES) for granting the master's scholarship to the main author. The authors would like to thank Brazilian National Council of Scientific and Technological Development – CNPq, for the scholarships given to the second author. We also thank 36th Annual Symposium on Sea Turtle, Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesquería y World Wildlife Fund for the travel grant to the main author.

DATA GAPS IN GHOST GEAR--RELATED TURTLE ENTANGLEMENTS IN THE CENTRAL INDIAN OCEAN: A FORGOTTEN THREAT

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According to the UN, around 640,000 tons of lost, abandoned, or discarded fishing gear (otherwise known as ghost gear) makes its way into the world's oceans annually. Ghost gear has devastating effects on marine animals and their environment. Millions of marine mammals, turtles, seabirds, and other species have been injured or killed by entanglement in, or ingestion of, ghost gear. Currently there is a lack of information on the amount and types of ghost gear generated annually in the Indian Ocean, from what countries and fisheries it originates, and the interactions between sea turtles and ghost nets. Despite global efforts to research ghost nets, the issue remains largely overlooked and unresolved. There are few records of entanglements from countries like Pakistan, India, Oman, and Sri Lanka, where fishing pressure is high. Based on a two-year study conducted in the Maldives, we suspect that a significant number of turtles are interacting with ghost gear in these regions. The Maldives consists of 1,192 low coral islands lying North-South across the East-West currents of the central Indian Ocean. Its geography means that it acts for a trap for flotsam. Maldivian fishermen reported seeing up to 15 ghost nets per day drifting offshore. Between 01 June 2013 and 30 June 2015, 174 sea turtles were recorded entangled in ghost nets in Maldivian waters. 163 of those turtles were olive ridley turtles (*Lepidochelys olivacea*). An additional eight individuals were found with injuries consistent with previous entanglement. 64% of the olive ridleys recorded were juveniles (CCL <60 cm). 61% of entanglements were reported during the NE Monsoon (December – March). Peak entanglement months were January and March. 83% of the turtles reported were either released immediately after disentanglement or after a period of rehabilitation. The authors recognize that the remains of dead turtles are quickly removed by predators and, therefore, may be under-represented in the dataset. The data collected from the two-year study in the Maldives represent only a small proportion of the true number of entanglements, as most go unnoticed or unreported. We recommend improved and increased efforts in data collection and collaboration between organisations focused on turtle research in the Indian Ocean in order

to properly quantify the problem. The problem of ghost gear also needs to be brought to the attention of the general public (i.e. education on how choices made as a consumer may affect ghost gear production across the globe). A centralized catalogue for different fishing techniques and gear used in the Indian Ocean region would be an invaluable source of information. This could be used to identify the origin of ghost gear and identify areas that contribute significantly to its production. Once we have this information, we can then work towards concentrated efforts to inform policies and best practices in order to catalyse and replicate solutions in these areas.

MARINE DEBRIS INGESTION BY GREEN TURTLE, *CHELONIA MYDAS*, IN URUGUAYAN COASTAL WATERS*

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Over the last years, marine debris has become a serious problem for marine fauna. An increase in the amount of debris has been reported in all the oceans. Fragments of hard and soft plastic are the most common anthropogenic debris due to their high persistence in the environment because of its long disintegration rate. Small buoyant fragments are vertically distributed in the upper water column because of wind driven vertical mixing, affecting marine animals with epipelagic feeding habits. These animals could interact with marine debris by ingestion, producing lethal or sub-lethal effects. Anthropogenic debris ingestion has been reported for green turtles in all their life stages worldwide. In the Southwestern Atlantic Ocean, the interaction with anthropogenic debris is one of the main threats for juvenile green turtles. The aim of the present work is to evaluate and categorize the marine debris ingested by juvenile green turtles stranded along the Uruguayan coast. Gastrointestinal contents were collected from the carcasses of 52 dead turtles stranded in Uruguay from 2009 to 2013. For each stranded turtle, curved carapace length was measured. The digestive tract content was collected and separated into esophagus, stomach and intestine sections. Diet items were separated from marine debris and analyzed separately. Each marine debris item was categorized and quantified by frequency of occurrence and relative weight. To determine in which part of the water column the turtles probably interact with the different debris categories a buoyancy study was conducted. The rise velocity of each debris category (n=10) was measured in a plastic tube with marine water. All the turtles analyzed were juveniles with mean ± SD curved carapace length (CCL) = 39.70 ± 6.8 cm (range 29.8–62.0 cm). A total of 73% of green turtles (n=38) presented marine debris in their guts. There was a negative correlation between the turtle size and the total weight of debris ingested per turtle (r2 = 0.1977; r = -0.4446, p = 0.0020). The most frequent debris category was soft plastics (plastic bags and wrappers) with %FO= 67.31, followed by threads (rope fragments, monofilaments); %FO= 59.61) and hard plastics (%FO= 55.77). Plastic rise velocity between categories ranged from 0.0049 m/s to 0.1550 m/s with a mean of 0.0493 ± 0.0338 m/s within categories. There were significant differences in the different types of marine

debris rise velocities (Kruskal-Wallis p-value <0.001). Debris categories with a lower rise velocity (monofilaments and fabrics) are susceptible to be more affected to vertical mixing, thus probably being eaten by juvenile green turtles in the first meters of the water column. In the other hand, high rise velocities (plastic fragments) overcome vertical mixing and concentrate in the superficial layer. The smaller turtles, which are being recruited from the oceanic realm, present higher probability to ingest floating debris according to the epipelagic feeding habits. In summary, turtles could interact with marine debris in oceanic and neritic habitats after recruitment. Collaborative and international conservation actions need to be addressed to reduce this impact in green turtles.

USING DRONES AND PHOTOGRAMMETRY TO ASSESS CLIMATE CHANGE ASSOCIATED SEA LEVEL RISE IMPACTS ON NESTING BEACHES*

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Sea turtles are particularly vulnerable to the effects of climate change, due to their temperature dependent sex determination and their need for sandy beaches to lay their eggs. By the year 2100, sea levels around the world are expected to rise between 0.22m and 2m. As a result, nesting habitat may be severely reduced or completely unsuitable for nesting. Accurate predictions of Sea Level Rise (SLR) impacts on nesting beaches will further empower conservationists to tailor their approaches to protecting sea turtle populations facing the greatest threat. In order to estimate the impacts of SLR on nesting beaches biologists must assess beach topography and typically opt between two solutions: expensive – high resolution, or inexpensive - low resolution methods. Currently, high-resolution surveying technology such as LiDAR means heavy equipment, high costs, and challenging logistics rendering them impractical for sea turtle conservation. Photogrammetry combined with a drone (or UAV) present an accurate, low cost and user friendly technique enabling us to obtain high-resolution datasets at remote and inaccessible nesting beaches. Photogrammetry software matches features in multiple overlapping photographs to create a high-resolution Digital Elevation Model (DEM) using a consumer-grade digital camera. The DEM model of a beach can then be exported to GIS for different SLR scenarios projections. An introduction to the technique is presented, followed by an outline of the methods used to create high-resolution DEMs. We propose this method as the current most reliable low-coast approach to obtain DEMs of sandy beaches due to its high accuracy and revolutionary visual representation while capturing complex topography.

Fisheries and Threats

WINTER FISHING CLOSURES ARE THE BEST MEASURE TO REDUCE LOGGERHEAD SEA TURTLE BYCATCH DUE TO BOTTOM TRAWLING IN THE WESTERN MEDITERRANEAN*

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Bottom-trawling has been identified as the main fishing gear involved in the incidental catch of loggerhead turtles over the Mediterranean continental shelf of Spain, where some 500 turtles are bycaught annually by the bottom-trawlers. Most of these turtles are captured in a relatively small area including the Ebro Delta and waters of the Castellon province. In this area, the continental shelf is the widest in the region and turtle catch per unit effort is three times higher than elsewhere in the Spanish Mediterranean. Here we compare data on loggerhead turtle bycatch with satellite tracking and aerial surveys conducted in 2005 and 2010 to understand habitat use patterns by loggerhead turtles in the area, and evaluate conservation measures such as seasonal closures or the creation of a no-take zone to reduce turtle bycatch. Aerial surveys suggested that loggerhead turtles were randomly distributed over the continental shelf year-round and that the region supported some 1800 turtles simultaneously, after correcting for percentage of time at surface (8.4%), although density changed seasonally. However, the number of turtles visiting the area on an annual basis was much larger, as satellite telemetry revealed the existence of both transient and resident turtles, the former spending only a few weeks in the area. Actually, aerial surveys revealed higher abundance of turtles in late summer and early fall, probably because of the arrival of transient turtles. This makes it difficult to compare the annual bycatch of loggerhead turtles in the area with the turtle stock size estimated from aerial surveys. Nevertheless, satellite tracking suggested a very high annual mortality rate of the tracked turtles (0.626, IC 95%: 0.566-0.716) corroborating that the continental shelf off the Ebro Delta – Castellon is a sink for loggerhead turtles in the western Mediterranean. Currently, the area is closed to bottom trawlers for one month every year, but mostly during the warm season, and upon decision of fishermen associations of each harbour. However, the concentration of most of the incidental captures from trawlers occurred in winter months, when turtle abundance declines according to satellite tracking and aerial surveys but turtle vulnerability may increase due to low water temperature. Overall, the random distribution of loggerhead turtles on the continental shelf and the seasonal bycatch distribution described suggest that a correct seasonal closure is probably a better measure to reduce loggerhead turtle bycatch rather than a proposed no-take zone where bottom trawling would be forbidden year-round. The overall evidence suggests that moving the closed season to late winter will be highly beneficial for the conservation of sea turtles in the western Mediterranean.

RENATURA'S BY-CATCH RELEASE PROGRAM

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A by-catch release program was created in 2005 to address the problem of the great number of sea turtles accidentally caught in artisanal fishing nets. Two agents go every day to coastal villages to meet fishermen there. A participative approach has been developed in which fishermen who release sea turtles receive the necessary amount of wire bobbins or net pieces to fix the nets damaged while releasing the turtle. This project is very popular and has been adopted by WCS from 2006 onward. A tourism activity has been set up around this program to fund some community projects. Over 17,000 marine turtles have been released since 2005. The program also helped the identification of a major feeding site for juvenile green turtles in the Loango Bay. Unfortunately, in 2012, an important marine pollution due to the dredging operation in the Pointe-Noire Port has impacted the rocky area. By-catches have thus decreased. Renatura has decided to study the fisheries effort in order to understand the origin of this reduction: less turtle or less nets?

SIX YEARS OF CONSERVATION EFFORTS IN THE SOUTH OF TORTUGUERO NATIONAL PARK, COSTA RICA

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Global Vision International, working the southern end of Tortuguero National Park, with the support of Sea Turtle Conservancy, works through the conservation of the green sea turtle covering 4 miles of the beach. With the support of volunteers from all over the world the conservation efforts to protect the sea turtles everyday become more real and strong. In partnership with the Costa Rica government, we work to conserve Tortuguero Beach and turtles. Tortuguero beach is one of the most important nesting sites of the endangered green turtle in the Western Hemisphere. Tortuguero is also the site of the longest running sea turtle monitoring program in history, having begun in 1955. The green turtle population is believed to have come perilously close to extinction in the 1960s when nearly every female turtle arriving to nest in Tortuguero was taken for the export market. Some of the biggest impacts are the illegal clear-cuts within the park that have created access for poachers to the second largest green sea turtle nesting beach in the World. Targeting the females that come ashore, as well as the eggs that have been laid. Poachers flip the turtles over under the cover of the night as they crawl onto the beach to nest. The turtles are placed in waiting boats and transported where they are butchered with turtles illegally harvested. Of shore harpooning efforts are seen targeting turtles mating. This impact has been maintained throughout the years. However, for the past 6 years GVI has been working to conserve and protect the south end of Tortuguero National Park, and have

witnessed a significantly reduction in the Illegal activities in this 4-mile section due to the constant presence of volunteers in the beach. Another impact observed by GVI is the jaguar depredation of sea turtles, even though the impact is less than 2% of the population, it becomes an interesting topic of study between these two endangered species.

TOO CLOSE YET TOO FAR; TWO NESTING POPULATIONS IN TAIWAN SHOWED DIFFERENT TREND OF CHANGE OVER 18 YEARS

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Sea turtles are endangered species, facing both natural disturbance and anthropogenic threats. Their long-lived characteristics and wide range of distribution stress the importance of long-term ecological studies to determine the major threats to the population. Two nearby nesting populations in Taiwan showed distinctly different trends from 1997 to 2004, with the Wan-an population decreasing significantly while the Lanyu population showed no long-term change; with peak abundance every 3 to 5 years. Analyses suggest that illegal poaching of sea turtles in the sea from China might be the main reason for the decrease in recruitment in the Wan-an nesting population. Both the Wan-an and Lanyu nesting rookeries are small populations. The negative impacts can magnify the effect and increase the variation in population, thus threatening the survival of the population. On the other hand, as long as recruitment is maintained at a similar level each year, the small population will be able to continue to survive. Regional and international sea turtle management treaties are desperately needed to save the depleted population from extinction.

ASSESSING SEATURTLE BYCATCH IN THE ECUADORIAN SMALL-SCALE GILLNET FISHERY AND TRIALING NET ILLUMINATION AS A MITIGATION MEASURE*

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Bycatch in fisheries is the main threat for many threatened species worldwide. Ecuador has one of the largest fishing fleets in South America, with over 45,000 small-scale vessels. Ecuadorian legislation encourages wildlife protection, including bans on the capture, processing and domestic or international commerce in sea turtles (Acuerdo Ministerial No.212). Ecuador has achieved important goals towards the protection of marine ecosystems, including the implementation of a network of marine reserves, and by being a Party to the Inter-American Convention for Sea Turtles and the Convention for Migratory Species. Despite these advances, bycatch in Ecuadoran fisheries remains understudied. The purpose of this study was to assess bycatch levels and to test mitigation measures to reduce these interactions in the gillnet fishery operating from the Santa Rosa and Jaramijo fishing ports. This gillnet fishery targets pelagic fishes

including common dolphinfish, skipjack tuna, yellowfin tuna, and blue and striped marlin. Since January 2014 we have monitored 98 fishing trips (258 fishing sets) and observed 39 turtles incidentally caught. Species composition was 48.7% olive ridley turtles (*Lepidochelys olivacea*), 43.6% green turtles (*Chelonia mydas*), and 7.7% leatherback turtles (*Demochelys coriacea*). The observed mortality rate was 10.3%. As a follow-up to this assessment, in October 2015, we began testing in this same fishery net illumination using LEDs as a potential mitigation measure. We reported 2 individuals caught that in illuminated nets, compared with 12 individuals captured in the control (without lights) nets. This represents a statistically significant 85.7% reduction in bycatch using illuminated nets (p = 0.005). Turtle bycatch CPUE for control sets was 0.025 ± 0.047 turtles/set while with illuminated nets was 0.0041 ± 0.021 turtles/set. There was a non-significant increase in target catch of 7.2% in illuminated nets (1.63 ± 2.63 fish/set) compared with control nets (1.41 ± 2.65 fish/set). These preliminary results suggest that while sea turtle bycatch rates in Ecuador are high, the use of net illumination might help reduce these levels, and do so without affecting the catch levels of target species. This also offers a valuable opportunity to involve local fisheries in turtle conservation.

WILD-CAUGHT SHRIMP IMPORTS INTO THE EU AND ASSOCIATED IMPACTS ON MARINE TURTLE POPULATIONS: THE NEED FOR ACTION*

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Trawl fisheries have long been recognized as having a major negative effect. The primary cause of impact on marine turtles is due to incidental catches that cause injury or drowning. Of all the forms of trawling, it is those operations that target shrimp in the tropical regions of the world that have received most attention due primarily to the shared habitat between tropical shrimp and marine turtles together with a widespread lack of effective management measures. Tropical Shrimp Trawls (TST) have been noted to account for more turtle deaths than all other human activities combined and new estimates, over the 2008 to 2013 period, average the total annual catch of shrimp from selected TST operations globally over 1 million tonnes, resulting in the bycatch of over 500,000 turtles annually. The problem can be greatly reduced by using a Turtle Excluder Device (TED) - designed to divert marine turtles (and other large marine fauna and objects) through an escape hatch while retaining shrimps. With a well-designed TED and collaborative implementation programme, target catch losses can be minimized. Of particular importance to incentivise TED usage are regulatory measures. Most notably, foreign fleets wishing to export shrimp to the US have to first demonstrate to the US government that their operations are conducted in a manner of comparable effectiveness to the turtle conservation measures that US domestic shrimp trawlers are obliged to meet. This measure has had a critical effect on major shrimp exporting countries globally, saving thousands of turtles a year. Approximately 40 countries and one economy are currently certified to export shrimp to the United States (US). However, the European Union (EU), the largest single market for fisheries products in the world, has no such regulation, thus providing an alternative market to countries that can't export to the US. We would like to outline the need and rationale for the European Union (EU) to enact a regulation that requires the adoption of effective marine turtle bycatch mitigation measures, such as TEDs, by countries

that export tropical trawl-caught shrimp into the EU. The report generates new estimates of the degree to which the EU is implicated in marine turtle bycatch by virtue of accepting these imports.

GHOST NETS JEOPARDISE THE REMAINING OLIVE RIDLEY POPULATIONS OF THE SE ASIA – W PACIFIC REGION*

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Derelict fishing gear is known to affect marine wildlife and ecosystems through entanglement, ingestion and smothering. Numerous "ghost nets" circulate in the shallow habitat for several species of sea turtles. Each year, thousands of tonnes of ghost nets wash up on North Australian shores containing several hundred sea turtles. Olive ridley turtles (*Lepidochelys olivacea*) appear to be particularly prone to entanglements in these nets. The north Australian olive ridley nesting population is believed to be the largest breeding population remaining in the southeast Asia–western Pacific region and potentially unable to sustain this annual mortality. With virtually no information on the origin and quantity of the nets adrift, it has been extremely difficult to estimate their potential impact, and management has thus far focused only on removing the nets from the beaches and burying the dead turtles. With this study, we aimed to predict where turtles are most likely to come into contact with ghost nests and which olive ridley stocks are most imperiled. We used a spatially‑explicit physical modelling framework to quantify where and when ghost nets likely accumulate across this region. High risk areas were identified by intersecting these net accumulation areas with satellite-derived olive ridley migratory pathways between nesting and foraging habitat. Finally, we applied population genetic techniques to identify the origin of entangled olive ridley turtles. Across the Arafura and Timor Seas we found several distinct ghost net accumulation areas which vary across seasons. Our empirical and modelling work suggest that olive ridley turtles are particularly vulnerable in one high-risk net accumulation zone. Genetic data also confirm the broad-scale reach of ghost nets on entangling, killing, and transporting olive ridley individuals to Australian shores, with West Papuan (Indonesia) and Arnhem Land (Australia) stocks at greatest risk. With this multi-disciplinary approach we identified a ghost net – turtle interaction hotspot area at sea, where implementation of mitigation activities will be of critical importance for the persistence of Southeast Asian and Western Pacific olive ridley populations.

HUMAN IMPACTS ON A SEA TURTLE BIODIVERSITY HOTSPOT IN THE NORTH PACIFIC, CAST OMINOUS THREATS FOR THEIR NESTING POPULATIONS*

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We describe a sea turtle biodiversity hotspot located on the western coast of Baja California Sur. Historically, this has been eroded (from the genetic to the phylogenetic level) mainly by bycatch and illegal trade, and in the short term might suffer additional losses due to a submarine mining project promoted by Exploraciones Oceanicas (a Mexican subsidiary of the US Company, Odyssey Marine Explorations), which would entail dredging 91,000 acres of seabed to extract 350 million tons of phosphate over a fifty-year period, raising serious concerns about its effect on sea turtle populations in the North Pacific. The mining project will take place at Golfo de Ulloa where, as stated, non-selective artisanal fisheries, incidental bycatch, traditional consumption and illegal poaching and trade, threaten the long-term viability of formerly abundant sea turtle populations (loggerhead: *Caretta caretta*; green: *Chelonia mydas*; olive ridley: *Lepidochelys olivacea* and hawksbill: *Eretmochelys imbricata*). By following standard protocols, we isolated mitochondrial control region sequences ($\approx$ 900 bp) from tissues collected from dead sea turtles found on the beach or at dumpsites in the area, displaying signs of bycatch (e.g. fishing gear debris) or human consumption (n= 456). By using the Basic Local Alingment Serct Tool (BLAST), all obtained sequences were compared to those stored in the nucleotide domain of the National Center of Biotechnology Information, to find that the loggerhead turtle was the most affected species (n=227) followed by green (153), olive (65) and hawksbill (11). Bayesian population assignment tests performed with the Mixtock software pointed out that one single, quite imperiled loggerhead population is being affected by human impacts in the area; it was interesting to note that beside green turtles nesting in Mexican Rookeries (e.g. Revillagigedo, Colola and Maruata), individuals arrive from quite distinct and distant populations (e.g. the Hawaiian archipelago, USA [$\approx$0.02], the Galapagos archipelago, Ecuador [$\approx$0.06], and Gorgona Island, Colombia [$\approx$0.06]). Bayesian population assignment tests also pointed out the admixture of at least two olive ridley's mainland nesting colonies in the area. Such marked stock admixture points to the Gulf of Ulloa as a sea turtle biodiversity hotspot in the North Pacific Ocean, where also neutral and likely adaptive sea turtle genetic diversity, is one of the largest found in a feeding ground of these species. Pairwise comparisons of functional and phylogenetic sea turtle diversity, between our study area and renowned nesting rookeries revealed unequal representation of each component in the Gulf of Ulloa, where phylogenetic diversity was significantly over-represented, stressing the need to adopt an integrative approach to sea turtle biodiversity conservation.

A GEOSTATISTICAL MODEL FOR EVALUATING THE INTERACTION BETWEEN SEA TURTLE AND ARTISANAL FISHERIES OFF THE NESTING BEACHES IN GUERRERO AND OAXACA, MEXICO*

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Because of the drastic decline in population density of many species of sea turtles in the last decade, all of them are categorized within the protection and/or conservation status at a national (NOM-059) and international (IUCN) level. There are several reasons for this decline, but in recent years two of them have taken on great importance, the first one is the lack of information about the zones they used during their inter-nesting time and the second one is that, interactions with artisanal fisheries at a regional level are not yet fully described, making it difficult to design, implement and evaluate strategies for sea turtle conservation in this zone. In this study, the determination of geographical regions conforming fishing areas was done in terms of : 1) the abundance of commercial fish species, 2) species sighting (leatherback turtle (*Dermochelys coriacea*), olive ridley (*Lepidochelys olivacea*) and green turtle (*Chelonia mydas*)) , and 3) type of interactions that occur with the six main artisanal fisheries in the study area: pacific red snapper (*Lutjanus peru*), Spotted red snapper (*Lutjanus guttatus*), pacific sierra (*Scomberomorus sierra*), ocean whitefish (*Caulolatilus princeps*), green jack (*Caranx caballus*) and green spiny lobster (*Panulirus gracilis*). All these groups were statistically compared to determinate regions. Using a Bayesian approach allowed the unequivocal determination of four regions in terms of abundance (AB1, AB2, AB3 and AB4), three regions in terms of sightings (AV1, AV2 and AV3), three regions in terms of the type of interactions (IN1, IN2 and IN3), and shows three statistical associations (leatherback-red snapper, whitefish–ridley and whitefish-green) in terms of geographical location. Also, we applied a predictive model (kriging) in all regions to determine where of interactions occur with higher likelihood. The comparison of this result with in situ data obtained by satellite telemetry for leatherback turtle was also made. For all of the above, the aim of this study to provide tools and methodologies of analysis to make informed decisions for conservation and management programs of these species and in order to develop integral solutions was fulfilled.

ALMADRABAS IN THE STRAIT OF GIBRALTAR AND ALBORAN SEA: A LETHAL LABERINTH FOR SEA TURTLES*

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Almadrabas, a millenary fishing art already used by Romans, are still in use in some parts of the Mediterranean, including Italy, Malta or Spain, with Spain having the highest number, especially in the Strait of Gibraltar and Albertan Sea. Numerous turtles have drowned or are trapped in the Almadrabas net

labyrinth, as well as cetaceans such as dolphins and small whales. Three of these Almadrabas have been monitored since 2000, with the highest number of captures occurring in 2013 when captures reached the alarming number of 53 dead loggerhead turtles and 7 dead leatherbacks during the 2 month peak along 10 miles of coast. During this time, 2 leatherbacks and 5 loggerheads were captured alive and released. In response, the Ministry of Environment reduced the number of Almadrabas to two, forced them to undertake strict day and night surveys, and submit captured animals to the rescue center. As a result of these changes, captures of dead animals were greatly reduced and for the first time, live rescued turtles significantly surpassed the numbers of dead ones. In addition to these changes, turtle excluder devices are under investigation for this type of net.

TAG, YOU'RE IT. TAG RETURNS AND REMIGRATION INTERVALS: A POSSIBLE CLUE IN THE DECLINE OF KEMP'S RIDLEY NESTING SINCE 2010

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In a New York Times article in 1996, Richard Byles, the National Sea Turtle Coordinator for the U.S. Fish and Wildlife Service proclaimed, "the Kemp's ridley has been saved from extinction, barring some 'unforeseen catastrophe." Then, in April 2010, the "unforeseen catastrophe" may have happened with the Deep Horizon oil spill. Much has been published and publicized about the dramatic decline in Kemp's ridley nesting numbers since the 2009 nesting season. The scientific community continues to provide data while population modelers have been working diligently to hypothesize theories to find "best fit" population models. One possible theory emerging as a strong candidate for the decline is a lengthening of the remigration interval between nesting seasons as a reflection of available resources at feeding grounds. This study examines historic and current remigration nesting intervals and clutch sizes of female Kemp's ridley sea turtles utilizing the beaches of South Texas (South Padre Island and Boca Chica Beaches) in comparison to documented values for nesting beaches in Tamaulipas, MX to examine recent trends in Kemp's ridley nesting physiology. South Texas beaches have been monitored by Sea Turtle, Inc. with constant patrol effort since 2006. Average clutch sizes found on South Texas beaches coincide with documented averages on primary nesting beaches in Tamaulipas, MX, with no discernible inter-annual variation. The beaches of South Padre Island and Boca Chica collect only between 30 and 70 Kemp's ridley nests annually, but anecdotal evidence from tag returns suggests that the remigration interval of Kemp's ridley sea turtles has lengthened in recent years. Historical records identify an average Kemp's ridley remigration interval of 1.8 to 2.0 years. Females with tags observed during the 2010 nesting season (n=13), mostly returned in 2012 (n=6) within the expected remigration period while 1 female nested 4 years later in 2014. Comparatively, tagged females nesting in the 2011 season were not observed during 2012, 2013, or 2014 nesting seasons, but 5 of the 15 tagged individuals returned in the 2015 nesting season with a remigration period of 4 years. Of 17 tagged females in 2012, only 2 have since returned (in the 2014 and 15 seasons respectively). Finally, of 12 tagged nesting females observed in 2013 expected to return in 2015, none have been recorded on South Texas beaches. Tag information evaluated in this study may help provide an important clue to population modelers and the entire Kemp's ridley scientific community as we prepare to "save" this species from that "unforeseen catastrophe."

COLLABORATIVE FISHERIES RESEARCH CAPACITY-BUILDING TO REDUCE MARINE TURTLE BYCATCH IN FISHERIES GLOBALLY: A GROWING NEED AND OPPORTUNITY AMONG FISHING INDUSTRY AND SEA TURTLE CONSERVATION NGOS*

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The capture of marine turtles in fisheries is one of the most significant threats to marine turtles (MT) today. Every year hundreds of thousands of MT die through bycatch in fishing gear worldwide. Today scientists and conservationists have learned that one of the best ways to find solutions that both reduce MT bycatch and maintain the livelihoods of fishers is by working together. At the 2014 International Sea Turtle Symposium (ISTS) meeting in New Orleans Louisiana (LA) a special capacity-building training session on how to achieve such solutions through the Collaborative Fisheries Research (CFR) method was conducted by Virginia Sea Grant and WWF. A comprehensive survey of ISTS members was conducted to determine the level of experience and interest in CFR within the Sea Turtle community. ISTS is composed of sea turtle biologists, conservationists, educators and advocates dedicated to the research and conservation of sea turtles. In addition, many national government agencies attend ISTS and were among the 101 respondents to the survey. We will present data on the geographic scope of work globally, types of fishing industry sectors and gear ISTS members have worked with, nature of those collaborations, and the nature of forthcoming CFR activities. Overall, responses reflect a growing need and interest from the international community in working on fisheries and bycatch through CFR, and findings characterized existing capacity, needs, global gaps, and opportunities for CFR. Clear opportunity for CFR growth exists, e.g. 80% of respondents interested in CFR indicated that they planned to work on fisheries and bycatch reduction related issues; 46% of individuals indicated that their interest in learning more about the CFR approach stemmed from their desire to cultivate skill sets and to learn from others; and 41% indicated their desire to develop partnerships and collaborations with industry and other scientist working on similar issues. We will discuss the findings and further outcomes from the 2014 ISTS CFR capacity-building training session, ramifications for CFR globally, and next steps currently underway and planed by the CFR capacity-building partners.

REDUCING THE IMPACT OF ARTIFICIAL LIGHT ON SEA TURTLES

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Sea turtles are affected by many human-caused problems in the water and on land. There is widespread agreement that on some nesting beaches one of the biggest impacts that can be sensibly fixed is problematic or poorly-managed lighting. Artificial light sources confuse and disorient both adult and hatchling sea

turtles. The result is fewer females nest on lighted beaches, while disoriented hatchlings wander toward landward sources of light and often die in the process. Tens of thousands of hatchlings disorient annually in Florida. In order to mitigate the impacts of the 2010 Deepwater Horizon Oil Spill, the Sea Turtle Conservancy (STC) received funding to implement a successful lighting retrofit program that uses mobile GIS technology to evaluate and track properties with problematic lights. STC also developed an education workshop to train local code enforcement officials on how to identify and correct problems themselves. Since 2010 STC has retrofitted problematic lights on 164 properties resulting in the darkening (restoration) of an estimated 98,400 linear feet or 18.6 miles of coastline (29.9 km). Lights are still being used in these areas, but they have been lowered in height, shielded and lamped with amber LED bulbs, producing long-wavelength light that is less disruptive to sea turtles. The result is a measured reduction in lumens reaching the beach, a reduction in nest disorientation rates and, as an added bonus, a decrease in energy costs. Because a large proportion of Florida's economy is tourist and retiree based, reducing the amount of beachfront light can be met with resistance. This is especially true in areas that have lax or unenforced lighting regulations. Regional partnerships between government officials, permitted nest monitoring groups, lighting distributors and concerned homeowners, in conjunction with an established lighting protocol, may be the best solution to reduce lighting impacts for the foreseeable future.

EAST COAST VS. WEST COAST: DO GEOTEXTILE CONTAINERS AFFECT SEA TURTLE NESTING?*

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As a result of Florida's coastal development, many of the state's beaches are classified as critically eroding habitat. These beaches also host some of the most important sea turtle nesting grounds in the world. Historically, homeowners relied on hard armoring technologies (rock revetments and seawalls) to protect their homes from coastal erosion. In recent years, mounting evidence suggests that hard armoring causes detrimental effects to sea turtle nesting habitat. Therefore, new technologies are being designed by coastal engineers. One of these solutions is a geotextile container system (geotube) which involves burying large, plastic, sand filled bags at the dune toe. The Florida Department of Environmental Protection has issued a small number of permits to construct geotubes even though little is known about their impacts on sea turtles. This study looks at the effects of two geotubes; one that was installed in Palm Beach County, Florida in 2014 (east coast) and one that was installed in Sarasota, Florida in 2011 (west coast). For the east coast geotube, loggerhead nesting success was not significantly different when comparing the two years prior to installation (2012-2013) vs. the two years after installation (2014-2015) ($X2=2.592$, df= 1, p=0.107). However, green turtle nesting success was significantly lower after the geotube installation ($X2=5.281$, df=1, p=0.022). When turtles crawled to within 5 meters of the structure, nesting success was significantly lower after the installation for loggerheads ($X2=4.702$, df=1, p=0.030) and green turtles ($X2=8.679$, df=1, p=0.003). For the west coast geotube, overall nesting success for loggerheads was not significantly different when comparing the two years prior to the geotube installation (2009-2010) vs. the two years after installation (2011-2012) ($X2=0.128$, df=1, p=0.720). For loggerheads that crawled within 5 meters of the structure, nesting success was not statistically significant after construction of the geotube ($X2=0.0003$, df=1, p=0.985). Green turtle nests are rare on the west coast of Florida. Therefore, analysis of green turtle

nesting success could not be performed. The east coast loggerheads that crawled within 5 meters of the structure did false crawl more frequently after the installation of the geotube. However, since loggerheads tend to utilize the mid-beach area to lay their nests and the beach was significantly wider after the construction of the geotube, overall nesting success was not affected. Unlike loggerheads, green turtles utilize the upper third of the beach for nesting. Since the geotube structure re-created the dune system, green turtles were affected. Their nesting success was lower than expected which could be a result of the artificial slope and/or the type of sand used to cover the sandbags. Interestingly, the west coast loggerheads did not false crawl more frequently when in close proximity to the structure; however, low accuracy (~15ft) GPS units used to document crawls in Sarasota, Florida may have influenced this result. In the future, more detailed studies need to be conducted to evaluate the appropriate slope and sand type used in the construction of geotube systems to minimize impacts on sea turtles.

LONG-TERM STUDY OF DUNE RESTORATION EFFECTS ON LOGGERHEAD (*CARETTA CARETTA*) AND GREEN TURTLE (*CHELONIA MYDAS*) NESTING PATTERNS

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Understanding the effects of beach reconstruction is vital for conserving sea turtle nesting habitat in Florida. With increasing urban development near nesting beaches, beach managers are forced to consider the concerns of private landowners while keeping beach conditions suitable for the sea turtles who return every year to nest there. Solutions range from permanent structures, like seawalls and groins, to beach renourishment projects that add sand to the beach. In some renourishment projects, the sand is added to increase the width of the beach, while in others, smaller amounts of sand are added only to the dune (hereafter called dune restoration). Due to the extreme effect of permanent structures on natural beach dynamics and the high density of nesting in the area, Brevard County managers chose to conduct dune restoration within the Archie Carr National Wildlife Refuge (ACNWR) after Hurricane Sandy caused extreme erosion in 2012. This study will examine how dune restoration affected sea turtle nesting within the ACNWR. This construction, and similar projects in 2005, 2006, 2008, and 2009, were monitored by the University of Central Florida Marine Turtle Research Group. Over this time frame, sand deposits have averaged 115,760 cubic yards of sand per year, with 692,418 cubic yards deposited in 2014. This monitoring has documented differing effects on the nesting success (i.e. the percentage of nesting attempts that result in a clutch being deposited) of the two primary species that nest there: loggerheads (*Caretta caretta*) and green turtles (*Chelonia mydas*). Both of these species nest above the mean high tide line, but loggerheads prefer nesting before the dune, whereas green turtles tend to nest further up the beach, including the dune. These differences are hypothesized to lead to the differing effects we document, but this hypothesis has never been explicitly tested. In the process of monitoring the effects of dune, we recorded the position relative to the dune construction of every nesting attempt, allowing for comparisons both among species and over the two nesting seasons since construction. Using these data, we aim to understand the differing effects of dune restoration on loggerheads and green turtles and how to improve dune restoration projects in the future.

SEA TURTLE BY-CATCH IN THE GULF OF GABÈS, TUNISIA: WHAT TREND?

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The Gulf of Gabès, located in the Central Mediterranean, is the most important fishing ground in Tunisia and hosts the largest fishing fleet of the country. The area is highly frequented by loggerhead sea turtles *Caretta caretta* and represents one of the most extensive since the 1990s indicate high interaction rates of the loggerhead turtle and various fishing gears. In order to evaluate the trend in by-catch in the Gulf of Gabès, we conducted interviews during 2013 in two large ports in the area: those of Sfax and Chebba. The questionnaires were conducted with local fishermen having experience of not less than 10 years. A total of 63 questionnaires were completed and the information provided suggests: (i) a trend towards a reduction in catch by bottom trawlers although it remains relatively high (more than 2000 turtles/year). Moreover, mortality seems to be more important (0.08 vs. 0.03 turtle/year/boat) (ii) an important interaction with both bottom and surface longlines (iii) that small vessels using set nets (trammel net and gill net) interact highly with sea turtles and cause more incidental or intentional deaths than large vessels typically using bottom trawls (iv) trends for longlines and set net are difficult to evaluate; fishermen can change their gears along the year following seasons, target species and landings importance (v) bycatch occurs throughout the year with a peak in May-June. Measures recommended to reduce sea turtle capture and mortality include: Awareness-raising activity in fishing communities, assessments of mitigation measures to reduce by-catch (circle hooks, TEDs, etc.), expand the studies in space to cover the rest of ports of the Gulf of Gabès and the rest of Tunisian coast.

FISHING AROUND SEA TURTLES: BEST-PRACTICE SUGGESTIONS FOR RECREATIONAL SHORE-BASED FISHERMEN IN HAWAII

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Nearshore recreational fisheries are one of the documented threats that sea turtles face. Interactions with hook-and-line fishing gear can cause entanglement, flipper amputation and death. To address this threat in Hawaii, a multi-agency partnership has established a Fishing Around Sea Turtles (FAST) program to promote sustainable and responsible nearshore recreational fishing around a recovering green turtle population. This program serves as a platform to disseminate information which includes best-practice guidance, State fishing regulations, and practical fishing tips developed by Hawaii fishermen and local experts to reduce or mitigate the effects of accidental interactions. The program also promotes "Turtle Friendly" fishing gear, such as barbless circle hooks and encourages reporting to NOAA's sea turtle

stranding program. Multi-agency field staff throughout Hawaii freely disseminate barbless circle hooks and provide program materials, such as posters and tackle box decals that provide guidance for assisting a hooked or entangled turtle. Fishermen, young and old, throughout the state are taught about the benefits of barbless hooks which support both sustainable fishing practices as they allow for catch-and-release of undersized or unwanted fish to conserve valuable nearshore resources and facilitate the easy release (dehooking) of other non-target species such as protected species, including sea turtles. Thousands of barbless circle hooks have been distributed and their use is gaining popularity as evidenced by a growing number of annual recreational fishing tournaments that now host a Barbless Circle Hook Challenge category. This success is a testament to the consistent and dedicated presence of staff working to support and engage with the fishing community over the past decade. Through this FAST program and dissemination of hooks and educational materials, Hawaii fishermen are becoming empowered to contribute to ongoing conservation efforts. To reach this point, communication between fishermen and state/federal partners has greatly improved. The resulting open and honest conversation between fishermen and Hawaii state/federal staff is likely the greatest success of the program which will continue to develop and improve over time. This poster will provide FAST program highlights and lessons learned which includes key messaging, such as "It's OK to Help." We have found this effectively resonates with Hawaii fishermen. With this one message, we have created proud allies who carry forward the message and feel like sea turtles are now their responsibility.

TRENDS IN THE SIZE AND SEX OF GREEN TURTLES, *CHELONIA MYDAS*, CAPTURED IN THE NICARAGUA FISHERY*

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Green turtles, *Chelonia mydas*, have been fished from the coastal waters of Caribbean Nicaragua by indigenous and ethnic communities for hundreds of years. This legal, artisanal fishery captures thousands of green turtles each year and the meat is sold in coastal communities and towns. Fishery data were collected by local community data collectors, who monitored up to 14 landing sites from 1994 to 2011. We assessed the landings by sex and size of green turtles captured in the fishery, and temporal and spatial variability using General Additive Mixed Models (GAMM). Our results indicate that the size, sex ratios, and maturational status of green turtles captured in the fishery have changed over the 18-yr study period. Characterizing the greens captured in the fishery and understanding temporal and/or spatial dynamics in the size, sex, and life stages of animals captured from long-term monitoring can be used to aid in better understanding potential fishery impacts and improve management of this fishery.

REDUCING GREEN SEA TURTLE BYCATCH IN SMALL-SCALE FISHERIES USING ILLUMINATED GILLNETS: THE COST OF SAVING A SEA TURTLE*

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Gillnet fisheries exist throughout the oceans and have been implicated in high bycatch rates of sea turtles. In this study, we examined the effectiveness of illuminating nets with light-emitting diodes (LEDs), placed on floatlines to reduce sea turtle bycatch in a small-scale bottom-set gillnet fishery. In Sechura Bay, Northern Peru, 114 pairs of control and illuminated nets were deployed. The predicted mean Catch Per Unit of Effort (CPUE) of target species, standardized for environmental variables using generalized additive model analysis, was similar for both control and illuminated nets. In contrast, the predicted mean CPUE of green sea turtles (*Chelonia mydas*) was reduced by 63.9% in illuminated nets. One hundred twenty-five green sea turtles were caught in control nets while 62 were caught in illuminated nets. We also observed an 89% decline on lighted nets in the bycatch of guanay cormorants (*Phalacrocorax bougainvillii*). These statistically significant reductions (GAM analysis, p<0.05) in sea turtle and seabird bycatch suggests that net illumination could be an effective, multi-taxa conservation tool. Challenges to implementing the use of LEDs include equipment costs, increased net handling times, and limited awareness among fishermen regarding the effectiveness of this technology. Cost estimates for preventing a single sea turtle catch are as low as $32 USD, while the costs to outfit the entire gillnet fishery in Sechura Bay can be as low as $8.8K USD. Understanding these cost challenges emphasizes the need for institutional support from national ministries, international non-governmental organizations and the broader fisheries industry to make possible widespread implementation of net illumination as a sea turtle bycatch reduction strategy.

A SUMMARY OF SEA TURTLE BYCATCH REDUCTION TECHNOLOGY TESTING AND DEVELOPMENT IN TRAWL GEAR IN THE NORTHWEST ATLANTIC*

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Turtle excluder devices (TEDs) were implemented in the 1980's in the Southeast U.S. to reduce sea turtle bycatch in the shrimp fishery. In the early 1990's, TED testing began in Northeastern U.S. to determine if TED technology could be applied to other fisheries and target species. In 2001, TED requirements were implemented in the summer flounder (*Paralichthys dentatus*) trawl fishery in the waters off North Carolina.

The Gear Research Group of the Protected Species Branch of the Northeast Fisheries Science Center (NEFSC), with the guidance and assistance of the Greater Atlantic Regional Office and the NOAA's Southeast Harvesting Systems Branch, began research on various bycatch reduction devices (BRDs) in mid-2000's implementing a process that involves close collaboration with industry, fishing communities, managers, and research partners. This work has resulted in twelve publications involving five fisheries, including two industry workshops that guided research in a logical and industry supported direction. This research has greatly improved the knowledge of the effectiveness of these technologies at retaining the targeted catch, excluding bycatch, and testing the operational feasibility of using these BRDs. Through industry partner testing and guidance, underwater video data collection, and flume tank studies, we have become more knowledgeable about how large catch volumes and large species can affect the performance of TEDs. This presentation will summarize the research and strategies employed during past and current work that are attempting to reduce sea turtle bycatch in trawl gear, and discuss future research and direction of this effort.

AN EVALUATION OF A REDUCED BAR SPACING TURTLE EXCLUDER DEVICE IN THE U.S. GULF OF MEXICO OFFSHORE SHRIMP TRAWL FISHERY*

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Shrimp are the most economically valuable internationally-traded seafood commodity. Wild-caught, trawled shrimp make up almost half of the ~6.6 million metric tons of annual global production. Shrimp trawling is responsible for one-third of the world's total fisheries bycatch, leading many to consider shrimp trawling to be the single most destructive fishing practice in the world. Though the bycatch of large marine animals including marine turtles can be significantly reduced by use of turtle excluder devices (TEDs) on shrimp trawls, current TED designs are ineffective at reducing the capture of smaller organisms, which represent a large portion of the total bycatch. To further reduce bycatch in the United States Gulf of Mexico shrimp trawl fleet, a variety of bycatch reduction devices (BRDs) are currently being used in conjunction with TEDs. I evaluated the efficiency of a new TED design, intended to reduce bycatch and maintain target shrimp catch. The new TED model is characterized by 5-cm spacing between flat bars, as opposed to the current industry standard of 10-cm spacing between round bars. Comparative towing experiments under standard commercial shrimp trawling operations in waters off of Georgia, Texas and Mississippi during the summer of 2012 demonstrated shrimp losses or gains of -4.32%, +6.07%, -1.58% respectively and an overall reduction in the capture weight of sharks (41.1-99.9%), rays and skates (76.5-93.4%) and horseshoe crabs (100%). These experiments were limited in time and space, and therefore not fully representative of fishing conditions throughout the year, but this study demonstrates the new TED's effect on the catch rates of target shrimp and bycatch. This research should lead to a broader understanding of the benefits of using reduced spacing flat bar TEDs in the U.S. shrimp trawl industry and highlight the fact that TEDs can do much more than reduce the bycatch of sea turtles.

REDUCING BYCATCH EFFECTS ON SEA TURTLES: THE IMPORTANCE OF ADDRESSING POST-RELEASE MORTALITY

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Incidental capture of sea turtles in shallow-set longline fisheries is known as an important cause for the decline of some sea turtle populations worldwide. Over the years a large number of studies have been conducted to identify ways to reduce the effect of longline gear on sea turtles, such as changing bait, depth of gear, time of gear deployment and retrieval, or changing the size and shape of hooks. In some instances the "magic formula" has been found, greatly reducing turtle bycatch, but other fisheries are still far from this point, with no definitive solutions in this respect. While ways to reduce turtle bycatch are found, the only effective way of reducing the impact of such bycatch on turtles is reducing post-release mortality. This can be achieved by improving onboard handling, hook-removal and release techniques of captured animals. The knowledge to implement this aspect of bycatch reduction is already available and only needs to be effectively transmitted to the fishing community. Since 2006 Submon has trained around 650 longline fishermen, observers and managers in countries as diverse as Spain, Italy, US, Canada, Colombia, Ecuador, Costa Rica, Guatemala or Mexico. These training events are well received by fishermen, and perceived as an easy way to help sea turtles, without going through complicated changes in their gear or fishing routine. They understand the importance of their actions on board, and the fact that a change in those actions can entail important benefits. There is still much to be studied on post-release mortality of captured turtles, but there is a great deal of already available information on anatomy and physiology, which can be translated into specific actions to greatly reduce mortality rates in some situations. Two factors are important when training fishermen: 1) the trainer must have ample experience working on board fishing vessels with turtles – someone who can answer fishermen's doubts and questions, who understands the variety of situations on board a fishing vessel and knows how to adapt to them. Only then will the trainer get the fishermen's attention and respect, and will they feel respected; 2) simply telling fishermen what to do or not to do is not enough; the reasons behind need to be explained – this type of training is about providing fishermen with knowledge to be able to decide what to do in each situation and to gain responsibility over their acts and decisions.

EVALUATION OF THE INCIDENCE OF BOATS STRIKES IN GREEN TURTLES (*CHELONIA MYDAS*) AT THE MOST IMPORTANT NESTING SITE IN THE GALAPAGOS ISLANDS

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The Galapagos archipelago has the second largest and important reproductive stock of green sea turtles in the Eastern Tropical Pacific. Furthermore, the Islands provide important feeding areas for the resident population that are concentrated around the coastal zones, with some turtles migrating to feeding grounds in Central and South America. While the Islands provide good conditions for green sea turtles, the increase of anthropogenic activities in both feeding grounds and nesting sites threaten the sea turtle population. Threats include boat strikes, interactions with fishing activities, and intake and consumption of waste. The objectives of this project were to provide information on the use of the nesting zones on the most important nesting beach in the archipelago (Quinta Playa) by female sea turtles, determine the distribution of marine traffic in and close to this nesting beach, and determine the incidence of boats strikes on reproductive females. For this study, the boat traffic in the nesting zone velocity of the speed boats. At the same time, five nesting females at Quinta Playa were outfitted with satellite tags (FastLoc F4H 47IA © Sirtrack) to determine habitat use and spatial distribution. To analyze the risk of boat strikes on turtles, the movements of the tagged turtles were mapped together with the speed boats routes to identify areas of overlap. Furthermore, nesting females were evaluated for any injuries during the monitoring of nesting turtles on Quinta Playa from December 15, 2012 to May 30, 2013. Each turtle was thoroughly examined for lesions on the carapace as well as on front and rear flippers, and around the head and neck area. Injuries for each female were recorded on a full body image, noting the following details: location, length, depth, and type of injury (cut, fracture, hole, lack of a piece of carapace, mutilation of limbs). The results of this study showed that the movements and distribution of satellite tagged turtles, as well as the movement and distribution of boat traffic through the nesting zone, showed areas of overlap. The analysis of the relationship between the abundance of turtles and the frequency of boat trips showed a greater abundance of turtles in or close to the nesting areas from November to May, which when combined with increased activity of boats traveling to the nearby tourist sites increases the probability of accidental injuries to turtles. Furthermore, the assessment of injury to turtles at the nesting zone shows that of the examined turtles, 25% (n = 366) presented injuries, mainly in the carapace, with 12% (n = 170) identified as having signs of boat strikes. The most frequent injuries observed were holes in the carapace (29%, n = 49) and cuts (28%, n = 47). This study shows that there are areas of interaction between sea turtle habitat and routes used by tour boats within the GMR and that turtles are distributed primarily in coastal areas (within the first four miles from shore). Based on the findings, we recommend management measures are developed to regulate the marine traffic within the GMR, that ensure the protection of the sea turtle and their key habitats in Galapagos, especially during the reproductive season.

DEVELOPING ACOUSTIC DETERRENTS TO REDUCE SEA TURTLE BYCATCH IN GILLNET FISHERIES*

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The accidental capture, or bycatch, of sea turtles in gillnet fisheries is a significant threat to the recovery of sea turtle populations globally. Despite the widespread use of gillnets and their high levels of bycatch, few bycatch reduction strategies and technologies are available for this gear type. Acoustic deterrent devices (ADDs or pingers) have been used to reduce the bycatch of marine mammals in some fisheries, but their efficacy has not been evaluated for sea turtles. We examined the potential efficacy of low-frequency ADDs in reducing interactions of green sea turtles (*Chelonia mydas*) with gillnets in known foraging areas in Bahía de Los Angeles, Baja California, Mexico using paired experimental ADD and control nets. As commercial low-frequency ADDs are unavailable, we developed field-deployable ADDs that were a combination of a speaker hung at depth on the net and a floating waterproof case containing a digital recorder/player, battery, and speaker amplifier. The ADDs generated alternating 200 and 400 and 300 and 500 Hz tones, 1 second in length, presented every 10 seconds at 139 dB re: 1 µPa at 1 m, and were placed every 20 meters along the net. To confirm sounds from the experimental ADD net were not detectable at the control net, we used a hydrophone and digital recorder to measure the sound field at each net during each trial. During 17 paired trials in 2014 and 2015, we captured 13 turtles in control nets (mean catch per unit effort: 1.84 turtles/100 m net/12 hours) and 4 turtles in experimental ADD nets (mean catch per unit effort: 0.684 turtles/100 m net/12 hours), indicating that the presence of ADDs reduced mean catch rates of green turtles by 65%. ADDs have previously been dismissed as a potential sea turtle bycatch reduction strategy because of the similar low-frequency hearing sensitivities of sea turtles and fishes and the subsequent expectation that even if the devices were effective in reducing the bycatch of turtles, ADDs would also reduce the catch of target species. However, in fisheries for flatfish, which have very poor low-frequency hearing capabilities, ADDs could be designed to produce acoustic cues detectable by turtles, but not by the target species. In these fisheries ADDs have the potential to reduce the bycatch of sea turtles without reducing the catch of target species. Our results illustrate the potential for using sensory cues, and in particular, sound to warn sea turtles of the presence of fishing gear and reduce sea turtle catch rates, and suggest further research and development of acoustic bycatch reduction strategies for sea turtles are warranted.

EFFECTS OF ARTIFICIAL LIGHTING ON NESTING AND HATCHLING LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) ON ST. GEORGE ISLAND, FL, USA

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Artificial lighting associated with coastal development has been criticized for the repellent and disorienting effects it can have on sea turtles using beaches as a nesting site. While many communities have attempted to regulate artificial nighttime lighting via a reduction in broad-spectrum light reaching the beachfront, inconsistent policies and enforcement have left some populations of sea turtles still vulnerable. To assess how an inconsistent reduction of artificial lighting could affect sea turtles, we proposed two questions: (1) Does variation in light intensity across a known nesting beach affect the arrangement of successful nesting attempts by sea turtles? (2) Does varying light intensity along the length of a nesting beach affect the distribution of hatchling disorientation events? We measured beachfront luminance during the 2015 nesting season within the residential portion of St. George Island, FL, USA, which has been monitored for loggerhead sea turtle (*Caretta caretta*) activity since 2001. We divided the beach into 500-meter sections and recorded multiple perspectives of luminance for comparisons with the frequency of nesting events in each area. The hypotheses tested were: (1) Increased light intensity significantly decreases the number of nests and nesting attempts in each section. (2) Luminance values have a significant relationship with the rate and number of documented hatchling disorientations. There was a negative relationship between luminance and nest arrangement, as nests and nest attempts significantly decreased in brighter sections of the beach. Therefore, the first hypothesis is supported and we are further evaluating the second hypothesis. These results reveal the impact of varying artificial lighting on the spatial distribution of nests and will help policy makers improve regulations and enforcement involving beachfront lighting. Acknowledgments: We would like to thank the Friends of the Apalachicola National Estuarine Research Reserve, Jack W. Schrey Distinguished Professorship, The Leatherback Trust, and Goldring Family Foundation for research support, as well as the Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria, and World Wildlife Fund for support through International Sea Turtle Society travel funds.

ILLEGAL FISHING AND ITS IMPACTS ON SEA TURTLES IN TERENGGANU STATE, MALAYSIA*

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Illegal, unreported and unregulated fishing (IUU) is a pervasive problem for fisheries management and maritime security in all of the world's oceans. Operating outside of prevailing regulatory structures, IUU may potentially place additional pressure on species already under threat from fisheries bycatch and overexploitation. Furthermore, IUU has been associated with poaching and wildlife trafficking of protected species such as sea turtles. Incidents of IUU involving sea turtles have been reported in Malaysia and Southeast Asia generally, but a lack of high seas and portside enforcement makes it difficult to gain meaningful information on the causes and extent of the problem. In order to identify management priorities and better understand the regional impacts of IUU on sea turtles, our study aimed to describe the motivations and practices of IUU fishers operating in Malaysian waters. During September 2015, we interviewed sixty local fishermen at major fishing ports throughout the state of Terengganu, Malaysia. Our results indicate that a high proportion of IUU fishing in Terengganu (50-75%) is done by foreign boats from countries such as Vietnam, Thailand, Myanmar and Bangladesh. Over 65% of respondents reported that sea turtles are intentionally targeted in Malaysian waters by foreign IUU boats. We found that consumption is the primary use for turtles captured by IUU fishers, although transshipment at sea to domestic and international markets was also identified as a likely outcome. Tactics to evade maritime enforcement personnel included fishing at night, operating during the monsoon season, and camouflaging foreign vessels to resemble Malaysian boats. Our study serves as a much-needed starting point for understanding how IUU fishing in Malaysia is impacting turtle populations in the wider Southeast Asia region. This type of baseline data is vital for prioritising effective management and enforcement activities, while also revealing potential connections between IUU fishing and wildlife trafficking of sea turtles.

LEVELS OF ILLEGAL TAKE OF GREEN TURTLES (*CHELONIA MYDAS*) IN TORTUGUERO, COSTA RICA (2005-2015)

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Tortuguero, located on the Caribbean coast of Costa Rica, is the most important nesting beach for green turtles (*Chelonia mydas*) in the Western hemisphere. In 1959 the Sea Turtle Conservancy (STC) started a monitoring and conservation program in Tortuguero, under the guidance of Dr Archie Carr. He soon realized in those early years that the legal, take of adult female turtles from the nesting beach to meet the

demand of both local and international markets, and the uncontrolled take of nests, were unsustainable, and they posed significant problems for the survival of the green turtle population. Thanks to the efforts of the STC, the local community and the Costa Rican authorities, laws were created to protect turtles and, in addition, Tortuguero National Park (TNP) was created in 1975, with the primary objective of conserving the green turtle population and the nesting beach habitat. Since 2002 it has been illegal in Costa Rica to hunt or kill sea turtles, or commercialize their eggs, meat or other products. And nowadays, within protected areas such as TNP, the poaching of turtles and eggs is minimal, when compared to levels of take on unprotected beaches, or in previous decades. It is necessary to evaluate the level of impact of these factors on the sea turtle population in order to take appropriate action to diminish the threats to this species future survival. This study will compare annual poaching data over the last decade (2005 – 2015) to understand how the trend has changed over time. During the annual Green Turtle Program coordinated by STC from June to October, daily surveys are conducted along the northern five miles of beach to register all nesting activity from the previous night. In addition, during these surveys the number of poached turtles and nests is also recorded, providing a daily record of illegal poaching activities. We will present an analysis of the temporal and spatial distribution of poaching activities since 2005, in addition to the overall trend in illegal take. STC will be able to share the findings of this study with TNP managers, providing the critical information they need to focus protection measures in poaching 'hotspots' with an aim to improve conservation efforts, reduce these threats and improve the survival outlook for this globally significant green turtle population.

ARTISANAL EXTRACTION OF MARINE TURTLES IN THE VENEZUELAN GUAJIRA: AN ASSESSMENT OF THE BIGGEST THREAT IN THE GULF OF VENEZUELA*

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Five of the seven marine turtle species are in the Gulf of Venezuela (GV): *Chelonia mydas, Caretta caretta, Eretmochelys imbricata, Dermochelys coriacea,* and *Lepidochelys olivacea*. The biggest threats that marine turtles face are harvesting, illegal trade, and by-catch. Hence, according to the IUCN these marine turtles are categorized as vulnerable, endangered, and critically endangered species. These reptiles are protected

under Venezuelan laws since 1996; however, in the Venezuelan Guajira they have been used for generations by the Wayuú indigenous people. Wayuu fishermen and clan leaders affirm that the sea turtles maintain and support their culture through their consumption, use for magical-religious rituals, and trade. For these reasons, we evaluated the harvest of marine turtles by the artisanal fisheries in Kazuzain, Venezuelan Guajira. In order to collect and measure carapaces (Curve Carapace Length-CCL), skulls and plastrons, seven field trips (covering dry and wet seasons) were carried out in three areas in Kazuzain. We surveyed a total of seven artisanal ports, including fisher houses and local dumps associated with them; then we identified species, and size classes. We calculated the monthly and annual Minimum Extraction Rate of harvest. Four out of the five species present in the GV were found. The most frequent species was *C. mydas* (92.2%) followed by *C. caretta* (5.4%), *E. imbricata* (1.8%), and *D. coriacea* (0.6%). The most common size class were juveniles (60.86%). The Minimum Annual Extraction (MAE) in the locality of Kazuzain was 359.04 marine turtles/year (mean= 3.74 MT/port*month). The high number of juveniles in the coastal waters of Kazuzain is a clear indicative of its importance as a recruitment area in the GV, and recent evidence of recaptures of tagged animals (2-5 years between recaptures) suggest a high residency of them in the area. We consider this MAE value to be conservative and potentially underestimated, since the majority of the carcasses evaluated in this research were easily accessible in ports, fishermen houses, and local dumps, but there was evidence of burnt and hidden turtle remains as well. The subsistence consumption and illegal trade of marine turtles are the main reasons for extracting these species. This research provides an estimate of the annual extraction in only one town in the Venezuelan Guajira Peninsula; however, when combining our results with Montiel-Villalobos' data (2012) from the ports of the northern region, the Minimal Annual Take in the GV is higher than 4,000 turtles/year. The high extensions of seagrass beds in the GV, and especially in Kazuzain, support great numbers of marine turtles annually; therefore, to protect and create appropriate management plans to minimize the anthropogenic pressures on these animals, it is vital to consider the social, economic and cultural realities in the area.

IDENTIFYING LOCATIONS OF AND MECHANISMS FOR SEA TURTLE MORTALITY FROM STRANDING DATA USING OCEAN DRIFT MODELS

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The Chesapeake Bay and its surrounding coastal waters are significant foraging and developmental habitats for thousands of loggerhead sea turtles, yet each summer, hundreds of turtles are found stranded on local beaches. As most sea turtle mortality likely goes unobserved due to low likelihood of landfall and carcass decomposition, these stranding events provide a unique window for studying drivers of turtle mortality. The annual elevated spring stranding event occurring in Virginia's waters is of concern especially as the cause of mortality is largely unknown. We have developed an oceanographic drift model for the Chesapeake Bay simulating the drift patterns of turtle carcasses after death to stranding locations. This model is used to identify likely mortality hotspots in the bay to be associated with indicators of possible anthropogenic

causes. In order to achieve these objectives, we first conducted field turtle carcass decomposition experiments to estimate drift times to stranding. Most of the sea turtle carcasses in Virginia are in a moderate to severely decomposed state upon stranding. Decomposition results indicate that turtles are fully decaying in about one week, and, therefore, spring/summer drift times in the bay before stranding are on the order of days. Next, carcass drift trajectories to stranding locations were simulated using an implementation of the Regional Ocean Modeling System for the Chesapeake Bay area and used as input to the offline Lagrangian drift simulation tool Ichthyop. Simulations assuming water-tracking, passive drift of turtle carcasses were used to estimate a probability distribution for point of origin of carcasses landing on beaches of individual counties around the bay. Most probable locations for mortality events are relatively nearshore, suggesting they are caused by coastal activities. Field experiments are currently being carried out to assess differences between turtle carcass drift and drift of the surface water particles as simulated by the ocean transport model. Water-tracking drifters are being released in the Bay and compared to the drift of actual sea turtle carcasses to observe the separation rate over time and, thereby, to correct simulated drift trajectories for direct wind forcing of floating carcasses. This final corrected drift model will more accurately represent mortality locations and serve as a basis for detailed comparisons with potential anthropogenic causes of mortality. Acknowledgements: The authors would like to thank for travel support the Whitely Fund for Nature, Columbus Zoo and Aquarium, and Sociedad Nacional de Pesqueria y World Wildlife Fund provided through the International Sea Turtle Symposium Travel Committee. Partial research support was provided by the College of William and Mary's Committee on Sustainability Green Fee funding.

COMPARISON OF THE POSSIBLE CAUSE OF DEATH OF TURTLES STRANDED IN FOUR NATURAL PROTECTED AREAS IN SINALOA MEXICO*

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On the coasts of Sinaloa, strandings of several species of sea turtles are recorded each year, which is considered a problem for their populations. Many of these strandings are attributed to bycatch since Sinaloa is one of the leading states in the production of marine fisheries in Mexico. Fishery target species in Sinaloa are sardine (32%), tuna (30%), shrimp (20%), crab (4%), tilapia (3%), sharks and stingrays among others species; fished with different gear types respectively. In this work, we describe and analyze the most representative causes of death of stranded sea turtles in four protected areas along the coast of Sinaloa with the aim that the collected information will serve to implement strategies for the management of marine resources in fishing communities. The study comprises data from 2012-2015; first surveys were carried out to determine the fishery resources of each community and fishing gear used, and as a second step, the stranded sea turtles were recorded and possible causes of death were described. The area of Ensenada Pabellones showed the greatest diversity of strandings with H'=0.82 Bits/Ind and the site of Playa Ceuta

displayed the lowest diversity of the four study sites with H'=0.42 Bits/Ind. Of the total strandings recorded, 26% were attributed to incidental fishery, while for 37% of the cases the cause of death could not be identified. Bottom gillnets used to catch sharks, manta and scaled fish proved to be the main fishing gear causing mortality of turtles. It can be derived from this work that frequent use of fishing gears like gillnets and seines are causing a higher occurrence of sea turtle strandings than the use of hooks in artisanal fisheries.

AN OVERVIEW OF IMPACTS FROM BYCATCH AND STRANDINGS ON ATLANTIC LEATHERBACKS AND RELATIVE RISKS TO INDIVIDUAL NESTING POPULATIONS*

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As transboundary species, leatherback turtles must be managed by multiple jurisdictions but information on threats should come from a broad perspective, at the Regional Management Unit (RMU) or even ocean basin level. In the Atlantic, nine distinct nesting populations have been identified, with other scattered nesting locations on islands and mainland nesting beaches. Using genetic fingerprinting over a number of years, we have been able to assess fishing practice impacts (bycatch) on distinct sea turtle populations. This work is supplemented by analyzing strandings information and in-water captures to provide valuable information for policy-makers and managers for the improvement and updating of federal recovery plans for the leatherback in the Atlantic. We used mitochondrial DNA (mtDNA) and nuclear DNA (microsatellites) to investigate population origins of leatherbacks sampled during bycatch, strandings and in-water studies (n = ~1200) throughout the Atlantic. Based on several case studies, we present an overview of the relative risks for turtles from each population within the Atlantic basin. We found that African leatherback populations have minimal threat risks, but others such as Costa Rica, may be under more pressure. We also investigation is needed. Project funding was provided by the Lenfest Ocean Program.

SEA TURTLE BYCATCH CHARACTERISTICS IN U.S. SHRIMP TRAWL FISHERIES

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Marine turtles interact with fisheries during multiple life history stages, and understanding regional and fishery specific impacts to each life stage is important to understanding population level impacts of various fisheries on these protected species. Southeastern U.S. shrimp trawlers impact neritic juvenile and adult marine turtles, primarily interacting with Kemp's ridleys and loggerheads, although other species have been observed as well. In addition to spatial patterns in fishery interactions, some gear types may selectively capture a certain size range of turtle. A turtle's size may determine whether it is able to pass through the

bars of a Turtle Excluder Device (TED) grid and be captured in the codend, rather than being effectively excluded from the net. To investigate the regional size distributions of turtles incidentally captured in the southeastern U.S. shrimp trawl fisheries, morphometric data collected by fishery observers were examined. The National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) operates Fisheries Observer Programs to collect vital catch and bycatch data from commercial fisheries in the southeastern United States. Fishery observers collected measurements (SCL, CCL, SCW, CCW, and SCLn-n) for turtles brought onboard whenever conditions allowed. Size distributions from these data, as well as observed sea turtle species composition, will be described by region (Atlantic Ocean and Gulf of Mexico) and fishery sector (skimmer and otter trawl). Such investigations can be used to enhance threat analyses, stage-based population models, and fishery management priorities.

THREATS FACING THE SEA TURTLES IN THE GULF OF CALIFORNIA - MEXICO

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Sea turtles are affected by human and natural threats throughout their lifecycle. Sea turtles have a long history in relation to humans in the Gulf of California and threats related to human activities are extensive. Besides natural mortality, human interactions pose the greatest threat to the survival of sea turtles. It should be recognized, even though Mexico has signed and ratified the conservation action which regulates international trade of CITES species and has decreed a ban on consumption, total and permanent use for all species of sea turtles, there is currently an illegal meat, eggs and products market derived from marine turtles. Despite national bans, continued poaching and turtle meat is a much-appreciated dish. In addition, various factors that compromise recovery and survival of sea turtles exist. There are a variety of wild and domestic animals that are predators of turtle eggs. Natural phenomena such as hurricanes and tropical storms that cause flooding in nesting beaches is another factor that negatively influence the hatchling success. When the hatchlings come out of their nests, they are easy prey for terrestrial and marine predators. Sharks and orcas, among others, prey on juvenile, subadult and adult stages of sea turtles. Sea turtles are also affected by a variety of diseases, such as fibropapilloma and parasites. Tropical storms and hurricanes, also contribute to the mortality of sea turtles in shallow water. The Gulf of California is considered a paradise for its beautiful scenery, beaches and the diversity of species that live in it. This has driven the development of tourism as a major economic activity mainly south of the Gulf of California. This has resulted in extensive loss of nesting beaches that have been modified by the construction of hotels, restaurants, marinas, etc. causing negative changes to sea turtle nesting beaches. Other activities that adversely affect nesting are pollution, use of all-terrain vehicles and human impact on the shore, artificial lighting on the beaches, crowds of people during nesting and contact with turtles. One more factor considered to have the most adverse impact in the survival of sea turtles are fisheries. This study aims to identify threats to sea turtles in the Gulf of California, the information presented is compiled from field studies, unpublished data, government reports, literature reviews, interviews and personal observations, in order to perform an analysis to identify key threats. A total of 16 threats to sea turtles, 12 of which were human origin and 4 of natural origin, were identified. These threats are described to propose some solutions and conservation measures.

SEA TURTLE STRANDINGS IN THE LAMBAYEQUE SHORELINE, NORTH PERU

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Between January 2014 and October 2015, ten shoreline surveys were performed alongshore from Cabo verde (06°22'12''S) to Cherrepe (07°10'27''S), in Lambayeque, northern Peru, in an attempt to quantify marine fauna occurrence in the area, body decomposition, size structure, together with their mortality causes: natural or anthropogenic. These surveys were carried out by the Peruvian Marine Research Institute (IMARPE) by its regional laboratory in Santa Rosa (06°52'32''S). During the study period, a total of 82 sea turtles were found stranded, according to our surveys the stranding incidence has slightly increased in the last three years. The majority of the captures were of the East Pacific green turtle or black turtle, *Chelonia mydas agasizzi* (90.2%, N=74): olive ridleys, *Lepidochelys olivacea* (6.1%, N=5) and leatherbacks, *Dermochelys coriacea*, consisted of only three individuals (3.7%). The mean curved carapace length (CCL) for black turtles was 56.5 cm ± 7.61 (range: 38.5 – 74), from those 93.2 % were juveniles (>69 cm CCL), 6.8% were sub adults (≥69 and ≤ 85 cm CCL) and no adults were reported. For olive ridleys the mean CCL was 66.5 cm ± 6.47 (range: 62.5 – 78.0), 20% of these were adults (>67 cm CCL) and 80% juveniles; finally, for leatherbacks the mean CCL was 125.8 cm ± 26.5 (range: 107.2 - 156), from these only one individual was adult (33.33%), the remaining ones were juveniles. The majority of the registered individuals (84.15%) during the shore surveys presented a high degree of decomposition (stage 4 and 5), not allowing us to determine the exact cause of death or to try to determine if the stranded individuals were a consequence of by-catch by artisanal gear in the area. Research on stranding dynamics will contribute with valuable information in order to try to quantify the take of these species, since all of them are included in the red list of endangered species. More structured surveys are needed to try to avoid bias and identify better conservation measures in the future.

HUMAN USE AND POTENTIAL IMPACTS TO THE GREEN SEA TURTLE (*CHELONIA MYDAS*) IN KEY IN-WATER HABITAT OF SOUTHEAST FLORIDA

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In 2009, there were 982,470 registered boats and 731 green sea turtle strandings in Florida. Key in-water habitat for green sea turtles (*Chelonia mydas*) has not been previously analyzed or characterized in terms of boating activity. The objectives of this study were to National Oceanic and Atmospheric Administration. The results present the benthic habitat the NRC to other benthic habitats along the coast, we analyzed boating activity data obtained from the Southeast Florida (Martin County – Biscayne Bay) Coral Reef

Initiative in terms of boat abundance, density, and activity within the different benthic habitats. We found that the NRC has one of the smallest overall boating densities and underway boating densities. Second, we compared boating density in the NRC for the two study sites to that of the entire coast of Southeast Florida. The boater density within the NRC for all of Southeast Florida is significantly smaller than that of the two reef tracts, Breakers Central (p=0.0024) and Broward County (p<.0001). We conclude that the NRC boater density is generally focused in the areas specifically identified as crucial for developing juvenile green sea turtles. Acknowledgments: We would like to thank the Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria, the World Wildlife Fund, and the International Sea Turtle Symposium for their financial support.

DEVELOPING A LOW COST ELECTRONIC MONITORING SYSTEM AS A TOOL FOR SMALL-SCALE FISHERIES*

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Fisheries bycatch in industrial and small-scale coastal fisheries is a major threat to many marine taxa and in particular to several sea turtle populations. Dramatic population declines of several sea turtle species have been linked with bycatch associated with high-seas industrial fisheries as well as small-scale coastal fisheries. Small scale coastal fisheries are often times extraordinarily problematic in that they often have relatively large fleet sizes, high density of fishing that co-occurs with many threatened sea turtle species, and very few if not any monitoring means. This issue of having poor monitoring to provide robust interaction rate data in these fisheries makes it very difficult to quantify bycatch rates, which are critical to population assessments as well as to the implementation of appropriate bycatch reduction tools. Electronic monitoring (EM) systems have been developed to help augment onboard fisheries observation to better understand catch composition and catch rates in many industrial scale fisheries and are now being implemented in some of those industrial scale fisheries. The concept has been to use EM systems to help augment and increase existing observer coverage while being more cost effective. These systems are relatively expensive and have not been designed for small-scale fishery use. Our project goal was to develop and test EM systems that could be used to augment observer coverage in small-scale coastal fisheries in order to collect data on fish catch rates. Such EM systems could be then adapted to help expand observer coverage to better understand and quantify bycatch rates of sea turtles in a specific fishery. As a first step, we examined the effectiveness of a low-cost EM system, in a SSF located in Bahía de los Angeles, Baja California, Mexico. Retained and discarded fish catch rates, as well as catch rates of individual fish species, were recorded by both onboard observers and an EM system on the same fishing boat, and then compared to determine the similarity of these two methods. Through 13 fishing trips, we observed no statistically significant difference between the two observer methods in retained or discarded fish catch rates. We also found no statistically significant difference between the two observation methods in the catch rates of the four most commonly caught species as well as the fishery's most valuable target species. This indicates that this low-cost EM system could be a potential data collection tool in similar data-limited SSF worldwide.

INSIGHTS INTO ILLEGAL HARVEST OF MARINE TURTLES IN EAST AFRICA*

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Although national laws in Mozambique have protected marine turtles for over 40 years, the illegal use of turtles has been an ongoing and widespread problem in the region. Previous efforts to monitor the rates of use have been inconsistent and restricted to small sections of the ~2700km coastline. Here we present the most comprehensive source of data collected from November 2009 to December 2014 on illegal turtle harvest that exists for the Inhambane Province, thought to be the nations leading province for the illegal use of turtles. Opportunistic beach patrols were conducted and turtle remains were identified to species level, measured, and geo-referenced. A total of 170 remains of turtles were found. Of the five sea turtle species inhabiting Mozambican waters, the carapaces, bones or full carcasses of only three species were found. Approximately half of the remains (48%) could not be positively identified to confirm species. Of those identifiable, the most abundant remains were of the Green (*Chelonia mydas*, n=55), followed by Loggerhead (*Caretta caretta*, n=29) and Hawksbill turtles (*Eretmochelys imbricata*, n=4). To better understand the motives and drivers for illegal take of turtles, we also conducted semi-structured interviews (n=19) with local fisherman. Through these interviews, we aimed to document how and if illegal use is associated with traditional and cultural use, limited alternative livelihood opportunities and increasingly low fishing yields. Based on fishers' responses, illegal take of turtles within our study area occurs from both targeted hunting and opportunistic harvest. Some evidence of cultural significance is noted. The primary reason cited by respondents for justifying illegal take was for meat consumption. Fishers also reported egg harvesting when the opportunity occurred, however, most fishers reported recent declines in encounters with nesting turtles or nests. Responses from fishers allowed us to link the drivers of illegal take with overall poverty levels and lack of alternative livelihood opportunities. The majority of fishers (n=18) were aware of the illegality of harvesting turtles but noted a distinct lack of law enforcement. Understanding the dynamics of illegal take of turtles is complex and the effort, motives and drivers for illegal use seem to vary across small geographic areas. More work is urgently required to better understand the situation. By adopting similar methods along wider expanses of the East African coast these patrols could be a cost-effective way to fill a currently resource deficient niche and provide greater insight into illegal take and trade of turtles in Western Indian Ocean.

HOPPER DREDGING: A POTENTIAL THREAT TO SEA TURTLES ON THE NORTHERN COAST OF RIO DE JANEIRO

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The northern coast of the state of Rio de Janeiro, eastern Brazil, is an important nesting ground for loggerheads (*Caretta caretta*), with about 1500 nests laid annually. It is also a foraging ground for juvenile green turtles (*Chelonia mydas*) and a migration corridor and possible foraging ground for olive ridleys (*Lepidochelys olivacea*) and leatherbacks (*Dermochelys coriacea*). Despite the key importance of the area, construction began in 2008 for a large private mixed-use port complex, named Açu Superport. To facilitate navigation of various vessels using the port complex, hopper dredges have been used since the beginning of the port construction, for clearing and maintaining access channels, a turning basin, and a harbor basin. In 2012 additional hopper dredges entered into operation for the construction of a new terminal and shipyard. Here we provide an account of sea turtle deaths observed in the region with indications that this mortality was a result of dredging operations during both the port construction and operation. Between 2008 and 2014, a total of 112 individuals were found with injuries indicative of dredging interaction, including two that were found entrained in the hopper dredge draghead. Of these, 68 were green turtles, 26 were loggerheads, 11 were olive ridleys, four were leatherbacks and three could not be assigned a species identification. All turtles with dredging-related injuries were cut in half and/or had parts of their carapace and/or flippers missing. All except two of the loggerheads were adult-sized, reflecting the fact that the northern coast of Rio de Janeiro is a nesting area for this species. Sixty-three green turtles were juveniles, reflecting the importance of the area as a foraging ground for juvenile *C. mydas*. Almost all leatherbacks and olive ridleys taken by the hopper dredge were adults and subadults, which have a higher "biological value". In order to minimize dredging impacts on sea turtle populations, Projeto TAMAR has provided technical support to the environment agencies for the development of a detailed plan to prevent additional incidental takes. Mitigation measures such as alternative dragheads, deflector equipment, as well as environmental time windows and using dredges other than hopper dredges, have been proposed. Considering these findings and what has been learned so far, even with proper application of all mitigation measures, we strongly discourage hopper dredging operations on sea turtle nesting grounds during nesting seasons. Additionally, in areas of high sea turtle concentration (e.g. foraging grounds) care must be taken to ensure that there is minimum impact on these animals and other marine species. This study might be used as a reference to assist future dredging project proponents and environmental agencies in the selection of safe and appropriate mitigation measures.

In-Water Biology

HAWKSBILL POPULATION IN THE GALÁPAGOS*

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The hawksbill turtle (*Eretmochelys imbricata*) is currently listed as critically endangered on the IUCN Red List, and no commercial use is permitted under CITES Appendix I. In 2008 Eastern Pacific hawksbills were considered as a non-viable population and new discernments about the eastern pacific population is currently in development. *E. imbricata* has been described as occasionally in the Galápagos. It had sporadically been found at feeding areas and there are no nesting records of this species in the archipelago. Recently, since the establishment of the first long-term sea turtle monitoring program by the Galapagos Science Center (GSC) and Universidad San Francisco de Quito (USFQ) Project Tortuga Negra-Galápagos; focus at the feeding and breeding areas of the Galapagos sea turtles; we could identify an important hawksbill population. Through different methodologies covering mark and recapture programs (21 individuals of *E. imbricata* (4 females CCL = 72.13 SD: 6.7 and 17 juveniles CCL = 49.7 SD: 8.01) were captured, additionally satellite (3) and acoustic (8) telemetry tags were applied, and reinforced with photo-identification and anecdotic interviews to local naturalistic guides. We corroborate a high fidelity to feeding areas, with records during at least five years of permanency in the same region of certain individuals. Thirteen sites were identified as important for hawksbills, where registers are constant and occur over many years. Additionally, during the first semester of 2015 we found *E. imbricata* hatchlings in San Cristóbal, the first record of a nesting event in the Galapágos for this species. To have a complete evaluation of the population, genetics, a health baseline and a diet analysis for *E. imbricata* are the next steps in conjunction with biogeochemistry; and plastic pollution. Acknowledgments: the authors would like to thank the Tortuga Negra-Galápagos project and all the people involve, the Galapagos Science Center, Universidad San Francisco de Quito, Parque Nacional Galapagos, Ecofondo, ICAPO, 36th Annual Symposium on Sea Turtle Biology Conservation, North Carolina State University, University of North Carolina at Chapel Hill, James Cook University and Migramar.

SATELLITE TRACKING ADULT MALE GREEN TURTLES AT THE ARCHIE CARR NATIONAL WILDLIFE REFUGE, FLORIDA (USA) THROUGHOUT THE NESTING SEASON AND TO THEIR FORAGING GROUNDS*

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Male green turtles leave the beach as hatchings, and are seldom seen again. They are rarely captured in in-water projects in Florida, and can be routinely captured in only one or perhaps two locations in the state, which has led to a paucity of data. The recent increase in green turtle nesting at the Carr Refuge in east central Florida has created an opportunity where it is possible to encounter male green turtles when they float onto the beach as part of a mating pair. To date we have satellite-tracked eight adult males from the Archie Carr National Wildlife Refuge at the outset of the nesting season. Fast-loc GPS satellite transmitters allow us to track local movements of these males as they move along the coast during the nesting season, presumably for the purpose of encountering females. One male covered an approximate total distance of 488 kilometers north and south of the deployment location before returning to the Carr Refuge and then migrating to foraging grounds. Seven of the eight males migrated to foraging areas in the Florida Keys, the remaining male returned to nearshore reefs approximately 49 kilometers south of the deployment location.

TESTING ANIMAL-BORNE CAMERAS TO PICTURE BEHAVIOURAL AND FORAGING ECOLOGY OF GREEN TURTLES*

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Technological advances for monitoring wildlife have expanded the ability of ecologists to study animal behaviour. The development of animal-borne cameras has provided the opportunity to observe and record fine-scale behaviour and collect important information on species interactions with their environment. In the Southwest Indian Ocean, knowledge of juvenile green turtle ecology in developmental habitats is still lacking, primarily because of the underwater observations constraints. To major advances in technology at the size and cost level, we evaluated in this study the capabilities of commercial compact cameras as instruments for research on sea turtle ecology. This technology benefits from rapid development, low-cost and compact size. Cameras were deployed on six juvenile green turtles (67 cm CCL; SD=7 cm). Video records were used to collect behavioral data and were compared to natural behavior directly observed by snorkeling on the same site. Fieldwork was conducted in the Bay of N'Gouja located on Mayotte Island, where green turtles are accustomed to snorkelers. This provides unique conditions to directly observe feeding individuals, while minimizing disturbance. Our results showed that, even if movements can be

altered by the capture and the camera, particularly during a short time (generally under 20min) after release, natural and unknown behavior can be recorded. In addition, video records revealed information about conspecifics and interactions between individuals. Animal-borne camera technology appears to be an efficient tool for investigating the ecology of juvenile green turtles and should provide novel insights into habitat use at fine temporal scales. Understanding how sea turtles interact with their direct environment is fundamental to identify the components required for the conservation of species.

MOVEMENTS OF BRAZILIAN HAWKSBILL TURTLES REVEALED BY FLIPPER TAGS

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A long-term capture-mark-recapture (CMR) study using flipper tags, was started in 1982 by Projeto TAMAR-ICMBio, the Brazilian sea turtle conservation program. The main focus was nesting sites, but since 1989 has also included foraging sites. We documented long-range movements associated with transition from one life stage (juvenile) to another (breeding adult) (n = 3), or that which occurred within a single life stage (developmental migration) (n = 5). Three hawksbill turtles tagged as juveniles in the island of Atol das Rocas were recaptured from 9 to 19 years later nesting on the Brazilian mainland: two on the southern coastline of Rio Grande do Norte state (305 and 270 km away) and one in the state of Bahia (1389 km). The time period between the last record at the developmental site and the first at the nesting site varied from 6.3 to 17.5 years, which may possibly indicate that the minimum time to reach maturity is 6.3 years. Flipper tags more often record movements within the same life stage; these include the reproductive migration of breeding females or migrations of immature turtles traveling between development sites. We also detected movements of five immature hawksbill turtles between sites. Two were from Fernando de Noronha to Rio Grande do Norte (a distance of 400 km). Both were found stranded on the beach with no signs of causa mortis, one of them showed an increase of size (CCL) from 46 cm to 54 cm over seven years; the other has no available CCL. Another individual was found in Ceará (at a distance of 835 km), 6.8 years later, killed in an illegal lobster net). Two were from Atol das Rocas; one of these was encountered in northern Bahia (1073 km, showing an increase in CCL from 46 to 76 cm in 7 years, with signs of fishing gear on the left hind limb, identified as a female by necropsy) and the other in Bermuda, exhibiting an increase in CCL from 40 to 68.2 cm in 9 years, despite having a broken hind flipper when first captured and despite having ingested a fishook. Amazingly, this individual was able to travel the longest distance yet reported for an immature hawksbill tagged in Brazil (5193km). The fisherman who captured the turtle indicated that the fishhook had been swallowed during capture, meaning that the specimen had not arrived there due to drifting after recent injury. Stranded animals always raise suspicions concerning their origin: were they living at that place, were they stranded, or did they drift there after being injured? For animals that may disperse over such a vast area, the use of a variety of methods is needed to allow their detection. Flipper tags remain a valuable method, as they are low cost and conspicuous, allowing the easy detection of a tagged animal by any person.

USE OF A GLASS BOTTOM BOAT FOR SEA TURTLE RESEARCH AROUND FERNANDO DE NORONHA ARCHIPELAGO, BRAZIL

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Fernando de Noronha archipelago is located 346 kilometers from the Brazilian continental coast, which is a green turtle rookery and developmental site for green and hawksbill turtles. Loggerhead and olive ridley turtles seldom appear in the archipelago. This is the first research that has used a glass bottom boat to gather data on the behavior, frequency, and species composition of sea turtle populations within the archipelago. This research aimed to test the effectiveness of this new method of observation, for scientific purposes. The research took place from December 16, 2011 to July 18, 2012; data was collected onboard a glass bottom boat called "NAVE" (Nave Visão Subaquatica, or Aquatic View), which was developed for oceanographic expeditions and adapted for tourism operations around the island. Sites were selected according to the seawater conditions on the day (e.g. visibility, current, and waves). Each site was defined considering its environmental characteristics; water depth varied from three to seventeen meters. The observer always stayed in the same position, looking at the water column through the glass lens and recording the initial and end time, species, estimated size (based on curved carapace length), estimated water depth, behavior (such as swimming, feeding, floating, resting, auxiliary resting, or at cleaning station), and environmental characteristics. After 75 operations (57 hours and 3 minutes of monitoring), 243 sea turtles were sighted at eight of eighteen sites, which were sampled at least once. Considering these eight sites, the frequency in Santo Antonio Harbor was the highest (9 turtles per hour), while the average was 4 turtles per hour per site. Only two species were detected: green (n=199) and hawksbill turtles (n=39), which correspond to 5.1 greens for each hawksbill. Five individuals could not be identified to the level of species. Most of the sighted turtles were classified as small juveniles (green=135; hawksbill=22), followed by juveniles (green=53; hawksbill=17), sub-adults (green=5), adults (green = 3) and undetermined size (green=3). Adults were male green turtles. Size was different between the two species. While most of the green turtles were recorded at sandy bottom (n=106; 53.27%), the hawksbill turtles were usually found in hard bottom areas (n=32; 82.05%). Both species were swimming most of the time (green=118; 59.3%; hawksbill=19; 48.72%), and feeding less frequently; floating, resting, auxiliary resting, and staying at the cleaning station followed this activity. Observations through the glass bottom boat seemed to be realistic, as data were collected only when the boat drifted above the turtles (except when turtles were floating around the boat), although turtles resting under rocks could not be detected. This method caused less impact on behavior than other in-water methods, such as snorkeling or scuba diving. Most of the turtles were observed from two to ten meters deep (n=188); hence, discretion was essential to ensure collection of reliable data. The wide water view through the glass bottom made this method an effective tool for sea turtle in-water research.

IDENTIFICATION AND CHARACTERIZATION OF THE POTENTIAL HAWKSBILL SEA TURTLE (*ERETMOCHELYS IMBRICATA*) FORAGING ZONES LOCATED IN THE AREAS INFLUENCED BY THE MARINO BALLENA NATIONAL PARK, OSA CONSERVATION AREA, COSTA RICA

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Groups of hawksbill sea turtles have been observed over the years, close to the coast of the Marino Ballena National Park, reports from tour operators and researchers have confirmed the presence of individuals in certain points. Despite this evidence, there has not been a study to justify the presence of this species in those places and the possibility to observe hawksbills in other sites nearby. For that reason, since January 2015, six sample points were established along the park´s coast to perform a formal monitoring of the aggregation sites of hawksbills. The turtle size and identification were done by direct observation by the divers and from the boat, its location was recorded with Global Positioning System (GPS). Dives were executed at each point to do an inventory of the potential food resource available for the species to compare to the literature in other parts of the Pacific coast of Costa Rica. For the description of the habitat, factors such as water turbidity, water temperature, environmental temperature, sampling point depth, and salinity were recorded in each zone for every excursion. Until October 2015, ten dives per sampling point have been performed, a total of 35 juvenile hawksbill sea turtles were recorded which showed a minimum size of 30 cm and a maximum of 70cm with 57% of the individuals aggregated in one of the sample points. Five genus of sponges were registered as the potential food resource for the hawksbill, Haliclona, Spirastrella, Mycale, Aplyscina and Axinella and one tunicade specie, *Rhopalaea birkelandi*. The objective of the study is to justify the presence of the hawksbill sea turtle in the areas influenced by the Marino Ballena National park, by identifying actual zones used by the species and describing the food resources available, another potential foraging area for these sea turtles in the park marine area.

ENVIRONMENTAL INFLUENCES ON THE TRANS-OCEANIC MIGRATIONS OF NORTH PACIFIC LOGGERHEAD SEA TURTLES*

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The oceanic stage of juvenile loggerhead sea turtles (*Caretta caretta*) can last for decades. In the North Pacific Ocean, much is known about their seasonal movements in relation to pelagic habitat and the Transition Zone Chlorophyll Front (TZCF). Yet understanding the timing of behavioral responses in relation to oceanic features, trans-oceanic migrations, ontogenetic shifts, and alternative foraging strategies have been more difficult. As foraging success is tied to population status, adaptation to climate-related changes in oceanic conditions is imperative. Predicted changes in the biophysical process associated with juvenile North Pacific loggerhead habitat (i.e. expansion of oligotrophic waters, shifts in TZCF location) will have lasting impacts on the ability of this top predator to adapt in a changing climate. Here, we examine the environmental influences of static variables (e.g. magnetic field) and dynamic variables (e.g. sea-surface temperature, chlorophyll-a, eddy-kinetic energy) on the multiyear timing of east and westward movements of juvenile loggerhead sea turtles and potential influences of changing environmental cues in the behavioral plasticity on the large-scale migratory movements of this animal.

THERMAL CORRIDOR CONNECTS CENTRAL NORTH PACIFIC LOGGERHEAD SEA TURTLES TO BAJA CALIFORNIA, MEXICO*

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The North Pacific Loggerhead sea turtle (*Caretta caretta*) undergoes a trans-oceanic migration to important juvenile foraging grounds in both the central and eastern North Pacific. However, connectivity between their oceanic dispersal mechanisms and foraging locations has remained difficult. The mechanistic reasons as to why some turtles may travel as far east as the peninsular coast of Baja California, Mexico in the eastern Pacific, whereas others stop short of this lengthy migration only to return to or remain within the central North Pacific is cryptic. Here, we provide the first evidence of the existence of a 'thermal corridor' that is only available during particular seasonal and inter-annual conditions. This corridor facilitates the movement of central North Pacific juveniles to the coastal waters of Baja California. Understanding transport and behavioral responses during this early stage is crucial to interpreting the life history and ontogenetic habitats of North Pacific loggerheads. From an ecological perspective, much can still be learned as to how physical forcing from ocean circulation influences the dispersal pathways and spatiotemporal dispersal of young juveniles from this population. From a conservation standpoint, evidence of such a corridor may enhance current U.S. fisheries management strategies in the central and eastern North Pacific Ocean. This new information can be used to actively reduce fishery interactions with at-sea loggerheads and possibly to project changes in the use of various developmental habitats with climate change.

ENVIRONMENTAL PARAMETERS INFLUENCING FORAGING GROUND SELECTION IN MEDITERRANEAN LOGGERHEAD TURTLES (*CARETTA CARETTA*)

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Loggerhead sea turtles (*Caretta caretta*) are widespread throughout the Mediterranean Sea, although during their adult life they mainly frequent the Eastern basin, where all the nesting beaches and most foraging sites are located. Loggerheads are known to have a strong individual fidelity to their foraging grounds, and satellite tracking has recently documented how females return to the same feeding areas after successive reproductive seasons. Moreover, adult loggerheads in the Mediterranean have been shown to move seasonally between two distinct foraging areas, typically separated by some tens of km. In the present paper, we have analyzed satellite tracking data collected from five female loggerheads nesting in Southern Italy (Ionian Calabria) that were tracked for a long period (from 1 to 4 years) while foraging along the Tunisian continental shelf. In this way, we aimed to identify small-scale movements done at the foraging grounds and to investigate the process of habitat selection of tracked turtles. After a preliminary speed filtering to remove erroneous locations, individual home ranges were determined using a kernel technique with an "ad hoc" h, to obtain information on the extent of the areas frequented and on individual turtles' differential utilization of different sites within each area. Remote sensing environmental data (sea surface temperature, chlorophyll and bathymetry) were then obtained from different sources to study turtle resource selection through a Resource Utilization Function analysis (package RUF developed in R). The procedure returns a "Coefficient Beta" as final outcome, which was used as an indicator of preference for a given resource. In four of the five tracked turtles, two distinct foraging areas were identified: one used during summer (April-November), when the turtles remained mostly along the Tunisian coast, and one during winter (December-April) that comprised more offshore waters. Home range extent was similar among turtles and the area frequented in winter was on average larger than the summer one. Repeated shuttling movements between these two locations were recorded in successive years, documenting a strong, multi-year fidelity to specific sites. Only in one case a turtle resided in the same area throughout the year, leaving it only occasionally with looping movements. Resource Utilization Function analysis suggested that temperature was the main environmental parameter influencing the turtle selection of the area frequented, with females staying in locations where the temperature was higher than in the surrounding area during winter and choosing relatively colder sites in summer. The analysis did not reveal significant area selection based on chlorophyll or bathymetry for any turtle. This study confirms previous findings on the existence of seasonally distinct foraging grounds in adult Mediterranean turtles, documents a strong inter-annual fidelity to specific, neritic foraging sites and reveals the importance of sea surface temperature in the process of habitat selection made by turtles within foraging sites. Acknowledgments: The authors would like to thank the ISTS travel grant fund that allowed one author to attend the symposium and present this work.

MIGRATORY ECOLOGY AND REPRODUCTIVE OUTPUT IN THE FLORIDA GREEN TURTLE (*CHELONIA MYDAS*)*

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Habitat selection carries with it direct ramifications for individual survival and reproductive potential. The energetic costs of migration and habitat quality of foraging areas impact a migrant's condition and reproductive potential in subsequent seasons, known as carryover effects. The green turtle (*Chelonia mydas*) is a long-lived, highly migratory species that habitually exhibits nest and adult foraging site fidelity. Migration patterns and habitat selection therefore are important factors influencing female condition and reproductive potential. Females utilizing the same nesting beach may differ in fecundity, depending on the foraging aggregation to which they belong. Disparities were identified in female size and reproductive output in loggerhead turtles (*Caretta caretta*) originating from different foraging habitats. However, limited data exist to quantify and directly test for the presence of these carry-over effects in green turtles. Understanding how variation in post-nesting foraging strategy affects female condition and key reproductive parameters is crucial for the conservation of green turtles and their habitat. To address these data gaps, we investigated the relationship between foraging ecology and reproductive output in the Archie Carr National Wildlife Refuge green turtle rookery, which contains, on average, 35% of the green turtle nests laid within the United States each year. We used stable isotope analysis to identify distinct foraging aggregations of females on the shared nesting beach. Skin samples were collected from 15 satellite-tracked individuals (2013-2015). Samples were also collected from fifty untracked nesting female green turtles during both the 2013 and 2014 nesting seasons (n=100 total females), and nests were marked for later reproductive output assessment. We divided individual females into related groups, or clusters, using a Gaussian finite mixture model in R based on stable isotope values of δ13C and δ15N derived from skin samples. Foraging aggregations were defined by individuals within different clusters. Clutch size, egg mass and diameter (2014 only), hatching success, and emerging success were compared across these adult female groupings to evaluate potential differences in reproductive output among foraging aggregations. This study provides insight into the efficacy of using green turtle fecundity as a proxy to assess resource limitations and impacts at distant feeding locations. By evaluating the impact of foraging habitats on productivity, we can identify conservation priority regions which are crucial for effective management of the species.

THE INFLUENCE OF OCEANOGRAPHIC FEATURES ON THE FORAGING BEHAVIOR OF THE OLIVE RIDLEY SEA TURTLE*

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The circulation in the Western Equatorial Atlantic is characterized by a highly dynamic mesoscale activity that shapes the Guiana continental shelf. Olive ridley sea turtles (*Lepidochelys olivacea*) nesting in French Guiana cross this turbulent environment during their migration. We studied how oceanographic and biological conditions drove the foraging behavior of 20 adult females, using satellite telemetry, remote sensing data (sea surface temperature, sea surface height, current velocity, euphotic depth), simulations of micronekton biomass (pelagic organisms) and in situ records (water temperature). The occurrence of foraging events throughout migration was located using Residence Time Analysis, while an innovative proxy of the hunting time within a dive was used to identify foraging events during dives. Olive ridleys migrated northwestwards using the Guiana current and remained on the continental shelf at the edge of eddies formed by the North Brazil retroflection, an area characterized by low turbulence and high micronekton biomass. They performed mainly U-shaped pelagic dives, hunting for an average 72% of their time. Hunting time within a dive increased with shallower euphotic depth and with lower water temperatures, and mean hunting depth increased with deeper thermocline. This is the first study to quantify foraging activity within dives in olive ridleys, and reveals the crucial role played by the thermocline on the foraging behavior of this carnivorous species. This study also provides novel and detailed data describing how turtles actively use oceanographic structures in one of the most dynamic oceanic ecosystems on earth.

DEVELOPMENTAL HABITAT AND MIGRATORY PATHWAYS: KEY AREAS FOR THE CONSERVATION OF FUTURE BREEDING GREEN TURTLES ACROSS THE CARIBBEAN-ATLANTIC REGION

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Aim: The identification of key areas used by immature sea turtles is required to ensure the conservation of these endangered species through the renewal of future breeders. This study delineates the residential and transitory hotspots used by immature green turtles in their foraging habitats and during their developmental migrations across the Caribbean-Atlantic region, and assess potential linkages between immature and adult home ranges. Location: Caribbean-Atlantic region. Methods: Nineteen juvenile green turtles were satellite tracked from Martinique for a mean tracking duration of 156 d, and kernel densities were used to quantify their home range. Results: Among the 19 turtles equipped, 14 remained up to 11 months in the coastal and developmental habitat of the Anses d'Arlet in Martinique. The resident turtles showed long-term fidelity to this site and used a restricted core range of 3.4 km². The five migrant turtles were significantly larger than the resident ones and left Martinique heading in four different directions from the Caribbean up to the African coast. Main conclusions: Through the tracking of 19 future breeders, new residential and transitory key areas were identified. The narrow home range of the Anses d'Arlet is likely related to the restricted distribution of seagrass beds, making this site a critical developmental habitat, supporting the implementation of a marine protected area, currently under consideration in Martinique. The extensive movements of the migrant turtles highlighted different corridors crossed during the multidirectional migrations, as the turtles crossed more than 25 exclusive economic zones. This strongly supports the need to track more animals to enable the application of urgent conservation measures in this extensive area composed of multiple jurisdictional waters and subjected to incidental bycatch.

MOVEMENT PATTERNS OF JUVENILE HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) AT A CARIBBEAN CORAL ATOLL: LONG-TERM TRACKING USING PASSIVE ACOUSTIC TELEMETRY*

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Understanding marine ecosystems and the interactions they host requires sufficient data on the spatial utilization of their inhabitants. Hawksbill turtles play a prominent role in coral reef communities due to their specific foraging preferences, although new information is still uncovering details of the spatial and temporal aspects of their habitat use. This study used long-term passive acoustic telemetry to monitor eighteen juvenile hawksbills (CCLmin 32.0 – 59.7 cm, mean = 43.9 ± 6.7) at a Caribbean developmental

foraging site, Lighthouse Reef Atoll (LRA) in Belize (tracking duration 10-1,414 days, mean= 570 ± 484). Though specific home ranges and displacements were difficult to quantify, several turtles showed high site fidelity to the site over several months or years with occasional wide-range use of the atoll. Significant differences between day and night detections suggest nocturnal resting resulting in fewer nocturnal detections. Of particular interest were three different patterns in site fidelity to the atoll based on the number of detection days near individual stations: high residency (n=4), sequential residency (n=2), and exploratory behavior (n=4). These variations in movement raise questions about the differentiation of foraging habits among hawksbills and the influences of microhabitats, human and natural disturbance, and individual specialization. Acknowledgements: The author would like to thank The Summit Foundation, British Chelonia Group, Wildlife Conservation Society, and the Mitchell-Petersen Family Foundation for the support for this project, as well as The Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria, World Wildlife Fund and the International Sea Turtle Symposium for providing financial support for attending this year's symposium. The field team that made this project possible: Dan Castellanos, Jason Castro, Darren Castellanos, Alex Garbutt, and James Lewis. Ivy Baremore also provided technical support for this project.

GREEN TURTLES THAT 'DIG' FOR DINNER AND SEAGRASS COLLAPSE?*

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Desertification due to intensive grazing is described for many ecosystems. An increasing number of studies demonstrate that degradation of those systems is not only dependent on herbivore density but also on abiotic factors hampering plant recovery. For a relatively simple seagrass-grazer (*Halodule uninervis* - green turtle, *Chelonia mydas*) system, we introduce a newly discovered destructive grazing strategy 'digging' of an exceptionally dense green turtle population (Derawan Island, Indonesia). Surprisingly green turtles not only graze on leaves but also 'dig' for roots and rhizomes and thereby initiate a spatial 'leopard' pattern of gaps in seagrass meadows. Using broad-scale long-term observational data we show that the green turtle density and digging intensity are increasing. Data from experimental gap clearings showed that decreased regrowth and increased erosion are the major explaining factors hampering recovery. By using a fully parameterized predator-prey model, we show that a mismatch between seagrass regrowth, erosion stress and grazing

('digging') pressure potentially leads to alternative stable states, which amplify the likelihood of an irreversible collapse of vital seagrass meadows. We furthermore discuss the possible strategies for conservation strategies to avoid, or navigate away from undesirable phase-shifts. These phase-shifts may become more likely to happen now efforts to conserve globally declining herbivorous green turtles are resulting in promising growth of some populations worldwide.

A REGIONAL AND MULTIDISCIPLINARY APPROACH TO ELUCIDATE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) LOST YEARS IN THE INDIAN OCEAN*

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Loggerhead sea turtle's (*Caretta caretta*) lost years have long been an iconic example of the juvenile sea turtle's impressive journey. Historically, loggerhead's juvenile cycle along the North Atlantic gyre was the first evidence of development at an ocean basin scale. Later, the same observations occurred in the northern and southern Pacific Ocean. Yet, little is known about the oceanic juvenile stage for the same species in the Indian Ocean that nonetheless hosts some of the world's largest populations. The unique hydrodynamics of this ocean, bounded to the north by a continental mass and affected by monsoon cycles, challenges the classical life history cycle. Here, we concurrently combined four distinctive approaches to investigate the early life cycle of the loggerhead populations of the western Indian Ocean, from Oman to Mozambique and South Africa. As a first step, a regional genetic study based on a long sequence (800bp) of the mtDNA control region was conducted. Results demonstrated that a great majority (94%) of oceanic late juveniles accidentally caught off Reunion Island, in the southern Indian Ocean, shared haplotypes mainly from northern Indian Ocean populations. Secondly, stable isotopes analyses of multiple tissues (plasma, red blood cells, skin, scutes) showed that these juveniles exhibit an oceanic strategy and forage at southern latitudes, possibly along the southern subtropical convergence zone. As a third step, satellite tags were deployed in the southern Indian Ocean on 40 oceanic late juveniles. Many individuals (n=30) migrated towards rookeries of the northern hemisphere where their spatial behavior was similar to the adult spatial behavior observed there. As a final stage in processing, lagrangian drift modeling simulations over 12 years were run to predict the spatial faith of hatchlings from the main rookeries of the western Indian Ocean. A habitat driven swimming behavior in conjunction with a growth model was implemented. Results showed a trans-equatorial connectivity across oceanic regions and a potential importance of persistent oceanic gyres as oceanic habitats. Results from all contrasted approaches, applied at different life stages, converged

towards the existence of a trans-equatorial juvenile cycle occurring at ocean basin scale for the populations of the northern Indian Ocean. Spatial congruency occurs between the northern and southern population that share common foraging areas along the southern subtropical convergence zone at some stages of their life history. Continuous methodological improvements will certainly allow a finer comprehension of the spatial cycle of juvenile loggerheads. Most importantly, the next major advance shall arise from a broader spatial coverage involving eastern Indian Ocean rookeries and also at-sea sampling in some key oceanic areas.

TOWARD THE AUTOMATION OF FORAGING SEA TURTLES SURVEY*

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In order to protect sea turtle species like the green turtle *Chelonia mydas*, particular efforts are made to protect the foraging areas in the South Western Indian Ocean. However, the effectiveness of sea turtle feeding habitat management and conservation plans requires abundance estimates of the population. Aerial survey appears to be the most appropriate technique to obtain these data thanks to their spatio-temporal coverage efficiency. The data provided are often integrated in Geographic Information System (GIS) to allow a faster processing time and to produce tracking maps quickly available for protected areas managers. In this context, we aim to develop a semi-automated solution to speed up the overall process, from data acquisition by a drone aircraft to their representation in an Open Source GIS (QGIS). The first contribution of our approach resides in the use of an embedded image processing algorithm to assist the user in the image analysis phase by proposing estimated turtle positions in each image. Secondly, thanks to an accurate geo-referencing of the images, each turtle detected this way can be registered straightforward in the GIS to provide a spatio-temporal vision of the population evolution in the studied area. Such knowledge has the potential to play a key role in guiding management decisions. The solution is not limited to drone based images as microlight or plane based images can also be treated. In the near future, we plan to extend this approach to other sites and other marine or land-based species.

A SARGASSUM-RELATED MASS STRANDING OF JUVENILE GREEN AND HAWKSBILL TURTLES IN BARBADOS

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Over the past five years the Wider Caribbean has been affected by increasing amounts of Sargassum passing through the region. Deposits of Sargassum on shore in 2015 reached unprecedented levels, affecting beaches from Tobago to Texas. Interest to date has primarily been focused on the potential impacts of these

increasing quantities of Sargassum on nesting turtles, hatchlings attempting to reach the sea, and small juveniles living within the Sargassum mats. Here we report a mass stranding of hawksbills (*Eretmochelys imbricata*) and green turtles (*Chelonia mydas*) that occurred on a south-eastern beach in Barbados in June 2015. Over the course of two days, 44 juvenile turtles were found trapped in Sargassum onshore, ranging in size from 30cm to 61.4cm (CCL, green turtles) and from 29.4cm to 66.7cm (CCL, hawksbill turtles). Only three animals were still alive; all the others were freshly dead to moderately decomposed. Twice as many green turtles as hawksbills were affected. Analyses of stomach and crop contents indicated that the animals were foraging in nearshore habitats when the Sargassum raft approached the shore and the likely cause of death was attributable to enforced submergence.

WHERE DO OLIVE RIDLEYS GO AFTER NESTING ALONG THE BRAZILIAN COAST?

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The coasts of Sergipe and Bahia states comprises the main nesting beaches for *Lepidochelys olivacea* in Brazil. Between Feb 2014 and Mar 2015, 40 olive ridley turtles were equipped with Argos enabled PTTs to better understand their spatial ecology. Of the 40 PTTs, 1 showed premature interruption of signals (after 14 d) and was excluded from the analysis. A switching state-space model (SSSM) was applied to each of the turtle tracks to identify foraging and migration behavior patterns. The mean duration of the devices was 158 d (min: 44 d, max: 337 d). To date 4 PTTs remain active. After installation, 14 animals left the inter-nesting area immediately (<9 d) and 25 sea turtles remained in this area for an average of 22 d (min: 11 d; max: 33 d). The inter-nesting area included the continental shelf, from the south of Alagoas, Sergipe, to the north of Bahia, totaling 2923 km^2 (KDE 95%), with a core area of 393 km^2 (KDE 50%). Post-nesting migrations were classified as: A) neritic N/NE Brazil to French Guyana (n = 4); B) neritic S/SE Brazil (n = 16), and C) oceanic waters (n = 19) from northern Brazil to northwestern Africa. Olive ridleys that migrated to neritic waters in the S/SE Brazil were larger (mean CCC = 74 cm; ANOVA, F=22.2, p <0.0001) than those that went to neritic N/NE and oceanic waters (mean = 69.9 cm and 69 cm respectively). Time and Distance spent during migration (mean and range) were; A) neritic N/NE: 38 d, 30-47 d; 1892 km, 1236-2120 km; B) neritic S/SE: 49 d, d 37-67; 1990 km, 1483 - 2250 km; C) Oceanic: 119 d, d 90-153, 4384 km, 3182 - 6118 km. One turtle stopped transmitting in French Guyana, covering 3277 km in 61 d, while 10 turtles stopped transmitting during their oceanic migration across the Atlantic. The core foraging grounds along neritic waters in N/NE Brazil encompassed 56 and 293 km^2 (average of 174.9 km^2), which contrasts with the southeast (N = 15, average of 2647 km2) and oceanic areas (N = 6, average of 5810 km^2). A total of 15 olive ridleys that migrated to S/SE Brazil, showed a partial overlap of individual foraging areas, revealing an important foraging ground located off the states of Rio de Janeiro, São Paulo, Parana and the northern portion of Santa Catarina. The estimated area comprised 38,126 km^2 (KDE 95%), with core area of 9789 km^2 (KDE 50%). The 6 Oceanic foraging grounds were found mainly about 100-200 km off

Northwestern Africa. These data demonstrate the complexity of behavior displayed by olive ridley turtles from Brazil and raises questions about their connectivity with populations of other areas in South America and Africa, as well as highlighting possible threats along the high use areas and future conservation strategies. Acknowledgments: We thank TAMAR's field staff who made this project viable. We are also thankful for the travel support provided by International Sea Turtle Society – (ISTS travel grants). This study was demanded by the General Coordination of Oil and Gas (CGPEG), that integrates the Brazilian Institute of Environment and Renewable Resources – IBAMA, to the seismic survey companies: Petroleum Geo-Services (PGS) and Spectrum Geo Brazil. Data analysis was performed by TAMAR, ENGEO Integrated solutions and CheloniData LLC.

PITMAR (MARINE TURTLES IDENTIFICATION PROGRAMME)

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The identification of sea turtle specimens at an individual level, allows the analysis of groups of individuals and their stability, their philopatry, displacement, the population size and its variations, the seasonality, admissions and readmissions in rescue centers, etc. Sea turtles have traditionally been identified by various methods, PIT tags or microchips, metal tags, living-tags, DNA fingerprinting and satellite tracking. All techniques have strengths and weaknesses, to turtles and monitoring programs. Created by Neotropico Foundation, PITMAR (Sea Turtle Identification Program by its acronym in Spanish) is formed by a computer algorithm and an associated database (with information, pictures and history of each specimen) that performs the work of photo-identification easily. The aim of PITMAR is to contribute to the conservation of sea turtles, facilitate research and promote international cooperation for optimizing tasks of control and monitoring actions during sightings registration, in breeding beaches and during rescue, rehabilitation and reintroduction procedures. The PITMAR is a computer algorithm that uses a technique known as photo-identification marking applied to the scale pattern of the facial region of the turtle, since that pattern is virtually unique in nature and can individually identify each specimen of a population of hundreds of thousands of individuals. The data set consisting of the number of scales in that region, their shape and arrangement is unique to each turtle as if it were a fingerprint, which does not naturally vary in form or number throughout the animal's life, modifying only its size. The PITMAR is free, versatile, non-invasive, non-traumatic and accessible online from anywhere in the world with an Internet connection (www.pitmar.net). Search tool has several filters and also provides data record with information associated with each marine turtle specimen. Its potential use covers tens of thousands of people, becoming not only a scientific valuable tool but a link for transnational cooperation and a useful system for environmental education. To date, the platform has received over 55,000 visits. It currently has registered users from 23 countries: Australia, Belize, Brazil, Canada, Colombia, Chile, Ecuador, Spain, United States, Greece, Cook Islands, Israel, Italy, Malta, Mexico, Panama, Peru, Portugal, United Kingdom, South Africa, Uruguay and Venezuela. With over 3000 scales patterns analyzed, the PITMAR software recorded 1500 correct sightings corresponding to 750 individual turtles. Karumbé and the Fundacion Neotropico have been using the photo-identification of marine turtles for over 15 years as individual marking system. On May 15, 2015, the '1st International Symposium on Photo identification and Conservation of Sea Turtles' took place in Santa Cruz de Tenerife; with speakers from Australia, France, Greece, Uruguay, United Kingdom and Spain. The

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CHARACTERIZATION OF THE SEA TURTLE POPULATIONS OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) AND EAST PACIFIC GREEN TURTLES (*CHELONIA MYDAS AGASSIZII*) AND IDENTIFICATION OF THE TROPHIC ECOLOGY IN A FEEDING AREA OF THE NORTH OF SINALOA, MEXICO

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Foraging areas play a key role in the life cycle of sea turtles, it is considered that they serve as a refuge for these animals to maturity. Specimens of different sizes have been found in the north of Sinaloa, this area is considered as a RAMSAR site, but with high anthropogenic impacts. Until recently, Sinaloa was considered to act as a migratory corridor but with the present work we intend to validate the idea that the coastal area of the Northern State of Sinaloa, should be considered as an important area for foraging and resting for sea turtles. In the region north of Sinaloa occur 5 species of sea turtles, in the present study we focus on two of them: *Lepidochelys olivacea* and *Chelonia mydas agassizii*; the objective of this study was to identify the species of organisms ingested by turtles. For this purpose, we captured turtles present in the study area. Samples of potential prey were collected and identified. This esophagic washes of the sea turtles were carried out at the time of the capture. As results we obtained a total of 49 organisms in the period from January to July in 2015 of which 47% were female, 43% male and 10% unidentified sex; basic morphometric data were registered and obtained an average of curved carapace length 63.44 cm, (LCC), an average weight of 30.91 kg and the rate of average body condition (ICC) of 0.47. In regards to the potential prey we collected samples of algae, cnidarians and gastropods but mainly late analysis of esophagical washes indicate that turtles were found in the study area feed primarily on different kinds of algae, *Caulerpa sp*., *Padina sp*., *Laminaria sp*., *Gelidium sp*., and *Gracilaria sp*.; as well as remains of cnidarians of the species *Physalia sp*. and *Stomolophus sp*.. Sea turtles found in the study area, use this area to feed. The data obtained through esophagic washes showed us the importance of the study area, since species that were collected coincided with the collected potential prey. More studies focused in this context is needed to be able to implement new techniques and strategies for the conservation of this important area.

PIC4TURTLE, A COLLABORATIVE IMAGE-BASED PLATFORM FOR SEA TURTLES

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The development of accurate knowledge about sea turtle distribution, identity and characteristics is fundamental for successful conservation programs. A key element of such development is the abundance of high quality data, which can be collected through multiple sources, such as citizens and volunteers. The recent progress in technology turns the production of images into an easy task. Most people, as well as the professionals who patrol the coasts, are likely to possess a smartphone with an internet connection. Moreover, the communities of enthusiasts, or citizen scientists, are often very passionate about the taxon and concerned with their conservation. Following this promising approach, we present Pic4Turtle, an innovative collaborative image-based platform. Volunteers, organizations and expert scientists are populating the platform with a large quantity of geolocalized and dated sea turtle photographs. A visual identification software automatically associates a photo with the correspondent species, aggregating important value to the dataset. The identification software, along with the photo collection, is available as both a web and a mobile application. Other useful information, such as the identification flipper tag numbers, may be collected. This will naturally lead to a geolocalized register of tagged individuals. We believe this is the first work that applies state-of-the-art computer vision techniques to identify sea turtle species from images. Initial experiments show that the system can correctly classify the five sea turtle species occurring in Brazil with more than 80% accuracy. To preserve data quality, collaborative validation by specialists will solve classification mistakes, ambiguities, and improve system accuracy. While common users just generate data, expert scientists guarantee that the information is useful for scientific and conservation purposes, by creating their own accounts within the platform. The widespread use of Pic4Turtle will facilitate the cooperation between sea turtle researchers, professionals and amateurs, supporting the creation of a large, high-quality dataset and providing the users with an easy and appealing interface to access this knowledge. The integration of such volumes of data and a robust validation procedure can provide the scientific community with an invaluable resource for future research. Potential applications are diverse: from species distribution mapping to investigations about the impact of human activities in the ocean and along the coasts, with the aim of influence public policies. The dataset serves as the essential reference to develop and improve software for species and even individual recognition. Furthermore, our platform represents an important tool for educating the general public about sea turtles. Pic4turtle presents to inexperienced users a great amount of information about sea turtle nature, habits, distribution and the importance of their conservation. This will help engage interested people, turning them into citizen scientists and producing two important results. First, increase the production of new images and the system accuracy. Finally, an increasingly aware nonprofessional community will contribute to sea turtle conservation programs, governmental or otherwise, which are often facing scarcity of human and material resources to handle their activities.

DO HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) FOUND IN THE SHALLOW WATERS OF PRINCIPE ISLAND, WEST AFRICA, EXHIBIT SIMILAR ISOTOPIC NICHES?

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Hawksbills, the most tropical sea turtle species. In Príncipe (1° 37' N; 7° 23' E) is located one of the last remaining aggregations in West Africa. Therefore, it is of high conservation value but research on their biology and ecology remains scarce. Here we report, for the first time, data on the trophic and foraging ecology of both juvenile and adult hawksbill turtles found in the coastal shallow waters of Principe Island, from December 2012 to June 2014, using stable isotopic ratios of carbon (δ13C) and nitrogen (δ15N). Differences between the two life stages were significant for δ13C but not for δ15N. Based on SIBER (stable isotopes Bayesian ellipses in R) adult hawksbills (n=11; >75 cm CCL) occupy a much larger isotopic niche then juveniles (n=29 <60 cm), most especially in relation to δ13C (i.e. habitat use) but also in relation to δ15N (i.e. trophic level). Almost no overlap was detected in the isotopic niches, with 40% credible intervals, which suggests foraging segregation between the two groups. The few larger juveniles found in the shallow waters (n = 3; 50 to 60 cm) presented isotopic signatures similar to the juvenile group, supporting a gradual transition between the two observed isotopic niches as larger hawksbills are able to explore deeper areas. The fact that Príncipe shallow waters are constantly being patrolled by spear-hunters, together with the existence of a large insular platform, might help explain this segregation not commonly reported in other studied areas. From our data and the ecology of the species we infer that the bulk (~2/3) of the Príncipe breeding population is distributed locally, by the entire island platform of Principe that is also the largest of the 4 Gulf of Guinea islands, with a few (~1/3) coming from isotopic distinct areas most likely located in the Gulf of Guinea region. This study, while revealing some of the connectivity between hawksbill habitat areas and life histories at Príncipe, highlights the importance of the island for hawksbill sea turtles within the region. Being so, all the island platform should be targeted for research and management purposes, with great benefits for the conservation of this genetically unique West African hawksbill population.

HOME RANGE SIZE AND HABITAT USE BY IMMATURE GREEN TURTLES FORAGING IN A SHALLOW CREEK AND ADJACENT DEEPER SOUND LOCATED IN ELEUTHERA, THE BAHAMAS

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Immature green turtles (*Chelonia mydas*) make trade-offs between home range size, foraging effort, and vigilance required to avoid their predators. The balance between how turtles acquire energy (foraging

success) and what steps they take to avoid their predators may vary with turtle size and food abundance. Determining an individual turtle's home range and subsequent habitat use within that range may provide insight into which strategies individuals use to optimize their foraging success and predator avoidance. Immature green turtles from rookeries throughout the Atlantic recruit to shallow coastal habitats in The Bahamas. The goal of this study was to determine how turtles behaved at a foraging site in The Bahamas, containing both a shallow tidal mangrove creek and an adjacent, deeper, open sound. Preliminary observations showed that some turtles fed in the creek while others fed in deeper sound waters. To determine where individual turtles fed, we attached acoustic transmitters to 8 subjects ranging in size between 33.8-59.2 cm straight carapace length (SCL). Turtles were divided into two classes (small [< 43.0 cm] and large > 47.0 cm]). Using active acoustic tracking, their daily movements were observed between July and December, 2015. Dietary preferences (based upon lavage samples), home range size, and home range location were determined for the two groups. These data show all of the turtles confine their movements to relatively small, and often overlapping, home ranges. There is no obvious relationship between turtle size and home range size. A minority (3 of 8) of the turtles exploit feeding sites in both the sound and the creek. Movement into the creek to feed is confined primarily to the flood tide periods, which may be due to the lack of depth during ebb tide periods. The data suggests that individuals avoid feeding in shallow areas where their ability to out-maneuver tiger sharks may be compromised. Forage, in the form of sea grasses and algae, appears to be abundant so that home range sizes are small compared to those reported from other sites. Site fidelity is pronounced. Other details will be discussed after completing a more detailed analysis of the data. This data will be used to better understand how immature green turtles utilize a foraging ground in The Bahamas and to help managers more effectively protect this endangered species.

TEUTHIDA SQUID IN THE DIET OF OCEANIC STAGE GREEN TURTLES: AN INSIGHT INTO HABITAT ASSOCIATION IN THE SOUTHWESTERN PACIFIC OCEAN

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Mobile marine species that are widely distributed and exhibit complex life histories are inherently difficult to study. Therefore, opportunistic observations become critically important for understanding the more cryptic aspects of their biology. For example, the foraging biology and habitat preference of oceanic life stage juvenile green turtles is poorly understood. Hence, through the examination of the gut contents of coastally stranded turtles in New Zealand, we can provide an insight into the oceanic habitats they occupy and prey they consume in the south-western Pacific Ocean. During a dietary investigation study of green turtles in New Zealand, 4 stranded juvenile green turtles (12% of 34 examined) (mean curved carapace length 47.12 cm, range 39.9 - 66.4, S.D. 10.9) contained cephalopod beaks in the intestinal tract. Cephalopod prey remains comprised 31 upper beaks and 24 identifiable lower beaks, attributed to seven oceanic squid (Teuthida) species in three families (Cranchiidae, Chiroteuthidae and Histioteuthidae). Histioteuthid squids were the most important cephalopod prey, accounting for 79.2% by number of the identifiable lower squid beaks. The Histioteuthidae occur mainly in the mesopelagic regions of the ocean, where they play major roles in oceanic food webs and are taken by a variety of predators throughout their entire bathymetric distribution, ranging from the surface over midwater to near the sea bed. This is the first account of the diet of oceanic stage green turtles southwest Pacific Ocean around New Zealand. The

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SPECIES, SIZE CLASS AND BEHAVIOUR OF MARINE TURTLES OF LORD HOWE ISLAND, SOUTH EASTERN AUSTRALIA

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While there have been many studies of turtles across tropical reefs worldwide, there is a paucity of information regarding the extent of habitat use across the southern range of marine turtles in eastern Australia and, therefore, how that may be impacted by climate change. Multiple predictive models suggest that sea temperatures are likely to rise, and that the waters off South Eastern Australian are a hotspot for this climate response. Marine turtles of the world are facing multiple threats at all levels of their life history. The impacts of climate change on the health and viability of inshore foraging reef habitat critical at multiple life history stages of the green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles, are perhaps the most threatening hawksbill turtles, have been recorded as far south as Argentina at 38.9□S 61.2□W and multiple records of greens, loggerheads and hawksbills have been recorded as far back as 1889 at Tasmania, Australia around -40□S 147□E. Prior to this study, our understanding of marine turtle occurrence in NSW waters between -28□S and -37□S (and below) was limited to reviews of ad hoc sightings and the results of incongruent tagging studies. At -31□S 159□E, the Lord Howe Island Marine Park is home to the world's southernmost barrier coral reef, an expansive lagoon and many protected bays. Historical records revealed a brief history of turtle harvesting which confirmed the presence of turtles around the island as far back as 1788. In this study, repeated in-water surveys were undertaken to determine the characteristics of turtles and their habitat use in this temperate marine ecology. Over a year of seasonal in-water surveys conducted during this study revealed foraging and resting green and hawksbill turtles at all sites chosen based on availability of suitable foraging habitat (reef >20m). Notably, no nesting was observed during surveys, or in historical logs. The majority of turtles sighted were within the 30 - 60cm CCL size class. The results of this study inform protected areas, threatened species and primary industry managers operating in reef habitat in south-eastern Australia, a predicted climate change hotspot. Integrating suitable habitat variables with verified sightings also has the potential to support a globally applicable turtle density estimation model in areas of known or predicted habitat.

BEHAVIOR AND HABITAT ASSOCIATIONS OF SURFACE-PELAGIC JUVENILE KEMP'S RIDLEY AND GREEN TURTLES WITHIN THE GULF OF MEXICO*

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Understanding the behavior and habitat requirements of sea turtles is essential to their conservation. Within the North Atlantic and surrounding oceanic regions, early (surface-pelagic) juveniles of several sea turtle species are presumed to be principally passive drifters associated with Sargassum-dominated surface-pelagic drift communities (SPDC). This information is supported by anecdotal observations, directed research, satellite telemetry, and oceanographic-based species distributional modeling. We used satellite telemetry to examine the movements and sea-surface habitats of surface-pelagic juvenile Kemp's ridleys (*Lepidochelys kempii*) and green turtles (*Chelonia mydas*). Eighteen individuals were captured at sea within the northern and eastern Gulf of Mexico during the summers of 2011, 2014 and 2015. Using switching state-space modeling, we classified track data into periods of directed travel and drift. Sea-surface habitats were characterized in terms of currents, winds, and temperature. We intersected satellite tracks and corresponding Landsat satellite imagery to quantify SPDC associated with tracked turtles. Turtles that remained within the Gulf of Mexico exhibited mostly passive behavior (10 Kemp's ridleys and 2 green turtles). These individuals were closely associated with SPDC or conditions favorable for its occurrence. Tracked turtles moved with, against, and across relatively weak Gulf of Mexico continental shelf surface currents. Shallow waters (< 20 m) and the presence of SPDC were the only features that appeared to constrain the movements of tracked turtles that remained within the Gulf. Five green turtles and one Kemp's ridley departed northern Gulf waters and traveled into the northwest Atlantic Ocean via the Gulf Loop and Florida Currents. These individuals exhibited faster and more direct movements reflecting the influence of the stronger currents within the Gulf Stream System. We tracked the movements of these 18 turtles for periods up to 80 days. During the tracking periods, we observed long-term associations between individual turtles and surface-pelagic drift habitats, likely Sargassum. We will present information on their behavior and details on the sea surface habitats that they occupied. This information on the sea surface habitats used by surface-pelagic juveniles broadens knowledge of their distribution and habitat requirements. Results suggest that SPDC within the northern and eastern Gulf of Mexico serves as critical developmental habitat for surface-pelagic juvenile Kemp's ridleys and green turtles.

THE REPRODUCTIVE AGGREGATION OF SEA TURTLES SOUTH OF ISLA MUJERES, QUINTANA ROO, MEXICO

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Sea turtles have long and complex life cycle. The mating process takes place in the water so there is not much known about it. It is believed the courting process can take place for several weeks before mating occurs. The present work is to document the area of reproductive aggregation of sea turtles south of Isla Mujeres (N2120174/W86.70985), which had been reported by local turtle fishermen in the past. Two trips were taken in 2015 in this area, which has a dimension of 0.3 km x 0.5 km with a depth average 9 m. The first trip was on May 31, observations were made while snorkeling between 10: 00 and 11:00 A.M. During this hour of snorkeling 30 pairs of green turtle (*Chelonia mydas*) copulating, 48 males and four females of the same species; four females and a male loggerhead turtle (*Caretta caretta*), and two juveniles of hawksbill turtle (*Eretmochelys imbricata*) were observed. The second visit was on July 10 from 11:00 A.M. to 1:00 P.M., 12 pairs of green turtles mating, 10 males of the same species and a female turtle were observed. The first male green turtle with a living tag observed copulating in the Mexican Caribbean when the male was 15-years-old. The importance of the area of reproductive aggregation within a protected Natural Area is discussed.

THE EFFECTS OF ARTIFICIAL LIGHT INTENSITY AND WAVELENGTH ON OFFSHORE MIGRATION OF OLIVE RIDLEY SEA TURTLE HATCHLINGS (*LEPIDOCHELYS OLIVACEA*)

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The first hour of a sea turtle's life is a time of high vulnerability due to shoreline predation and exposure to the harsh, high temperature environment. Within this hour, hatchlings emerge from the nest, crawl to the shore and swim through the surf into the open ocean. Photopollution that accompanies coastal development poses an increasing, additional threat to coastal habitats of hatchling sea turtles. Studies have examined the detrimental effects of artificial light during the hatchlings' seaward crawl along the beach, yet little is known regarding the impacts of artificial light on hatchlings' offshore orientation. Here we examine the effects of

different light intensities (5 lumens to 2,000 lumens) at variable wavelengths (red, 720nm; green, 660nm; yellow, 660nm) on olive ridley sea turtle hatchlings (*Lepidochelys olivacea*). Our laboratory design consisted of two circular pools with a camera positioned above each pool to capture behavior. The footage was analyzed to determine the mean angle of orientation and swim patterns through circular statistics and Tracker ® software. We examined swimming behavior and orientation, and observed how threshold intensities of light at different wavelengths may elicit disorientation or misorientation of a hatchling during offshore migration. This was indicated by a set direction other than seaward or lack of set direction. The threshold identified will be utilized to examine potential impacts of illumination around nesting beaches (e.g. Playa Grande, Costa Rica) upon initial neonate dispersal. This information can be translated into artificial illumination thresholds, enabling managers and planners to promote more turtle-friendly coastal development policies and practices. Acknowledgments: We would like to thank Jack W. Schrey Distinguished Professorship, The Leatherback Trust, and Goldring Family Foundation for research support, as well as the Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria, and World Wildlife Fund for support through International Sea Turtle Society travel funds.

THE POTENTIAL FOR CITIZEN SCIENCE TO BETTER PROTECT MARINE TURTLES IN THE MALDIVES

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An increasing number of research programs are incorporating untrained members of the public to assist in data collection. A citizen science data collection program allows for large amounts of data to be collected over vast geographic areas and temporal scales in a cost-effective manner. However, citizen science programs have long been criticized for over-estimating abundance and species diversity and recording effort is extremely difficult. The Maldives is particularly suited for a citizen science data collection program, given the number of tourists that visit the country specifically to dive, snorkel, and view marine wildlife. Sea turtles are particularly suitable for monitoring projects that require little scientific training, such as nesting beach surveys and records of in-water sightings. Although the opportunity to view sea turtles in the wild is often acknowledged as a tourist attraction, very few research projects have investigated this as a potential way to collect data. Even fewer projects based on non-invasive in-water citizen science for monitoring foraging turtles have employed this technique. Photo-ID is a cost-effective, non-invasive technique that can easily be used by citizen scientists with little to no training to monitor sea turtles provided the photos are forwarded to a centralized data hub. Until recently, there has been no systematic collection of quantitative data on marine turtles in the Maldives; therefore, without baseline data, it has been difficult to study the population trends or distribution of any species. The Maldives is fortunate to have many biologists permanently stationed in about one third of all tourist resorts in the country. These biologists regularly collect information but these data are not standardized and staff turnover is high, leading to gaps in the datasets. Without a centralized platform to share these data, the information does not get incorporated into a larger, regional scale database and it cannot be used by the government to strengthen conservation measures. A new data collection program for sea turtles has been piloted in the Maldives to record in-water sightings and nesting events. Photo-ID has been incorporated into the program to validate species identification, and recognize individual animals. This has allowed for a more detailed study of individual animals (capture-mark-recapture), which eventually will reveal patterns of residency and movement

between reefs. Submissions of archived photos have helped narrow down the size at maturity for Maldivian hawksbill turtles and calculate the inter-nesting period for green turtles. The study has also revealed that the majority of hawksbill turtles sighted in Maldivian waters are juveniles, indicating that the reefs provide excellent foraging habitat and that the population is recovering from previous decades of exploitation. Analysis of photo-ID shows that one Photo-ID trip per week is sufficient to estimate the population of turtles of a surveyed reef within error of a closed population statistical model. Plotting a discovery curve of captured individuals over time indicates that it takes between 12-24 months of surveys to photograph all of the individuals on a reef. This program can provide a model whereby citizen scientists can provide information for conservation policies.

NĀ HONU O KAHALU'U: ENGAGING THE COMMUNITY IN PLACE-BASED MANAGEMENT

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Kahalu'u Beach County Park located in the big island of Hawai'i was established in 1970, is an important cultural and recreational area. The park hosts over 400,000 visitors a year who participate in recreational activities including surfing, snorkeling, sunbathing, and fishing. The Kahalu'u Bay Education Center (KBEC) was established in 2011 and it includes the ReefTeach Program which aims to educate visitors and residents alike on how to avoid damaging corals and how to take care of Nā Honu O Kahalu'u (the green turtles of Kahalu'u) and other reef animals. While it is an exemplary program, there was concern regarding the interactions of tourists and honu in the bay. This project builds on 21 years of field research at Kahalu'u by M. Rice and G. Balazs, and had two major goals. The first was to better understand the ecology of the turtles at Kahalu'u. The second was to identify the human-turtle interactions through a citizen science program and to develop site-based management plans to enhance turtle conservation through visitor awareness. Baseline data was gathered on growth rates, feeding preferences, movements, health status, and habitat requirements for the honu at Kahalu'u Bay. Twenty-nine honu were captured, tagged, and morphometric data were taken. The honu were harmlessly marked with a carapace number (K1-K29). The mean growth rate for 9 recaptured turtles was .82 cm / year. The average size (SCL) of turtles captured was 50.0 cm with a range of 39.6 to 66.9 cm. Mouth samples collected showed that turtles feed on *Pterocladia sp.*, *Ulva sp.*, and other unidentified algae. We found that the majority of the turtles monitored stayed within the bay (20 of 29) during the project. Honu spent 66% of the time feeding, and 34% of the time resting or traveling during the day. At night, 100% were observed resting. Community members, ReefTeach volunteers, high school students and visitors monitored the location and behavior of the numbered honu on a regular and a haphazard basis (visitor reports). This data was compiled to gain a clearer understanding of the range and behavior of the honu. At the same time, human use patterns and behaviors were recorded and mapped. Separately, timed observations of the behavior of humans in the presence of turtles and levels of disturbance were recorded. Observed human-turtle interactions involved very few "disturbance" incidents with only two classified as level 2 (turtle actively fled the area). Seven percent of the tourists that were observed within 2 feet of a honu caused a minor reaction (Disturbance level 1). Following these

observations ReefTeach Volunteers adjusted their location to more tourist and turtle dense areas. The ReefTeach volunteers have also begun educating tourists to consider cameras on telescopic mounts (GoPro type) as an extension of their body that should be kept at least 10 feet away from the honu. With these changes, the program is more effective at managing human-turtle interactions at Kahalu'u Bay Beach Park.

DIET ANALYSIS OF *CHELONIA MYDAS* "GREEN TURTLE" IN NORTHERN PERU, 2013-2014

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Diet and food preferences data of the green turtle *Chelonia mydas* based on content of the digestive tract of dead specimens caught incidentally by an artisanal gillnet fishery in the Sechura Bay, northern Peru, 5°12'S and 80°50'W was collected from July 2013 to June 2014. We examined 27 digestive tracts of *Chelonia mydas* and identified 32 food items, grouped into six categories: algae, cnidarians, mollusks, arthropods, chordates and debris. Of all items identified, five had the highest occurrence frequency values (%FO): *Caulerpa filiformis* (77.78%), eggs of *L. gahi* (51.85%), *Rhodymenia Corallina* (44.44%), *Gigartina chamissoi* (29.63%), *Ulva lactuca* and *Gellidium congestum* (22.22% each); whereas, by weight (%W) green turtles consumed mainly five food items: *L. gahi* (eggs) (33.25%), *Stomolophus sp.* (7.33%), *Aphos porosus* (6.50%), *R. Corallina* (5.03%) and *Synum simba* (eggs) (4.58%). Debris presence was common in the digestive tracts analyzed. Plastic items reached an occurrence frequency of 55.56%. The greater supply food in diversity of items and consumer values was observed during summer and autumn followed by spring and winter. This study shows that *Chelonia mydas* in Sechura Bay, forages on a variety of resources, but focuses on particular species. This may indicate the existence of a possible selectivity for certain items. Based on these results, it is recommended that conservation plans, land use planning and future management plans, include green turtles as a sentinel species for monitoring of biodiversity and the degree of marine pollution in the bay.

HABITAT USE AND CONNECTIVITY OF GREEN AND HAWKSBILL TURTLES IN THE WESTERN CENTRAL PACIFIC: MANAGEMENT REQUIRES MULTINATIONAL EFFORT*

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The Marianas archipelago hosts nesting and foraging habitat for green and hawksbill marine turtles. The USA NMFS and USFWS recently proposed listing green turtles in the Central West Pacific (including Guam and CNMI) and the Central South Pacific as distinct population segments (DPS) and listing these populations as endangered, the highest level recognized by the US Endangered Species Act. To better understand the connectivity and threats of green and hawksbill turtles in the Marianas Islands we conducted small boat surveys in the nearshore and coastal waters of Guam, northwestern and northeastern Saipan, and western Tinian. When turtles were encountered on surveys they were hand captured while snorkeling or by diving from a slow-moving boat. Hand capture involved free-diving (2-25 m) to capture turtles resting/foraging on bottom substrate. Captured turtles ranged in straight carapace length from 37-72 cm and in mass from 7-49 kg. Turtles were captured while resting or foraging on the bottom and while in transit. Thirty-five turtles were outfitted with GPS capable SPLASH tags from Wildlife computers. These tags give information on location, dive depths, dive durations, and temperature profiles. Twenty-four turtles were satellite tagged in the Apra Harbor area on Guam (all green), 4 in the waters of western Tinian (1 green / 3 hawkbills), and 7 in the nearshore waters of northwestern and northeastern Saipan (6 greens / 1 hawksbill). Kernel density estimates revealed high site fidelity and limited movements for the green turtles as well as for 2 of the hawksbills while resident of Guam, Tinian and Saipan. Two hawksbill turtles tagged off Tinian made long range movements with 1 turtle leaving Tinian and now residing off southern Guam in the Cocos Lagoon region (migration covered a distance of 286 km and lasted 7 days) and the other still currently on the move heading eastward along the northern edge of FSM. Dive patterns suggest that both hawksbill and green turtles remain in deeper waters during daylight hours and move nearshore during the night; however, the trend is more pronounced in hawksbills. Hawksbills spent more time in deeper waters than the greens, reaching depths of 100 m or more. Green turtle average depth was less than 10 m for day and night, respectively. The data suggest a dichotomy in selected habitat and habitat use for green and hawksbill turtles, which is unsurprising given their unique foraging habits. However, both species display small home ranges typically less than 4 km2 and limited movement between islands with only two turtles, both hawksbills, making treks from Tinian to Guam and Federated States of Micronesia FSM. Fifteen nesting green turtles were tagged from the islands of Rota, Tinian, and Saipan; these females migrated to foraging areas of the East and South China Sea including the Philippines. The movement patterns and habitat use of the turtles suggests divergent origins for the life-history classes found in the nearshore waters. The connectivity of turtles suggests that management will require international efforts and understanding of life-stage threats will better our understanding of population trends. Acknowledgments: The project was

successful due to the collaborative effort of the U.S. Pacific Fleet, Naval Base Guam, NOAA PIFSC, Guam DAWR, Guam OLE, and the Apra Harbor Patrol.

THROUGH THE CAMERA LENS: A PHOTO-IDENTIFICATION CATALOGUE (1998-2015) THAT SUPERBLY CAPTURES THE LIVES OF ENDANGERED HAWAIIAN HAWKSBILL SEA TURTLES

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Along with the more common Hawaiian green sea turtles (*Chelonia mydas*), endangered hawksbills (*Eretmochelys imbricata*) inhabit many accessible nearshore habitats within the Main Hawaiian Islands (MHI). This makes this rare species an ideal candidate for a photo-ID research project. Juvenile and adult hawksbills can be non-obtrusively monitored long-term by matching photographs of their head and flipper scale patterns. Sampling effort by year, location and photographer ranged widely, but the compiled results still provide the greatest amount of information known about Hawaiian hawksbills in their marine environment. Photographs were obtained opportunistically from 1998-2015 in several ways, but primarily from a network of personal contacts. Flyers were distributed to ocean recreation shops that illustrated the differences between greens and hawksbills and encouraged the reporting of hawksbill sightings. Requesting hawksbill photographs and finding incidental sightings on various websites, especially with the popularity of social media sites, also increased records. Targeted in-water surveys were conducted on Maui, Lana'i and Moloka'i to assess habitats beyond popular snorkeling destinations. Over 200 photographers contributed to a total of 704 confirmed sightings of 79 MHI individuals, all with various metadata: date, time, location, depth, habitat, behavior, and reaction to human presence. Since the authors reside on Maui, the majority of individuals have been documented there (Maui= 47, Hawai'i Island= 13, O'ahu= 11, Lana'i= 3, Moloka'i= 2, Kaua'i= 2, and Kaho'olawe= 1). All individuals were given numbers, plus each photographer who submitted a unique individual to the catalogue were given the opportunity to choose its name. Sightings of individual hawksbills ranged from 1-110 (mean= 8.9±17.2 SD, mode= 1), within 100 m depth) sightings. Hawksbills were photographed foraging on algae, coral, sponges, fish, and invertebrates. Some hawksbills displayed no visible reaction to humans, while others exhibited flight behavior. Documented threats include fishing gear interactions, harassment, habitat degradation, marine debris entanglement, and boat strikes. Acknowledgments: This insightful 18-year collection was partially funded by NOAA (2010-2015), and this travel grant has been made available through generous donations from the Whitley Fund for Nature, Columbus Zoo and Aquarium, National Fisheries Society, World Wildlife Fund, and the International Sea Turtle Symposium.

HABITAT USE AND MOVEMENTS OF SMALL JUVENILE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) FROM THE NORTHERN ADRIATIC SEA*

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The northern Adriatic Sea is one of the most important neritic foraging habitats for the loggerhead sea turtle (*Caretta caretta*) in the Mediterranean basin, inhabited by juveniles and adults primarily belonging to the Ionian-Adriatic management unit. Loggerheads recruit to the northern Adriatic at a small size, but habitat utilization and movements of juveniles, which constitute the bulk of population, are unknown. In this study, we equipped 10 juvenile loggerhead turtles (mean curved carapace length: 35.5 ± 3.9 cm) with pop-up archival satellite tags (PAT Mk-10, Wildlife Computers). Turtles were released from Piran (Slovenia) and Savudrija (Croatia) between August and November 2014. Results obtained showed that small juvenile loggerhead turtles: (i) remain in the Adriatic Sea throughout the year; (ii) perform seasonal movements between exclusive summer foraging habitats in the northernmost part of the Adriatic Sea (wider area of the Gulf of Trieste) and overwintering areas located in the north-central Adriatic Sea; (iii) exhibit behavioural plasticity and different patterns of habitat use during the winter, including migrations to the southern Adriatic; (iv) show site fidelity for northern Adriatic foraging grounds; and (v) utilize national waters of all Adriatic countries, which emphasizes the importance of international cooperation in the Adriatic for conservation of regional stocks of this endangered species. Acknowledgments: This study was performed within the project NETCET - Network for the Conservation of Cetaceans and Sea Turtles in the Adriatic, co-financed by the IPA Adriatic Programme of the European Union.

PHOTO IDENTIFICATION RESEARCH INVOLVING LOCAL COMMUNITIES AND TOURISTS FOR CONSERVATION OF SEA TURTLES IN THE WATERS OF PERHENTIAN ISLANDS MARINE PARK, MALAYSIA

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Perhentian Islands is a popular tourist destination and home to foraging and breeding green and hawksbill turtles, and recorded the second highest turtle nesting in Terengganu's archipelago, Malaysia. Other than the number of female landings, nests, eggs and hatching success rate, little is known about the sea turtle population. The identification of individuals within a population is essential to species conservation and management. For sea turtles, tagging, which is the most common mark-recapture method applied to females on nesting beaches, may underestimate the population size due to the paucity of information about sea turtles that spend most of their time at foraging grounds and at sea. Conversely, the photo identification (ID) method is non-invasive, reliable and easier than tagging to identify sea turtles in the water. This method requires minimal experience in data collection where the local communities and tourists can participate, which allows a more comprehensive population study sea turtles, including males and juveniles. Using the photo ID method, Perhentian Turtle Project aims to infer the sea turtle population size, their distribution, habitat use and movements around shallow waters of the Perhentian Islands. Photos of both sides of the face were taken through snorkeling at foraging grounds not deeper than 10m and on nesting individuals. Locals and tourists participated through submission of underwater and nesting photos. Sighting data such as date, time and location were recorded. Collectively, all photos obtained from 2012 to 2015 during the tourist season (February – October) were identified using NaturePatternMatch software or manually by eye to develop a sea turtle photo database based on facial scales. Based on underwater photos from 12 snorkel and dive sites, 56 individual green turtles (14 males, 22 females and 20 juveniles of unknown sex) and 10 individual hawksbills of undetermined sex were positively recognized. Nesting photos from nesting beaches documented 45 female green turtles that were not observed in the nearshore waters of the Perhentians. It is possible that these nesters stayed in offshore deeper waters during inter-nesting period rather than around the nearshore sea grass beds where 93% of the identified green turtles were seen. Hawksbill turtles were sighted among coral reefs at various locations, with the highest number recorded at Shark Point. Fourteen individual turtles were seen only once in the waters whereas the remaining 79% were sighted more than once within a year or more, showing fidelity to the foraging site. Repeated sightings of individuals suggest that some may be resident turtles. Overall, a total of 101 green turtles and 10 hawksbill turtles were recognized in the Perhentians with local and tourist participation. This is a preliminary estimate of the population size but the number may increase if the survey area expands to other nearshore and deeper waters, as well as nesting beaches. The database will contribute towards informing conservation and management practices of the local government on the islands. Acknowledgements: We would like to thank National Marine Aquarium and Durham University Charities Committee for funding this project,

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THE YOUNG AND THE RESTLESS: PREDICTING JUVENILE GREEN TURTLE (*CHELONIA MYDAS*) HABITAT USE USING A BEHAVIORAL MODEL*

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Neritic juvenile marine turtles are notoriously difficult to study over long periods of time due to their tendency to move seasonally among habitats and transition to different developmental habitats as the individual turtles grow and mature. As a result, our ability to understand the ecology of juvenile marine turtles is reduced to snapshots of their lives. Our ability to make inferences about population status is correlative and dependent on measures of abundance, rather than an understanding of how individual turtles respond to changes in their environment. Telemetry techniques can provide important information about habitat use but these studies are often not hypothesis-driven. With this study, our goal was to create a simulation of how juvenile turtles within a neritic foraging ground would behave if they follow the predictions of ecological theory. Our aim is to test these predictions by applying transmitters to juvenile turtles and comparing movements to relevant environmental variables. Specifically, we aim to test the relative importance of predator abundance, food availability, temperature, individual condition, and individual size on the habitat use and residency time of juvenile green turtles (*Chelonia mydas*) at the Trident Basin at Cape Canaveral Air Force Station, Florida, USA. This site has been studied by the University of Central Florida Marine Turtle Research Group since 1993. The Trident Basin, a man-made embayment lined with rock riprap, is particularly well suited for both behavioral modeling and tracking applications for juvenile green turtles. This site supports a population of small green turtles (20-35 cm SCL), which forage on abundant red and brown algae growing on the riprap after recruiting from oceanic habitats. Algae is only available at shallow depths (1-2 meters) along the edges of the Basin; therefore, turtles are more vulnerable to predation while foraging because they cannot dive or maneuverability is limited by the shoreline. We established rules for habitat use in the Basin relative to the variation in algae availability and energy content (known from previous research), predator densities (nearly always low at this site), temperature, and individual condition and size (standardized and known from 23 years of research). These rules were incorporated into a spatially-explicit individual based model. In accordance with ecological theory, we hypothesize that turtles will seek to maximize the product of survival probability and energy intake through changes in daily habitat use. However, when this measure does not consistently surpass a size-dependent threshold level they will abandon the habitat in search of more productive areas. By varying this threshold level, and the relative importance of the different habitat variables, we created a hypothetical turtle habitat use model to be compared and tested against the actual habitat use generated by future telemetry work. Through testing the relative importance of factors underlying habitat use, we can more easily extrapolate the results of telemetry work beyond the study site in question, greatly increasing the value of this work to conservation and management.

ASSESSMENT OF GREEN, *CHELONIA MYDAS* AND HAWKSBILL, *ERETMOCHELYS IMBRICATA* (REPTILIA: CHELONIIDAE) SEA TURTLES AT NEAR-SHORE FORAGING AREAS IN THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

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The green (*Chelonia mydas*) turtle is listed as Threatened while the hawksbill (*Eretmochelys imbricata*) turtle is listed as Endangered under the Endangered Species Act throughout the Western Pacific range. Limited sea turtle population data is available for the Western Pacific and Philippine Sea regions. The objective of this study was to characterize the size class distribution, growth rates, habitat utilization, behavior, diet, and site fidelity of a foraging aggregation of green and hawksbill sea turtles in near-shore habitats of the southern CNMI region. Between August 2006 and February 2014, 642 captures were made of 493 green and 36 hawksbill turtles. The turtles ranged in carapace length from 32.5 to 91.6 cm and juveniles of 50.7 cm size class made up the majority of captures. Four adults (straight carapace length ≥ 81 cm) were caught in the nearshore waters (88.9 - 91.6 cm). Similarly, all 36 hawksbill turtles were juveniles (SCL < 78 cm). Coral habitats were found to provide important foraging and resting areas for both species. Forage sampled from 47 green turtles included *Amansia* sp., *Gelidiella* sp., *Hypnea* sp., and *Ceramium* sp. Growth rates for both species ranged from 0.29 to 5.76 cm yr-1). Recapture of a Saipan nesting green turtle on foraging grounds several months after near-shore surveys suggested an unexpected short-range post-nesting migration. These results are an assessment of green and hawksbill turtle population demographics and habitat utilization in CNMI regional waters and the first study within CNMI to report on morphometric data and diet composition.

THE USE OF I3S SOFTWARE FOR PHOTOGRAPHIC IDENTIFICATION OF MARINE TURTLES WITHIN A CITIZEN SCIENCE MODEL IN THE GALAPAGOS MARINE RESERVE (GMR)

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Photographic identification allows for an efficient and non-invasive technique for accurate recognition of individual sea turtles and to obtain population dynamics data. Traditional techniques such as marked identification tags are problematic due to a high tag loss rate and repeated animal manipulation. There is need for investigation into computer programs that can assist researchers in identifying individual

organisms more efficiently and accurately. This study evaluates the effectiveness of one such program, I3S Pattern, in identifying individual sea turtles and establishing a database of *Chelonia mydas* in the Galápagos archipelago. Out of 178 turtle sightings entered into the software, I3S data analyses provided 18 examples of turtles that were sighted and re-sighted on at least one additional occasion. Time between sightings ranged from one day to five years, and all turtles were re-sighted in the same location as their original photograph. A significant gap exists between current scientific research and local public participation in ecologically significant areas of the world. A citizen science model for data collection was employed to achieve an enhanced collection range across the archipelago, an increase in local interest and a greater participation of the community in the monitoring of issues of increasing environmental concern. Posters advertising submission for sea turtle photos with date and location were placed in 12 tour agencies in the town of San Cristóbal and talks were delivered at official naturalist guide seminars. Members of the public including Galápagos naturalist guides, international and national tourists and tour agency employees submitted 41 photos of new individuals across 9 new locations in the archipelago. This extended the data collecting range from 17 locations to 26 across the archipelago. Our results suggest that a citizen science model allows for a greater spatial range for data collection and that I3S software has potential to be highly beneficial in obtaining population dynamics data for sea turtles, pending additional studies and considering inherent limitations within the system.

DEVELOPING A COMMON CURRENCY FOR TISSUE ANALYSES USING STABLE ISOTOPES OF NESTING GREEN TURTLES (*CHELONIA MYDAS*)

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Understanding patterns linked to specific geographic regions is essential to the development of proper management and conservation strategies for migratory species. Stable isotope analysis has proven to be a valuable tool used to understand migratory connectivity in a diverse range of taxa. Many studies have found this to be an innovative tool with significantly reduced costs compared with other techniques, allowing for more robust sample sizes. Green turtles (*Chelonia mydas*) are a highly migratory, endangered species that often travel vast distances between their foraging and nesting sites, but are regularly only studied at nesting areas. In the past, isotopic data has been used to identify distant foraging areas for marine turtles sampled on the nesting beach. However, as different tissues types are added to the growing repertoire available to stable isotope studies, the relationship between these tissues needs to be evaluated. Understanding the isotopic relationship between tissue types would allow for the generation of conversion equations that would allow for a "common currency" across stable isotope studies, providing researchers with a means of comparing results. We investigated this relationship by comparing isotopic signatures of two types of tissue, shoulder skin biopsies taken at the time of nesting and unhatched, addled (rotten) eggs collected during nest excavations to evaluate reproductive success. These samples were collected from 40 nesting green turtles at the Archie Carr National Wildlife Refuge, Melbourne Beach, Florida, USA in 2013 and 2014. The relationship between both the $\delta15N$ and $\delta13C$ isotopic values of the two tissue types were evaluated using linear regression to develop conversion equations that can be used in future green turtle isotope studies. Although green turtles nesting numbers and population size are steadily increasing in the United States, they are still classified as an endangered species. Studies such as this one, which allow for comparisons

between sampling methods used by a variety of studies will aid in improving strategies used for conservation and management across green turtle populations.

TORTUGA NEGRA-GALÁPAGOS IN-WATER BIOLOGY FROM A SEA TURTLE OASIS

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Galápagos is perhaps one of the most important sites in the world for some sea turtle populations. However, in-water biology studies are almost nonexistent. Current sea turtle species are key for the socio-ecological system, and are strictly protected. However, they are starting to be threatened by direct and indirect anthropogenic influences. The project Tortuga Negra-Galápagos, involves advances in the understanding on the ecology and biology of these species in the archipelago, a place that apparently is a protection oasis for these organisms. Our conservation research efforts are based on community, primarily developed by local university students (USFQ-GSC). We conduct a standardized long-term project researching sea turtles at the feeding areas to gather information on abundance, habitat use, biochemical parameters and health. Our initiative is based on an integrated, scientific approach. In two years with an average field effort of 3:27 hours SD: 1.59 hours and a total of 107 field trips (November 2013 to August 2015) at the islands of San Cristóbal, Española, Floreana, Darwin and Wolf. We have had incorporated techniques such as Photo ID and citizen science (more than 700 records in our central database); growth rates models and mark-recapture (426 *C. mydas* (123 males CCL= 78.92 SD: 5.14; 95 females CCL= 79.19 SD: 6.09; 208 juveniles CCL= 63.06 SD: 7.46) and 21 *E. Imbricata* (4 females CCL = 72.13 SD: 6.7 and 17 juveniles CCL = 49.7 SD: 8.01); aquatic census estimations (San Cristobal>4000 individuals); population genetics for *C. mydas* and *E. imbricata* (First genetic results indicate a connection of *C. mydas* with continental Ecuador. Further on, we confirmed nesting of *E. imbricata* nest in the Galápagos); acoustic and satellite telemetry (8 *E. imbricata* and 16 *C. mydas* with large and small home ranges); baseline health and diet analysis in conjunction with biogeochemistry; and preliminary plastic pollution analysis. Our results will be incorporated in the new zoning plan currently being developed for the Galápagos Marine Reserve (GMR). Our information also forms the baseline for continuous monitoring of local populations. In this sense, we contribute to the effective management of the taxon in Ecuador and the world; particularly taking into account, that the Galápagos is under risk concerning the tourism development in the islands. We emphasize the need and importance of continuing to work with local communities and the need to replicate these initiatives along the entire coast of the Galapagos; this information is expected to expand timely effective knowledge in order to achieve true conservation. Acknowledgments: We would like to thank the Tortuga Negra-Galápagos project and all the people involve, the Galapagos Science Center, Universidad San

Francisco de Quito, Parque Nacional Galápagos, Ecofondo, ICAPO, 36th Annual Symposium on Sea Turtle Biology and Conservation, North Carolina State University, University of North Carolina at Chapel Hill, and James Cook University.

THE PHOTO-ID TECHNIQUE IN MARINE TURTLES AS A TOOL FOR THE IDENTIFICATION OF RESIDENT SPECIMENS IN TAGANGA, COLOMBIA

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Marine turtles are species whose life strategies and constant relation with coastal communities and anthropic pressures have led to them being part of the red list of endangered species UICN in different grades of threat. Before this, the Program for the Conservation of Marine Turtles and Mammals of the University Jorge Tadeo Lozano - Acuario Mundo Marino (proCTMM) in Santa Marta, conscious of the need to empower local communities in the development of strategies that preserve these species, has for 15 year considered these animals in their processes and conservation activities. Thus, before the frequent sightings of sea turtles by dive centers in Taganga Bay, there were established since 2013 strategic alliances which have allowed specialized training in the theme and the implementation of underwater photographs as the basis for a Photo-ID technique. The photographs are later modified to zoom in on the post-orbital scales which form unique patterns in each individual, making it possible to generate a code for their identification. To date, we have accumulated a bank of 95 photographs supplied by the diving centers Reef Shepherd, Octopus, Poseidon, Scubapro and Under Pressure, from which a set of 13 photos was used to create the corresponding codes of each individual found. Once the codes from the initial data set were obtained, to date there is are a total of 9 specimens identified, 5 reported for 2014 and 4 for 2015. These include 7 *Chelonia mydas* and 2 *Eretmochelys imbricata*, including 2 instances of individuals observed over 2 years or within the same year in different periods. Additionally, the communication processes between the people involved in the region, allowed the recovery of a specimen captured by fishermen in the fishing port, providing the opportunity to compare the underwater photographs with images ex-situ and ot corroborate as part of the individuals reported as resident of the evaluated area. Also, the robustness of the scale patterns found is supported by the fact that the code is not influenced by the distance or angle of the photo. Therefore, the fortuitous encounters between divers and turtles provides the perfect tool to develop the Photo ID method. With the information obtained about the number of turtles and the incidences found over the years, it can be inferred that Taganga Bay and its surroundings are important foraging and habitat areas of different populations of resident or migratory marine turtles. The utilization of the Photo-ID technique offers an approach to the identification and quantification of these specimens and a tool to create areas of protection and conservation for these endangered species, as long as there exist continuous processes of environmental education and spaces for information exchange that involve the various actors in this matter.

DESCRIPTION OF THE ROUTES OF FIVE HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) RELEASED AT DIFFERENT STAGES OF LIFE IN THE COLOMBIAN CARIBBEAN AND FOLLOWED BY SATELLITE TELEMETRY

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Satellite telemetry has been the most used tool in the past decade to generate information that allows us to understand the influence of oceanographic dynamics, types of ecosystems and human activities on the marine turtle migration. This was the reason why the Turtle and Marine Mammal Conservation Program of the UTADEO-Mundo Marino Aquarium began its implementation in the Colombian Caribbean, marking three *Eretmochelys imbricata* juveniles and two adults. In 2009, four-year-old Cumbiarey was released in Gayraca - Tayrona National Natural Park (PNNT). During the first 20 days of its journey it went west to reach the archipelago of Bocas del Toro, Panama. Once in the archipelago, it made local moves to get to its final location, completing 540 days of tracking. This area is reported as a feeding ground and features a marine protected area. In 2010, Colombianita and Tuggy, two 13-month-old juveniles, were marked after their head start process and released in Mendihuaca, Magdalena. Colombianita, over 697 days, initially took a coastal route up to Panama, came back to Colombia through Chocó State, and went to the archipelago of San Bernardo - PNNCRSB, a location registered as a foraging area. It then headed to Costa Rica, making a turn to the southeast off the coast of Panama to go further north, up to Belize and Honduras. Finally, after traveling around the Yucatan peninsula, it settled in Laguna Chacmuchuk, Mexico, where it made localized movements. Tuggy, meanwhile, visited the PNNT bays, and soon died in a trammelnet in Bahía Concha after 48 days of tracking. In 2011 Chepa, a wild-caught adult, was marked and released in Medihuaca, in cooperation with the Regional Autonomous Corporation of Magdalena. After 21 days of transmission, its coastal route reached the waters off Cabo de la Vela, of La Guajira State. It is noteworthy that the area of last transmission is an area known for illegal sea turtle fishing activities. In 2015, Wayurey, a wild-caught adult captured by the Regional Autonomous Corporation of La Guajira, was marked and released in Riohacha with the support of Petrobras. During the first days of its journey it headed northeast to Punta Gallinas, and then went to Monjes del Norte where it left the country to go to Aruba. After that, it went north in Caribbean ocean waters half way to Puerto Rico. However, during Hurricane Danny it returned to Colombian waters off the Guajira Peninsula in Puerto Estrella, to head to Cabo San Roman, Península de Paraguana, on the Venezuelan coast. It has been monitored for a total of 90 days to date. After tracking five specimens of hawksbill from the Colombian coast, a trend seems apparent where juveniles head west/northwest, while adults head east/northeast. The present study uncovers less known corridors for the species. This creates a basis for authorities to formulate and implement strategies for local and regional management, allowing interconnection between existing development, foraging and nesting zones in the south and center of the Greater Caribbean.

DIVE BEHAVIOR OF GRAVID LEATHERBACK TURTLES DURING INTER-NESTING PERIOD NESTING AT JAMURSBA-MEDI, INDONESIA AND SOLOMON ISLANDS IN THE PACIFIC

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For critically endangered species where adult mortality may be high enough to result in local extinction, reproductive success is crucial for their population recovery. Therefore, an understanding of behavior and habitat use during reproductive periods is important for informing conservation management. In this study, we present the dive behavior of gravid leatherback turtles during the period between nesting haul-outs (inter-nesting period) within the season at two Western Pacific nesting regions; Jamursba-Medi, Indonesia and Solomon Islands during 2006-2010. We used three types of dive data; Time-at-depth data (Jamursba-Medi; N = 4, Solomon Islands; N = 6), intermittent dive data (Jamursba-Medi; N = 6) obtained from the ARGOS satellite transmitters, and continuous dive data obtained by directly retrieving the tags (Jamursba-Medi; N = 1, Solomon Islands; N = 1). The three types of dive data demonstrated that gravid leatherback turtles nesting at both Jamursba-Medi and Solomon Islands spent 37.3% of the time for routine dives to deep waters (>150 m), and stayed at cold waters over the thermocline during the inter-nesting period. Gravid leatherbacks experienced a wide range of water temperatures. Average sea surface temperature was 28.8 ± 3.5°C and declined to a low of 5.4°C at 846 m depth. Thermocline was generated at 100-150 m in depth. Comparison of descent rate for routine deep dives between our study and the previous study using an accelerometer suggests that a routine deep dive is the dive with gliding while descending, indicating that it may serve as the behavior for both saving their energy and cooling down. Mean depth of routine deep dives was deeper during daytime than nighttime. This shift may indicate that the dive depth depends on ambient light condition under which they can ensure the safety, because the dive depth was significantly correlated to a light level. This pattern of routine deep dives with diel rhythm was also reported in the Atlantic (St. Croix and Grenada), and assumed as a foraging dive to the deep scattering layer. However, a recent study investigating gastrointestinal tract temperature in St. Croix observed the sporadic feeding associated with the routine deep dives mainly in the first four days, but it concluded that the gravid leatherbacks were opportunistic feeder. Therefore, these facts may indicate that gravid leatherback turtles demonstrating the routine deep dives, have the energy-saving strategy that reduces the amount of activity by gliding dive, and maintains a low level of body temperature by attaining to cold waters, in order to maximize the reproductive output. On another aspect of inter-nesting behavior, gravid leatherback turtles spent a considerable amount of time (24.7%), in shallow waters (300 m) seemed to be over the aerobic dive limit, the behaviors at shallow waters would serve for degradation of lactic acid accumulated in a proceeding dive. However, alternative explanations are possible (e.g. basking and handling of prey).

FOCAL PHOTOGRAPH SURVEYS: FORAGING RESIDENT MALE INTERACTIONS AND FEMALE INTERACTIONS AT FISH-CLEANING STATIONS

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Following the loggerhead sea turtle mating period from March to May, the marine area of Laganas Bay (Zakynthos, Greece, Mediterranean) supports nesting females (until around mid-August), in addition to foraging by resident males and possibly immature turtles. Here, through regular daily photo-id surveys during 2015, we gained insights into interesting behaviours exhibited by these two groups in two different parts of the bay. At one site, with submerged rocky reefs (Agios Sostis), several individuals (n = 13, of which 5 were confirmed males, 1 was a confirmed female and the remainder could not be determined) were regularly encountered (n = 10 surveys), and were observed to forage, with regular aggressive interactions (4 incidents of biting-like behaviours out of 7 paired encounters). We hypothesise that, at least, the males are residents competing over limited forage resources. Interestingly, even though some females forage during the nesting period, few were detected during surveys at this site, although they were present in the shallow sandbanks 0.4 km shoreward of the survey site. In contrast, at one of potentially several fish-cleaning stations (a small collection of rocks in the shallow submerged sandbanks), several individual females (n = 13 individuals over 19 surveys) but not males, were detected. At least 3 species belonging to the Mullidae and Sparidae families were observed conducting cleaning activities. Some females (n = 6) were observed at the cleaning station on more than 1 day. One female used the station as a resting site for at least 6 consecutive days, but was not approached by fish, possibly because they had consumed all forage items of interest on her. Some individuals (n = 4) also exhibited self-cleaning behaviour by scratching on rocks at the station. Unlike the interactions at Agios Sostis, 2-3 females sometimes gathered at once without antagonistic interactions, although individuals displaced one another on occasion. The number of turtles frequenting the station declined over July, possibly because females were departing the bay following the completion of nesting, whereas the numbers of individuals observed at Agios Sostis remained constant. It is possible that cleaning activities are important to prevent the settling and growth of barnacles; for instance, we documented the same females without barnacles in June, but with small barnacles in July. Thus, barnacle larvae may be heavily recruiting onto females that rest in the shallow warm waters to develop their eggs between nesting events. The growth of too many barnacles during female residence at the breeding grounds could potentially slow subsequent migration speeds to foraging grounds, which would be detrimental if energetic reserves are already low due to the females in this population generally not foraging during breeding. In conclusion, our observations provide new insights about both foraging behaviour by males and important inter-nesting behaviours by females at this important breeding site in the Mediterranean.

WESTERN PACIFIC GREEN TURTLES: INTERNATIONAL AMBASSADORS

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Sea turtles are hailed as ocean ambassadors often due to the extensive journeys of loggerhead and leatherbacks that span ocean basins. While green turtles do not travel across entire ocean basins, they are also international ocean ambassadors traveling between many countries in the Caribbean region and also in the East Asia region. The Turtle Islands of Sabah and the Philippines started flipper tagging of green turtles in 1972 and returns of these tags showed a distribution west into the China Sea, south into Indonesia, north into the Philippine Sea and east into the Western Pacific. In this presentation, we discuss the importance of nesting sites of the island nations of the Western Pacific. Tags were reported from post-nesting green turtles of the Federated States of Micronesia (FSM) island of Yap being returned from Japan as well as the Philippines and the Republic of the Marshall Islands (RMI). In 2005, satellite tags deployed on turtles in Yap, FSM went to the Philippines and Malaysia. In 2007, satellite tags were deployed from Yap, FSM and RMI. Turtles from Yap moved to Japan and the Philippines, while turtles from Erikub, RMI went to the Philippines, Kiribati and FSM and RMI islands, although many stayed pelagic for an extended period, similar to green turtles that were reported in the Bonin Islands. These tracks highlight the importance of sea turtles as a shared resource among the Western Pacific island nations extending to the China Sea. We recommend that additional studies be done in the China Sea region and at other island nesting beaches in the Western Pacific in order to understand the full extent of the green turtle's range within this area, allowing this species to be an ambassador for the Region.

CUPID CHELONIANS: A NEW ECOLOGICAL ROLE FOR OCEANIC-STAGE SEA TURTLES*

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Knowledge of the ecological roles that sea turtles play in marine ecosystems is essential to understanding ecosystem function and the implications of sea turtle population decline or recovery. Compared to sea turtles in neritic habitats, we know surprisingly little about the ecological roles of sea turtles in oceanic habitats. In addition to being important predators and prey, oceanic-stage sea turtles act as settlement platforms for epipelagic organisms in habitats that are often devoid of substrata. To better understand this ecological role, we first compared the total surface area and refuge surface area of oceanic plastic flotsam and oceanic-stage loggerhead turtles. Then, we compared the size and composition of groups of Planes crabs living on flotsam and turtles. We found that (1) surface area of refuges (barnacle colonies on flotsam

and supracaudal space on turtles) is a better predictor of adult crab number than total surface area for both flotsam and turtles, and (2) flotsam and turtles with similar refuge surface area host a similar number (1-2 individuals) and composition (male-female pairs) of adult crabs. These results show that refuge area is an important predictor of group size and composition of crabs in oceanic habitats and that the refuge area provided by the supracaudal space of sea turtles lies within the size range of available refuges that tend to support crabs in male-female pairs. These results suggest that sea turtle symbiosis facilitates social monogamy in Planes crabs. This represents a new and interesting ecological role for oceanic-stage sea turtles, in which turtle hosts affect the mating strategies and social behavior of facultative symbionts by providing refuges of a particular size.

IS THERE AN ONTOGENIC CHANGE IN JUVENILE GREEN TURTLE (*CHELONIA MYDAS*) MICROBIAL COMMUNITY STRUCTURE AS THEY MOVE FROM PELAGIC HABITATS TO INSHORE RESIDENT AREAS?*

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The diverse community of microorganisms throughout the bodies of animals has become increasingly regarded as a system responsible for supporting vital functions, such as digestion, amino acid production, and immune response. Although the putative roles of these systems within sea turtles have been discussed, there is limited understanding of the structure of these microbial communities and of effects they can have on the health of an animal. Green turtles (*Chelonia mydas*) provide an interesting model of change in these microbial communities because the turtles take part in a pronounced shift between a surface-pelagic distribution and omnivorous diet, and a shallow coastal distribution and herbivorous diet. We have been investigating the structure of microflora within green turtles before and after this ontogenetic shift. Following their post-hatching migration to offshore habitat, young green turtles eat a largely omnivorous diet while living among pelagic Sargassum patches. However, they soon recruit to neritic environments where the turtles gradually increase the vegetation in their diet to become primarily herbivorous. This project characterized the microbial communities of juvenile green turtles before and after the recruitment to neritic waters. We captured green turtles among pelagic Sargassum habitat in the Gulf of Mexico, as well as within the neritic foraging grounds of St. Joseph Bay and St. Andrew Bay, FL, (Gulf of Mexico, USA). Cloacal swabs were taken from each turtle as a proxy for fecal bacteria and DNA were isolated for analysis of the 16S rRNA sequences. Hypotheses tested were: (1) Did the shift in dietary selection and habitat lead to variation in the bacterial community as identified from cloacal samples between the two groups of turtles? (2) Did juvenile individuals in neritic environments develop increased representation of cellulolytic and fermentative bacteria in cloacal samples due to a shift towards an herbivorous diet? The results we present provide a preliminary characterization of some common bacteria within the hindgut of green turtles and how developmental shifts in these animals affected their microbial communities.

EFFECT OF AGULHAS CURRENT ON THE INTER-NESTING MOVEMENTS AND DIVING BEHAVIOUR OF LEATHERBACK TURTLES IN SOUTH AFRICA*

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Sea turtles, like many migratory species, congregate in dense assemblages during reproductive periods. While concentrated in breeding habitats, these individuals are vulnerable to localized threats, such as fisheries by-catch. In addition, changes in environmental conditions at the breeding habitats can have wide-ranging effects on their reproductive behaviour and success. As a result, understanding the factors influencing the movements and behaviour of sea turtles in their reproductive habitats can help inform conservation management plans. Here, we aimed to characterize the movement patterns, diving behaviour, and thermal habitats of inter-nesting leatherback turtles *Dermochelys coriacea* in the iSimangaliso Wetland Park, South Africa. As leatherback turtles tend to lay multiple clutches in a single nesting season, we also investigated whether the movement patterns and diving behaviour of these turtles changes over consecutive inter-nesting intervals. If significant changes occur then this would have implications for interpretations of previous satellite tracking studies on inter-nesting turtles, especially in respect to the design of spatially-explicit protect areas. Using satellite telemetry, we tracked the movements of 10 leatherback turtles over a combined total of 26 inter-nesting intervals, with 2 individuals each being tracked for 5 inter-nesting intervals. The satellite transmitters were programmed to opportunistically relay binned dive depth and duration data that were summarized over 4 hour periods. In addition, for 4 turtles we were able to recover the transmitter before the turtle began its post-nesting migration. From these transmitters, it was possible to access the raw dive diving data over the entire inter-nesting period. Inter-nesting turtles dispersed up to 300 km from the initial nesting area, yet they generally remained within 100 km of the coast. Turtles generally inhabited waters between 25 – 29 °C and no individuals ventured into the warmer, offshore waters of the Agulhas Current. Turtles also tended to dive deeper than at other inter-nesting habitats world-wide and a single turtle was recorded diving to a depth of 636 m. Lastly, we found no evidence of consistent changes in the movement patterns or diving behaviour of leatherback turtles over consecutive inter-nesting events. We conclude that the inter-nesting habitats of leatherback turtles in South Africa may be constrained to coastal habitats by the warmer waters of the offshore Agulhas Current. This could also explain why leatherback nesting habitats in eastern Africa are predominantly focused in southern Mozambique and northern South Africa, and only sporadic nesting occurs in more equatorial habitats. If this is the case, then the form and strength of the Agulhas Current may strongly influence the ability of this species to expand to higher latitudes under conditions of future climate change.

FORAGING MOVEMENTS OF LOGGERHEAD SEA TURTLES MONITORED BY SATELITE TELEMTRY IN THE GULF OF CALIFORNIA, MEXICO

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The loggerhead sea turtle (*Caretta caretta*) is a species that is considered threatened worldwide by IUCN and endangered in Mexico according to the NOM-059-ECOL-2010 SEMARNAT norm. Loggerhead turtles inhabit tropical and subtropical waters of the Atlantic, Pacific and Indian Oceans. Recent satellite telemetry studies indicate that this species is active in their oceanic movements, the population of *C. caretta* in the North Pacific nests in Japan and migrates to Hawaii and Mexico to feed. In the Mexican Pacific, there is an important feeding area in Baja California Sur called Gulf of Ulloa (GU), where high mortality is recorded mainly due to fishing activities. There are also some records of this species in the Gulf of California (GC) but there is no information about the habitat use in the GC. The objective of this study was to relate the movements of loggerhead sea turtles with environmental variables in the GC using satellite telemetry, for which SPOT 5 Wildlife Computers satellite transmitters were attached on four loggerhead sea turtles. The sea turtles traveled an average of 2562 km inside the GC and transmitted an average of 95 days. Environmental variables such as chlorophyll and sea surface temperature estimated by satellite images were provided by MODIS Aqua platform and processed with Matlab. Two of the four turtles spent most of the transmission time in the Upper Gulf, one reached the Tiburon Island where it stopped transmitting and the fourth also headed north inside the GC to Salsipuedes Basin. This is the first study that describes foraging movements in this important region by loggerhead sea turtles, and it can be concluded preliminarily that *C. caretta* uses the GC as an area of alternative foraging to the GU due to its high productivity conditions.

DIVING PATTERN DIFFERENCES OF FEMALE LOGGERHEAD TURTLES NESTING ON DALYAN BEACH, TURKEY

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The nesting biology of sea turtles are mainly studied on nesting beaches. In this work, we studied the inter-nesting diving behavior of sea turtles that nested in the years 2013 and 2014 on Dalyan Beach, Turkey. It is known that sea turtles swim near nesting beaches and spend more time on the water surface during the breeding period. The loggerhead turtles lay 3-5 nests with 12-15 day intervals. We employed Time Depth Recorders (TDR) on nesting females and were able to examine the dive pattern of nesting females between these intervals. The dive patterns presented in this inter-nesting periods were examined. The general dive

pattern we observed during the first nesting interval, the turtles were able to dive during the first half of the inter-nesting season (i.e. the first 7 days) a maximum of 5 meters and then up to 7.25 meters in the remainder of first inter-nesting period. The female turtle's dive range increased to a maximum 13.37 m in the second inter-nesting period, and the turtle were able to dive to a maximum of 15.75 m in the third. These increases in the diving behavior of nesting females correlated with the number of eggs laid and/or remaining developing eggs in the oviduct due to laid in the next clutches. The mean dive depths during these inter-nesting periods did not differ much but one explanation of these female turtles was that they were able to dive deeper with less developed eggs in the oviduct. The clutch frequencies and the number of clutch sizes were also analyzed for the TDR attached turtles.

POST-NESTING AND POST-REHABILITATION MIGRATION PATTERNS OF LOGGERHEAD TURTLES FROM SOUTH-WEST TURKEY

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The protection of sea turtles on the beach is not enough because they spend probably 1% of their life-span on the beach. They spend the majority of their time in the oceans. Therefore, the migration routes, wintering grounds, feeding grounds have to be determined in protecting one population. We deployed 18 satellite devices on turtles during the last 5 years on Dalyan and Fethiye beaches. Nine of these turtles were females, three of them were males and six of the sea turtles were juveniles that were rehabilitated at a sea turtle rescue and rehabilitation center (DEKAMER). Seven female turtles were deployed after nesting on the beach, the remaining two females both nested on the beach and were rehabilitated for short periods and then released. The males, a few females and juveniles did not follow a distinct migration pattern. They tended to stay along the Turkish coasts. The rest of the females migrated to the coasts of Egypt, Libya, Syrian and Tunisia. The migration paths and protection of sea turtles are discussed and the importance of the Marine Protected Areas in addition to the nesting beaches recommended for the conservation of sea turtles in the Mediterranean.

INCORPORATING TEMPORAL EFFECTS ON HOME RANGE ANALYSIS FOR ROBUST CONSERVATION PLANNING*

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Home range analysis is a powerful tool to identify priority areas for conservation but estimating home range is still challenging for many species. In particular, highly mobile species may use different habitats at different times of day, year or during different life stages, so temporally-biased location data may only partially represent their habitat use. Using satellite-telemetry data obtained from green and loggerhead turtles in north-eastern Australia, we identified long-term site fidelity to foraging ground by study turtles (i.e. over a decade), but within the habitat used in the long-term, they generally shifted their foraging areas seasonally. These characteristics of sea turtles emphasize the importance of protecting habitat areas according to the turtles' space use, with careful consideration given to identifying temporal trends in habitat selection. Our findings have direct relevance to conservation managers for planning or revision of designated conservation habitat such as Marine Protected Areas or restricted area zones to protect these threatened species from risks associated with increasing human activities at their foraging habitats in Australia and other regions.

DIET-TISSUE DISCRIMINATION FACTORS (Δ13C AND Δ15N) IN CAPTIVE ADULT MALE GREEN TURTLES (*CHELONIA MYDAS*)

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Carbon and nitrogen stable isotope composition (δ13C and δ15N) has been used for trophic ecology studies in several species, including sea turtles. Diet-tissue discrimination factors (Δ13C and Δ15N), or the offset between an organism's diet and a specific tissue, are necessary for accurate dietary reconstructions or trophic-level estimations. It has been reported that discrimination factors can vary upon several factors (taxon, tissue, life stage, sex, etc.), thus, it is important to use discrimination factors that are specific to the study species when possible. Limited diet-tissue discrimination factors are available in sea turtles, and there have been no studies to date in male sea turtles. In this study, we measured Δ13C and Δ15N diet-tissue discrimination in whole blood (WB), plasma (PL), red blood cells (RBC), skin (SK) and carapace (SC) of

9 captive male green turtles (*Chelonia mydas*). Males were separated into three groups (G1, G2, and G3) with three individuals in each group. From August 2013 to January 2015, samples were taken alternating each group every three months, thus, individuals were sampled up to six times. Green turtle diet consisted of 35% crude protein, 7% crude fat, 4% crude fiber, 1.75% to 2.25% calcium, 1% phosphorus, and 11% ash. Our results showed that $\Delta 13C$ ranged from 0.54 ± 0.30 (WB) to 1.71 ± 0.61 (SK), and $\Delta 15N$ ranged from 3.13 ± 0.16 (RBC) to 5.36 ± 0.56 (SK). These results are similar to those reported by Vander Zanden et al. (2012) for captive female green turtles, although discrimination factors from this study are slightly higher ($\Delta 13C$: 0.76 ± 0.19 vs. 0.24 ± 0.61 (PL), 0.55 ± 0.22 vs. 0.30 ± 0.58 (RBC), 1.71 ± 0.61 (SK) vs. 1.62 ± 0.61 / 2.58 ± 1.19 (epidermis/dermis); and $\Delta 15N$: 4.49 ± 0.20 vs. 4.17 ± 0.41 (PL), 3.13 ± 0.16 vs. 2.48 ± 0.35 (RBC), 5.36 ± 0.56 (SK) vs. 4.04 ± 0.44 / 4.93 ± 0.59 (epidermis/dermis). This male-female difference contrasts with the observed differences in omnivores mammals where females presented higher $\Delta 15N$ values than males. However, the male and female green turtle results may not be directly comparable, given diet differences between the two studies. Our results provide support for the idea that discrimination factors may vary with species, tissue, and sex, among other variables. Acknowledgments: Authors express their gratitude to the International Sea Turtle Society, the International Sea Turtle Symposium, Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria, and World Wildlife Fund for the travel grant support.

REPORT OF DIGESTIVE TRACT CONTENTS OF SEA TURTLE IN THE COAST OF KANTO AND OGASAWARA ISLANDS

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We studied to find out the feeding ecology of sea turtles by obtaining and identifying digestive tract contents and measuring the weighing dried digestive tract contents with the cooperation of Everlasting Nature of Asia (ELNA), which is an authorized nonprofit organization. The sites of the research were the coasts of Kanto and Ogasawara islands. On the coast of Kanto, sea turtles are found stranded every year and we obtained their digestive tract contents. On Ogasawara islands, there is a tradition at this island to consume green sea turtle (*Chelonia mydas*) and many turtles were slaughtered annually during the spring season. We are present ar the slaughter of sea turtles and obtain their digestive tract contents. We examined 22 individuals which were stranded and 6 individuals which were slaughtered in this year. We then compared the results of this year with results which we obtained through last year and examined them.

INTRASPECIFIC COMPETITION IN A GREEN TURTLE *CHELONIA MYDAS* FORAGING AGGREGATION

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The intraspecific behavioral dynamics of coastal sea turtle foraging aggregations are a relatively understudied aspect of sea turtle biology. Using animal-borne video cameras, we investigated interactions among green turtles *Chelonia mydas* foraging in Shark Bay, Western Australia, to test the hypothesis that limited availability of a valuable habitat type facilitates interference competition. Shark Bay is a shallow, subtropical seagrass ecosystem characterized by expansive seagrass banks surrounded by deep, sand-bottom channels and open plains. We obtained 301 h of video footage from cameras deployed on 93 individual green turtles (mean deployment footage duration = 3.2 h, SD = 0.9, range = 1.1 – 4.7 h). We recorded 176 turtle encounters, which ranged from 1 s to 20 min in duration (mean = 64.8 s, SD = 146.4) and involved 1-7 individuals per encounter. We recorded a variety of behaviors (e.g. inspecting, following, mouth gaping displays, biting) and classified encounters into 3 classes (passing, brief, and strongly interactive) based on these behaviors. The majority of encounters (55%) and turtle sightings (68%) occurred in rare, structurally complex benthic habitat (e.g. rock ledges, coral) in deep channels, despite turtles spending only ca. 5% of their time in these areas. Strongly interactive encounters occurred exclusively in deep, structured habitat. Turtle activities in these areas included solitary and group resting, symbiotic and self-cleaning, and competitive contests. Competitive contests, which featured biting, chasing, and mouth gaping displays, occurred 7 times more frequently in structured (88%) compared to unstructured habitat. Encounters in shallow, unstructured habitat like seagrass beds tended to be brief with minimal interaction. Interference competition resulting from the limited availability of key non-foraging habitats may influence the distributions, habitat use patterns and foraging tactics of sea turtles in coastal foraging areas. Acknowledgments: We thank the Western Australian Department of Parks and Wildlife for providing flipper tags and our volunteer assistants for their efforts in the field and with video analysis. This research was funded by National Science Foundation grant #OCE0746164 to M.R. Heithaus.

LONG-TERM PATTERNS OF HABITAT USE BY JUVENILE GREEN TURTLE, *CHELONIA MYDAS*, OFF URUGUAY REVEALED BY STABLE ISOTOPE VALUES IN CARAPACE SCUTE LAYERS*

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Green turtles (*Chelonia mydas*) use Uruguayan coastal waters (ca. 34º S) as a developmental and foraging area after recruiting from the oceanic phase of their life cycle. Recent research using stomach contents analysis and epidermis stable isotope analysis has revealed that such a habitat change is accompanied by a gradual dietary shift from neustonic and pelagic invertebrates to macroalgae, but little is known about the details of the process. Here we used stable isotope analysis of scute samples to study the ontogenetic and seasonal habitat changes of the green turtle in Uruguayan waters. Carapace scute biopsies were collected from 20 juvenile green turtles (curved carapace length, CCL, range: 27.8 to 66.8 cm) intentionally captured with nets from January to April of 2012 and 2013 while foraging on coastal rocky outcrops off the east coast of Uruguay. All turtles were in good condition and, after sampling, were tagged with Inconel flipper tags and released at the site of capture. All samples were preserved in salt previous to lab analyses. Once in the lab, carapace biopsy was subsampled in successive 30-µm-thick layers using a criostat. The stable isotope values of the innermost (new tissue) layer of the turtle scutes are supposed to integrate the diet over two months prior to sampling and the others 30-µm-thick layers are supposed to integrate the diet over the same time span, backwards in time. Thus, the time period represented in the scute samples ranged from 0.8 to 2.5 years, depending on the total thickness of the sample. In most turtles less than 55 cm CCL, we observed a steady and remarkable enrichment in δ15N and δ13C form the outermost (oldest) to the innermost (newest) scute layer, which according to the regional isoscape represents the shift from tropical, oceanic habitats to neritic habitats along the coast of South America. Conversely, the δ13C and δ15N values in the scute layers of turtles larger than 55 cm were much higher than those of most scute samples from the turtles less than 45 cm CCL, thus confirming that they were coastal foragers. The innermost layer of six turtles, ranging in size from 39.3 to 49.8 cm CCL, had δ13C and δ15N values similar to those of turtles larger than 55 cm CCL and much higher than those in the earlier layers. Accordingly, these were considered newly recruited turtles. However, the δ13C and δ15N values of turtles larger than 45 cm where not constant, but exhibited cyclical fluctuations. According to layer sampling, these turtles presented a small decrease in δ15N between June to November (austral winter), when they might have migrated north to Brazilian waters, in accordance with previous satellite telemetry and mark-recapture studies. In conclusion, the present study

shows that the ontogenetic habitat shift of green turtles, from oceanic stage to neritic stage, takes place in this area of the southwestern Atlantic Ocean when they reach 35 to 40 cm of curved carapace length.

VOCALIZATIONS FROM AN ARRIBADA OF LEPIDOCHELYS OLIVACEA IN THE SEA IN FRONT OF THE NESTING BEACH IN ESCOBILLA, OAXACA*

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We have been documenting underwater vocalizations during different social behavioral patterns in both freshwater and marine turtles in nature for the last several years. We use the term vocalizations in that we have video recordings of turtles vocalizing underwater and simultaneous muscle movements on the inferior posterior cephalic region suggesting the sounds are being produced in the buccal cavity. Although our most extensive and intensive work has been with one freshwater species, the giant South American river turtle (*Podocnemis expansa*) in the Brazilian Amazon Basin we have also documented vocalizations in many other freshwater species from both suborders in North and South America, Mexico, and Australia, as well as marine forms: *Chelonia mydas* (hatchlings), *Lepidochelys olivacea* (eggs, hatchlings, nesting females, adults), *Dermochelys coriacea* (eggs, hatchlings), and *Natador depressus* (hatchlngs, juveniles, and adults). There are a number of hypotheses that attempt to define the factors that stimulate the behavior of *Lepidochelys olivacea* during arribadas, such as phases of the moon, meteorological factors, water temperature, Rathke's gland secretions, and olfaction. However, the mechanism that these animals utilize to maintain these groups and to stimulate simultaneous group behavior during nesting is unknown, and is perhaps a combination of a number of factors. Since we know that *Lepdochelys olivacea* vocalizes during nesting, mean peak frequency of the sounds recorded was 6180.42 Hz (281.2- 10593.8), we wanted to test the hypothesis that these turtles are also vocalizing while congregated in the sea in front of the nesting beach. The study was conducted at Playa Escobilla, Oaxaca, México, during an arribada of about 50,000 turtles. On 15 August 2015, we located the arribada, about 800 m out from the nesting beach. At any one moment 200-300 turtles were surfacing, including copulating pairs. The sky was clear, wind and waves were calm allowing for us to record with a Reson C4200 hydrophone and Fostex recorder without any interference at a depth of 10 m from 1330-1530h. The vocalizations recorded sounded like 1000's of electric motors running out of synchronization. Recordings made away from the arribada did not have these sounds. The propagation of low frequency sound underwater is an excellent media for long distance communication. Now that we have verified that these marine turtles are vocalizing underwater during an arribada, we hope that this will stimulate more people to go out and find out more about this behavior and document whether vocalizations underwater are used to stimulate arribada formation when they leave the foraging grounds and to maintain groups during their migrations. The use of underwater speakers playing back the vocalizations of the arribada may function to call turtles into less concentrated nesting areas on the same beach to disperse the nesting activities, now the nests are concentrated in only a 5 km stretch of the 15 km beach in Escobilla, resulting in the loss of 1000s of eggs due to females destroying many nests during their nesting activities. This was a rather small arribada, the arribada in early November 2013 had 600,000 nesting females.

WHERE YOU SPEND YOUR SUMMER VACATION MATTERS: QUANTIFYING THE IMPORTANCE OF MIGRATORY STOPOVER AREAS TO LEATHERBACK LIFE HISTORY USING A BIOENERGETICS APPROACH*

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Within their broad geographic distributions, marine migratory species such as leatherback turtles can exhibit remarkably fine-scale preferences for and fidelity to particular areas that allow them to consistently detect and exploit areas for acquiring resources to fulfill their life history requirements, namely reproduction. Because these critical habitats in migratory stopover areas have disproportionate influence on population dynamics relative to their small spatial scales, identification of such areas provides conservation targets that are not only more logistically feasible to address, but also result in higher return on investments in threat reduction and habitat protection. In this study, we obtained fine-scale data on leatherback feeding rates and energy acquisition across multiple seasons in Nova Scotia, Canada, to quantify the importance of a discrete, seasonal feeding area to individual- and population-level bioenergetics. We analyzed video footage of foraging behavior and used published values on prey energy content to estimate energy budgets for adult males and females – in breeding and non-breeding years – as well as subadults. We compared the life history consequences of environmental variation on different leatherback populations (e.g., Northwest Atlantic vs. Eastern Pacific), and we interpreted our results in the context of bioenergetics of migration and life history of other non-sea turtle species. Our analyses provide robust quantitative illustration of the large influence of fine-scale habitats to the ocean-scale life history of leatherbacks and demonstrate the importance of maintaining the integrity of these habitats to ensure future population sustainability.

SEASONAL CHANGES IN THE BEHAVIOR OF CAPTIVE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) MAY INDICATE INNATE MIGRATORY PATTERNS

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Long distance migrations occur at multiple stages during a sea turtle's life, and are typically associated with reaching important foraging or breeding grounds. Most of what is known about these movements is based on studies conducted on post-nesting females, while little work has been conducted on the pre-nesting migration from foraging grounds to mating areas. This study aims to shed light on this subject, by providing a behavioral assessment of two captive-raised, reproductively mature female loggerhead sea turtles (*Caretta*

caretta) housed at Mote Marine Laboratory in Sarasota, Florida. There are a number of anecdotal accounts from facilities housing sea turtles that have noticed behavioral changes in their animals, but this study offers the first systematic examination of such observations. The goal of this project is to investigate the relationship between behavior and season, in order to gain a better understanding of the migratory process in sea turtles. Behavioral ethograms were designed and implemented to monitor daily activity over a 29-month period, beginning in December 2013. Video recordings were taken for 12 months of this period so that each animal could be documented at night. A number of behaviors were tracked to analyze changes in swim patterns and activity levels for each individual. Since data collection will continue through May 2016, we plan to present initial findings on observed behavioral changes associated with seasonal time frames, specifically with time periods of reproductive migration. Preliminary analyses indicate the turtles exhibit seasonal behavioral shifts where directed swimming becomes their primary activity. The animals show reduced interest in food during this time period, suggesting this behavioral change may be associated with long distance displacement.

MIGRATORY AND FORAGING STRATEGIES OF FLATBACK TURTLES: THE MULTI-STOP TRAVELLERS*

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The understanding of the foraging ecology of marine turtles has significantly increased in the past decades. However, for flatback turtles (*Natator depressus*) in the Great Barrier Reef the migratory routes and foraging areas remain largely unknown. Flatbacks are endemic to Australia, and remain mainly in tropical coastal waters within the continental shelf. Based on tag recaptures and by-catch records, it has been estimated that flatbacks in the Great Barrier Reef are restricted to sub-tidal turbid waters. By implementing satellite telemetry technology for understanding fine and large scale movement of turtles, this research aims to identify and describe the migratory and foraging strategies of female flatback turtles in the Great Barrier Reef, Australia. Between 2009, 2013 and 2014 we deployed 26 Argos-linked Fastloc GPS tags on nesting flatback turtles in three locations of the Queensland coast: Curtis Island (N=20), Mackay (N=4) and Peak Island (N=2). Data was filtered and analyzed to identify shifts in the behavior of turtles. In addition, utilization distributions (UD) were estimated with Kernel Density Estimators at 50% (core area) and 90% (home range). The migration of turtles in this study spanned across 8 degrees in latitude with mean travel distances of 390.14 km (range= 1,488.09 km). All turtles remained in shallow coastal waters within the boundaries of the Great Barrier Reef. Overlap in the distribution of foraging grounds was evident in four different regions, with up to seven turtles using similar areas. Size of foraging grounds was significantly larger than reported for other coastal marine turtle species, with average core areas of 166.52 km2 (range=934.51 km2) and home ranges of 601.75 km2 (range=2,950.55 km2). The average duration of

foraging events was 57.61 days, however in some cases turtles displayed residence times greater than 200 days. We identified four types of distinctive behavior: (a) Direct migration (N=10), in which turtles migrated straight to their foraging grounds; (b) Multi-stop travel (N=9), characterized by multiple temporary areas where turtles spent between 5 and 30 days before resuming migration; (c) Switching foraging grounds (N=4), typically consisting in two well defined foraging grounds used repeatedly by the turtle; and (d) Wandering movements (N=4), in which the turtle uses a specific foraging ground, but frequently undertakes short journeys (up to a week) around the area. To our best understanding, migration routes displaying multiple stops along its course and dynamic foraging strategies such as the ones described in this study are unusual in other marine turtle species, but seem to be a common pattern among flatback turtles. The great variability in behavior, as well as the large size of home ranges reported herein, raise the question of whether flatback turtles really display fidelity to foraging grounds, or rather have a more generalist and opportunistic strategy when choosing their temporary or permanent home. Acknowledgments: The authors would like to thanks The International Sea Turtle Society and the Symposium Sponsors, GRS-James Cook University and CMES-James Cook University for the funding and support this project was provided.

SUCCESSFUL AND UNSUCCESSFUL ADHESIVES FOR USE ON NEONATE FLATBACK TURTLES (*NATATOR DEPRESSUS*): WHAT WORKS AND DOESN'T WORK ON THE "TEFLON TURTLES"

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Flatback turtles (*Natator depressus*) are notoriously challenging to fit with bio-logging tags because of their thin, flexible scutes and very smooth carapace surface. We tested adhesives from the medical, cosmetic, and marine industries. Our ultimate goal was to develop an adhesive-based tag attachment to attach bio-logging devices. We tested 17 different adhesives and three carapace cleaning/preparation methods. All candidate adhesives initially adhered to both carapace and epoxy (a common surface for bio-logging devices). We tested the adhesives on rapidly growing neonate flatback turtles from summer nesting populations in Queensland and in Western Australia that were held in captivity for another study. Criteria for initial success were (i) turtle tolerance of the material, (ii) duration of adhesion to the carapace of more than two weeks and (iii) no clinical signs of damage to the carapace. The majority of adhesives were shed quickly. The next level of evaluation included (iii) duration of attachment to dummy tags and (iv) relative strength of attachment. We found the best candidate adhesives were viscous, retained flexibility over periods of more than three weeks, cured in air and saltwater without heat, and attachment duration was greater than three weeks, however curing time was relatively long (>6h). Many adhesives that work well in other cheloniids peel easily from flatback carapace. Several adhesives were nominally similar in the chemical components (e.g., similar silicon compound or similar polyurethane) based on their material safety data sheets, but differed in their performance. Attachment duration was influenced by the growth and maturation of the carapace surface. Turtles showed no negative reaction to adhesives. How the carapace

was cleaned influenced adhesion; isopropyl alcohol and one medical skin-prep cleaner delayed curing in some candidate adhesives.

Nesting Biology

PACIFIC NORTHERN NICARAGUA: POTENTIAL SITE FOR RECOVERY OF THE HAWKSBILL TURTLE IN THE EASTERN PACIFIC OCEAN*

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The Eastern Pacific hawksbill is one of the most endangered sea turtle populations in the world. Since 2008, the Eastern Pacific Hawksbill Initiative (ICAPO) has worked creating a research and conservation network focused in this species in the region. In Nicaragua, since 2010, Fauna and Flora International (FFI) and ICAPO, in alliance with a local stakeholders committee, lead the implementation of Proyecto Carey (Carey Project) in Estero Padre Ramos Nature Reserve, Chinandega. Recently, a second nesting site was discovered in the estuary Aserradores, located south of Estero Padre Ramos. Consequently, in 2014 we started a conservation project in this site. During the 2014 nesting season, we documented 117 nests and 28 nesting females in Aseerradores. Adding both sites, we recorded 312 hawksbill nests during the 2014 season. After five years of conservation, we have achieved unprecedented results: protection of 999 hawksbill nests, release of 94,676 hatchlings, and a reduction in hawksbill nest poaching rates from 100% to less than 4%. In six years, the two projects have documented the existence of 286 individual females. We have also recorded exchange of females between these two sites, including initially females tagged in Estero Padre Ramos nesting in Aserradores and vice versa, within the same season; in Aserradores we also observed a nesting female that was previously marked in El Salvador. Our results indicate that Padre Ramos and Aserradores are the two largest hawksbill nesting sites in the Pacific coast of Nicaragua. Furthermore, this site may represent around 50% of known hawksbill nesting activity in the entire Eastern Pacific Ocean. This makes these sites and Nicaragua key locations for this species conservation.

TEMPORAL ANALYSIS IN NESTING HABITAT AND DISTRIBUTION PATTERNS OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) IN MARGARITA ISLAND – VENEZUELA*

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Erosive processes seem to be impacting the nesting habitat of the northeastern region of Margarita Island, in Venezuela. These processes affect the selection and use of habitats by nesting females, which influences the development of eggs and increases the risk of loss of nests. This study aimed to quantify these processes and their relationship with the nesting patterns of *Dermochelys coriacea* nests on a temporal scale. We used geoinformatic technologies to collate historical information, manage vector information and implemented remote sensing analysis. The study covered two beaches "El Agua" and "Parguito", for which we performed the historical reconstruction of the coastline based on seven satellite images (years 2002, 2004, 2005, 2007, 2009, 2010 y 2011) from different sensors: Quickbird, Worldview and GeoEye. Radiometric and geometric corrections were performed as part of the pre-processing of satellite images. Then, processing analyses were completed using (a) classification algorithms (Decision trees) to create polygons in order to estimate the beach surface (BS); (b) spectral angle mapper (SAM) classification method, which uses the spectral signature to calculate the surface and historical distribution of the sand (SS) most used by leatherbacks; and (c) methods of change vectors and post-classification comparisons, to detect multitemporal changes among paired images. The BS and SS values were significantly different between beaches and years. The BS for "El Agua" beach in 2007 (75,396.39 m^2) was greater than the rest of the evaluated years in the same area. In Parguito beach, the highest BS value was in 2011 (45,282.04 m^2). In contrast, the most important losses of SS in both areas were recorded in 2007 ("El Agua": 4,964.23m^2, Parguito: 7,450.08 m^2) and in 2011 ("El Agua": 882.86 m^2). When comparing these values with the distribution of leatherback nests, it became evident that turtles had a different selection and use of these beaches. On the vertical axis (sea-vegetation), the nesting females selected the open sector of the beaches of both localities. On the horizontal axis, the turtles used the most stable sectors in terms of available beach width (sectors 2 and 3 in "El Agua", and sector 3 in Parguito), as well as selecting a specific type of sand. This study demonstrates that there is a relationship between the SS (type of sand) and the patterns in nest distribution of leatherback turtles. The progressions and multitemporal change detections on both beaches revealed an important lost in the type of SS. The eroded areas of each beach corresponded with the increase in numbers of nests under risk (lost/inundation). The implementation of geoinformatic tools provides an innovate approach to explain the changes in the habitat of leatherback turtles due to erosion and its relationship with the distribution patterns of leatherback nests. Hence, we were able to gain a better and wider understanding of the underlying ecological processes and relationships between species and habitat.

ARE GLOBAL CHANGES AFFECTING LOGGERHEAD NESTING IN CUBA?

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Temporal and spatial variation in nesting and reproductive success as well as morphometric characteristics of gravid females were used to characterize ecologically this colony. Ten beaches of the southernmost coast of Guanahacabibes Peninsula were monitored for 16 years (1998-2014) to determine nesting activity, from May to September. Females were measured and tagged. Remigration intervals were also determined. A comparison between nest number in high versus low nesting seasons was made using a Student's t-test. Regression analysis was used to determine the relation between season duration and years. Pearson's correlation was used to determine if there was any tendency in nest number during the study period. Intra-seasonal frequency of nest number was compared using a Kruskal-Wallis test, at three different time periods of 6 years. One-way ANOVA was also used to compare female and hatchling body size and incubation period per nesting season considering all beaches together. A Student-Newman-Keuls (SNK) test was used for multiple comparisons. There was no tendency in nest numbers during this eighteen years (Pearson, $r = 0.33$; $p = 0.25$). We also found intra-seasonal variation with the highest nesting activity in June, with a 15% increase in nesting activity in the second half of the month. A significant and negative relation was found between the middle and the end of the season and the years with a reduction of 36 days from the year 1998 to 2015 for the end of the season ($r2=0,45$; $p<0,01$). Clutch size also decreased over the years ($r = -0.61$; $p = 0.02$) as well as incubation period ($r=-0.81$; $p<0.01$) and hatchlings size. The comparison between years of hatchlings size showed significant differences. Summarizing, Guanahacabibes loggerhead nesting population shows signs of recovery considering the positive trend in the annual nest number as well as the high hatchlings emergence success. Nevertheless, some results indicate a possible impact of the increasing temperature in the health of the population such as: shortening of the nesting season, the reduction in clutch size, incubation period and hatchlings size as well as a potential feminization of hatchling production. Following of these variables is needed to apply adequate management policies to guarantee a future for the westernmost Cuban loggerhead nesting population.

INDIVIDUAL NEST SITE SELECTION IN HAWKSBILL TURTLES WITHIN AND BETWEEN NESTING SEASONS*

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Nest-site choice is an important behavior in sea turtles, since the incubation environment affects many offspring characteristics. We analyzed 410 nest locations from 150 individual nesting hawksbill turtles (*Eretmochelys imbricata*) on the Northeastern Brazilian coast during eight nesting seasons from 2006 to 2014, to evaluate individual nesting preferences. A total of 78 individuals were recorded nesting only once and 72 from 2 to 6 times within a season; 23 individuals were seen nesting in two seasons, 20 in three nesting seasons and 6 in four nesting seasons; 27 individuals were recorded in at least two nesting seasons and nested at least twice in each season and comprised the restricted group. The average stretch of beach where females nested within the entire 4.2 km was 1830 +/- 1030 m. We determined the consistency of nest-site choice within and between nesting seasons for open sand and vegetation microhabitats and also for nest-site distances from the current water line, highest spring tide, vegetation line and position along the beach. We found that behavioral consistency within seasons was more robust than between seasons. The decrease in the consistency of individual micro-habitat nest-site preferences support a behavioral flexibility along time that may be related to progressive landscape changes in the nesting environment.

THE SHIFTING REPRODUCTIVE BEHAVIOUR OF OLIVE RIDLEYS AT COROZALITO, COSTA RICA*

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Olive ridleys (*Lepidochelys olivacea*) nest solitarily along the entire Pacific coast of Costa Rica. In addition, some of the largest arribadas (mass synchronous nesting events) in the world occur at Ostional and Nancite, two beaches on the northern Nicoya Peninsula. Early arribada tagging studies at these two beaches suggested that olive ridleys are reproductively polymorphic, exhibiting either solitary or arribada nesting

phenotypes. However, recent solitary nesting tagging studies have shown that olive ridleys can display both reproductive behaviours within a nesting season. It is unknown whether olive ridleys commonly switch between nesting behaviours throughout their reproductive life stage, or if they primarily exhibit one strategy depending on local population dynamics. To address this question, we herein report 28 individuals that switched from nesting solitarily throughout the southern Nicoya Peninsula, to nesting in small arribadas at Playa Corozalito. Corozalito has been monitored annually since 2008 between July and December to quantify olive ridley nesting activity levels, and mark solitary nesting individuals with external inconel metal tags on the fore flippers. In 2014 the tagging program was expanded to include turtles participating in arribadas, because these mass synchronous events had grown in size and frequency in the six years of monitoring Corozalito. For instance, single events were recorded in 2008 and 2012 of approximately 300 and 2000 turtles, respectively, whereas three separate events occurred in 2014 ranging from 3000 to 13000 turtles. The three arribadas amounted to 15 days of mass-nesting, in which 47 turtles were tagged, and 28 turtles were recaptured. The recaptured turtles had been tagged previously while nesting solitarily at Corozalito (n=9), Cocal (n=1, 41.3 km SE), Montezuma (n=6, 40.5 km SE), Caletas (n=4, 18.5 km SE), Costa de Oro (n=2, 12.3 km SE), San Miguel (n=2, 8.5 km SE), Camaronal (n=2, 6.7 km NW), and Buenavista (n=1, 20.1 km NW). The inter-nesting interval of the ridleys that nested twice within the 2014 season was 26.6 days (n=23, stdev=9.6, max=47, min=15). In addition, three turtles had been tagged 1, 2, and 6 years earlier. Finally, one of the turtles tagged during the second arribada was observed re-nesting 27 days later, during the third arribada. This study demonstrates that olive ridleys are flexible in their nesting behavior, both within and between nesting migrations. However, it is limited to a small sample size from one nesting season, and future mass-nesting tagging efforts can only be increased if Corozalito arribadas continue. Although the unique events appear to be growing, the fate of this unprotected beach is uncertain, with current hotel development and unrestricted fishing in the area posing a serious threat to Corozalito's nesting population. Acknowledgments: The senior author thanks the Riester Foundation for the grant that made it possible to attend the International Sea Turtle Symposium.

POPULATION PARAMETERS OF LEATHERBACKS (*DERMOCHELYS CORIACEA*) NESTING IN PLAYONA BEACH, COLOMBIA, BETWEEN 2008-2012*

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Leatherbacks are currently listed as Critically Endangered in Colombia and Vulnerable worldwide by the IUCN. The main nesting beach of leatherbacks in Colombia is Playona, located northwest on the Caribbean coast. During the last few years, many volunteers have been tagging turtles, and recording data on morphometry and clutch size among others, however such data had not been analyzed or published, meaning a large waste of time and resources. Here we analyzed this data compiled by Mama Basilia NGO recorded during the 2008, 2009, 2010 and 2012 nesting seasons. We calculated some population parameters and compared them with past data of the same population and other populations in the region. Our results indicate that (1) Playona beach holds a nesting population size of 192 females per season, ranging from 136 to 262 in these 4 years. This population size is within the range of the population size calculated in the previous decade in this beach (189 in 1998 and 282 in 1999). (2) Average linear carapace length (LCC, cm)

was 150.5, with 80% of the females ranging between 140-160 cm. Previous records of leatherbacks body size in this beach are similar, 150.9 cm in 1998 and 154.4 cm in 1999; however, turtles are in the lower size range when compared to other nesting beaches within the Western Atlantic (147 cm in Puerto Rico and 160 cm in Brazil). (3) Average clutch size was 107.1 eggs (72.4% fertile eggs and 27.6% infertile eggs). Again, clutch size is similar to that reported for Playona in previous years: 115.5 in 1998, and 107.5 in 1999. (4) We found a positive correlation between LCC and clutch size (fertile eggs) (n = 633, p < 2.2e-16, b = 0.741, though R^2 = 0.1073), meaning that larger females lay more eggs and favoring a fecundity selection hypothesis. (5) Of the 771 nesting females observed in 4 years, 44.3% were already tagged, meaning either a high rate of tag lost or insufficient tagging. From this total of tagged females, 67% were captured once, 24.3% twice, 7.3% three times, 0.9% four times, 0.3% five times, and 0.3% six times. Data analyzed here was recorded with different capture efforts per season, thus it does not represent the total activity of the population. Instead, data should be considered the minimum activity of the nesting population in the years evaluated. Nevertheless, our results should provide a baseline to design conservation actions of leatherbacks in Playona, now part of the Acandi, Playon and Playona Wildlife Sanctuary recently declared in Colombia.

UNRAVELING THE MYSTERY OF ARRIBADA TIMING*

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During the mass nesting or arribada of olive ridley sea turtles, thousands of turtles emerge from the ocean to lay their eggs along a small stretch of beach. Although this has fascinated both researchers and the general public for decades, little is known about how turtles synchronize their behavior so that thousands emerge to nest at the same time and place. In principle, synchronized nesting might be controlled by an endogenous biological rhythm; alternatively, it might be triggered by specific environmental conditions (e.g., wind or rainfall), arise from social facilitation among turtles massing offshore, or result from a combination of several such factors. As a first step toward unraveling the mechanisms underlying the timing of arribadas, we acquired records of arribada start dates at several locations around the world and analyzed them in the context of environmental cues. Initial analyses reveal a correlation between arribada timing and lunar phase in some but not all geographic locations. These findings suggest that lunar phase may be an important component of synchronization in mass-nesting sea turtles in some parts of the world, but that lunar phase alone probably cannot account for the timing of arribadas worldwide.

FEMINIZATION IN MARINE TURTLES' POPULATIONS OF GUANAHACABIBES, CUBA

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Global warming will affect marine turtles due to different causes; among them, temperature increase is critical since sex is determined in these species by temperature. There are studies in Cuba, mostly in Guanahacabibes Peninsula, about nest incubation temperature that indicates the existence of high temperatures. Therefore, continue this monitoring is important for the conservation of these species. With this in mind, the objective of this work is to estimate the sex proportion of hatchlings in two beaches of Guanahacabibes from 2012 to 2014. In order to do so, thermal sensors were placed in nests of Antonio and La Barca beaches in three different years. Sex proportion was estimated taking into account incubation temperature during the thermo-sensitive period and incubation duration. Direct determination of sex in dead hatchlings were made as well. Difference were found in nest temperature between years ($F(5;1286)=18,14$; $p<0,01$) and beaches (t 2013 (230;739) =-11,76; $p<0,01$ y t2014 (362;603) =-6,07; $p<0,01$). Lowest temperatures were registered during 2013 season at Antonio beach. With the exception of the mean temperature at the bottom of the nests in 2013, the other values were close or above 30°C. These temperatures are evidence of female production, more evident in loggerheads. Nevertheless, in sex determination through histological analysis only one loggerhead female was found while all green turtle embryos were female. Values of incubation period and the determination of sex in hatchlings corroborate the tendency to female production. These results highlight the urgency of adequate and adaptive management. Acknowledgments: We are thankful to World Wildlife Fund Program in Cuba, Ocean Foundation and the Southern Archipelago United Nations Program for Development project for their support to the research. We would also like to thank the joint PhD program of the Universidad Autónoma de México (UNAM)-Universidad de La Habana and The Academy of Science for the Developing World (TWAS). We especially want to thank the efforts of the more than 2300 volunteers that helped collect field data during the 18 years of the study and to the sponsors, the ISTS travel funds and the symposium organizing committee for the opportunity to participate in this event.

TEN YEARS OF TURTLE NESTING IN TOBAGO

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Save Our Sea Turtles (SOS) has conducted regular community beach patrols since 2000 and a monitoring programme since 2005 on three key index beaches in the Courland Bay area (together 3.1km of nesting beach) on the Caribbean coast of the island Tobago. Regular monitoring of Lambeau (Magdalena Grand) beach (0.25km) on the Atlantic coast began in 2013. Nightly patrols and morning surveys serve to reduce

the incidence of poaching and are used to record nesting and hatching events, combined with tagging of nesting females and nest excavations, in order to collect valuable data for effective management and conservation. The index beaches in the Courland Bay area are the most important leatherback nesting beaches on the island, with an average of 346 nests recorded per year (range: 154-559). Lambeau (Magdalena Grand) beach has significant hawksbill nesting activity, with 40 nests recorded in 2013 and 66 nests recorded in 2014, compared to an average of 20 nests recorded per year in Courland Bay (range: 8-38). Mean percent hatching success among excavated nests was 56% for leatherbacks since 2009 and 86% for hawksbills since 2013. Poorly managed beachfront lighting results in significant disturbance of nesting turtles and hatchlings with the highest incidence of disturbance/disorientation recorded at Grafton Beach in Courland Bay among both nesting turtles (average of 21% leatherback nesting activities since 2009) and hatchlings (average of 54% leatherback hatching events since 2013). Acknowledgments: The authors would like to thank the Campus Research and Publication Fund, The University of the West Indies, St. Augustine, for the travel grant to participate in this meeting.

SEA TURTLES IN GRENADA, WEST INDIES: A SUMMARY OF RESULTS 2005-2015

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Grenada provides nesting, foraging and developmental habitats for four species of sea turtle, the leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*) and loggerhead (*Caretta caretta*). In 2015, Ocean Spirits, a local non-profit NGO, conducted their 16th consecutive year of nesting research with local staff supported by international volunteers on Levera and Bathway beaches on the northeastern tip of the main island of Grenada. Grenada hosts a critical population of nesting leatherbacks, the third largest nesting site in the Caribbean. Over the past sixteen years, an average of 735 ± 234 leatherback nests have been seen on Levera beach each nesting season ranging from 97.2cm – 177cm in Curved Carapace Length. Each female nests between 3-10 times within a season laying 83.6 ±21.6 eggs each time. Leatherback turtles have been protected by national legislation since 2001. A legal fishery still exists for hard-shelled species during nine months of the year (September to April). During the 2015 season, 80% of nests on the south side of Levera beach were lost and destroyed through predation, sargassum inundation and erosion. Despite these losses, 967 confirmed nests were laid by leatherback turtles in the 2015 season. In 2015, nearly 160 new leatherback turtles were tagged with monel flipper tags. Each season a minimum of 2000 hours are spent collecting data. Turtles from Canada and Trinidad visited Grenada this season and successfully nesting, in previous seasons turtles have nested from Tobago, Venezuela, Costa Rica, Barbados, Puerto Rico and Panama. Green and hawksbill turtles were recorded on Levera Beach in small numbers. Ocean Spirits work on a range of educational outreach activities to raise awareness of the importance and value alive of Grenada's marine resources reaching over 250 students each year. Ocean Spirits liaise with the Fisheries Division of the Ministry of Agriculture and we are working with WIDECAST to encourage protection of all marine turtles in Grenada.

FIRST MONITORING OF SEA TURTLE NESTING POPULATION ON PUIPUY AND SIETE MARES BEACHES

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Venezuela is privileged in its geographical location since of the 7 existing sea turtle species five are found in our waters and 4 come to reproduce. The Paria peninsula, Sucre state, is the most important coastal nesting area in the country for the species *Dermochelys coriacea*, or leatherback turtle, and the Puipuy beach belongs to this zone. The Vargas coast has been poorly monitored for turtles, although events have been reported for several beaches, some of the most important being Sabana, Caruao, Osma and Siete Mares. The turtle conservation project is focused on two tourist beaches, Puipuy and Siete Mares. Field work was carried out from April to August and consisted of night patrols from 8.30pm till 12pm or 1am, for one week each month. At 5am day censuses were carried out to quantify the events of the previous night, and if nests were found in danger of flooding or near the village they were transferred as soon as possible to the hatchery. Nests left in place were protected by enclosing the area with wire netting or tape. When the incubation period was over, the hatchlings were set free and the nests exhumed to quantify the content. On Puipuy beach two species nested, the leatherback sea turtle and the loggerhead sea turtle (*Caretta caretta*), for a total of six (6) nesting females, which were studied by taking carapace measurements, checking if they had metal tags from other beaches, and collecting the eggs directly from the cloaca to transfer them to the hatchery, quantifying a total of 45 events in the censuses and the exhumation of 24 nests, and more than 900 hatchlings were freed. On the Siete Mares beach, two species nested, the loggerhead turtle and the green sea turtle (*Chelonia mydas*), 15 events were registered of which 4 nests were verified and 3 two were poached, and more than 200 hatchlings were released to the sea. These numbers underestimate the reproductive potential of the Puipuy and Siete Mares nesting beaches since this is a basic study. Monitoring must be increased and techniques for management and research improved for better results to be obtained. Acknowledgments: The authors would like to thank the Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesquería, World Wildlife Fund, Symposium International Sea Turtle Society, Ecoposada & Spa Sietemares C.A, URCOSA y Urbanizadora de la Costa, S.A.

NESTING CHARACTERISTICS OF A NEW AREA FOR *ERETMOCHELYS IMBRICATA* AND *LEPIDOCHELYS OLIVACEA* IN THE BRAZILIAN NORTHEASTERN

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The northern coast of the state of Rio Grande do Norte/Brazil has been characterized as an important breeding ground for sea turtles, specifically for the species *Eretmochelys imbricata* and *Lepidochelys olivacea*. This study aims to evaluate the nesting pattern and the factors influencing the reproductive success of sea turtles that nest in the northern coast of Rio Grande do Norte, Brazil. Between the years 2010 to 2013, 238 nests were registered, through a daily monitoring in six beaches located in the municipalities between Guamaré and Macau/RN, Brazil, totaling 52 km of total area. For the last season, between the months of December 2014 to August 2015, there were a total of 100 nests, with a success rate of 56% (number of live hatchlings = 4.250). Of these, 60.71% were *Eretmochelys imbricata*, 19.64% of *Lepidochelys olivacea* and 1.78% of *Chelonia mydas*. In 17.86% of cases it was not possible to determine the species. Reproductive success was mainly affected by animal predation, which was mainly by fox (*Cerdocyon thous*) and by the proximity to the tide line, with 36.36% of affected nests. The success rate was higher in an average distance of the tide line of 17.89 meters. A total of 37 nests were preyed upon, and 860 eggs/hatchlings affected by animal predation, with 15.91% of the cases resulting in complete nest predation. A mean of 140 eggs per nest of *E. imbricata* was observed, whereas for *L. olivacea* this value was on average of 82 eggs. There was also a possible temporal overlap of nesting among the species, being the nesting of *E. imbricata* taking place from December 2014 to April 2015 and that of *L. olivacea* predominantly from March to August of 2015. It was noted, for both species, a difference in nesting pattern, since the nesting of these species in the Brazilian continent generally occurs from September to March. Thus, the area previously unknown in terms of reproduction of these animals, appears to be of great importance for both species, reinforcing the need for intensification of studies and efforts for the preservation and conservation of the region.

THE ROLE OF WEATHER AND SAND MOISTURE IN SHAPING LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) HATCHLING GROWTH AND SURVIVAL

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Numerous variables affect the early development of incubating eggs, some of which are more widely studied than others. The specific effects of temperature are frequently considered in understanding developmental rates, sex determination, and embryonic survival, but until recently, the role of moisture has been little-studied. Recent studies show that increased moisture in the field may affect sexual differentiation and embryonic development. It is likely that loggerhead (*Caretta caretta*) hatchling growth and survivorship may also be impacted by variable moisture. Loggerhead eggs studied in southeast Florida nests experience different moisture amounts during incubation depending on local weather patterns. The 2015 nesting season was characterized by a hot-dry earlier half, and a hot-wet later half. Rainfall amounts were confirmed using National Weather Service monthly summaries and temperature loggers were used to monitor incubation temperatures. Early season nest temperatures ranged more widely than those of later nests. We compared growth and survivorship of loggerhead sea turtle hatchlings that incubated earlier in the nesting season (dry) and those of hatchlings that incubated later in the nesting season (wet). Loggerhead hatchlings from natural nests in southeastern Florida were raised at Florida Atlantic University's Marine Laboratory until reaching approximately 130 g for separate study. Weekly mass, straight carapace length (SCL), straight carapace width (SCW), and body depth (BD) measurements were taken throughout this time period. Hatchlings that incubated earlier in the season were significantly narrower in initial SCW, but heavier than those incubating later in the season. Initial SCL and BD measurements did not differ between the two groups. Hatchling samples from hot-dry nests tended to have higher emergent success than hot-wet nests; survival between the two groups during their first weeks in the water did not differ greatly. Given concerns about increasing temperature and shifting rainfall patterns along much of the Florida coastline due to climatic change, it is important to understand how differing or extreme weather patterns may impact marine turtles. Acknowledgments: We would like to thank the following funding sources: International Sea Turtle Symposium, Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria, World Wildlife Fund, National Save the Sea Turtle Foundation, Nelligan Sea Turtle Research Fund, and personal funds. For logistical help, we are grateful to the Gumbo Limbo Sea Turtle Specialists and the FAU Sea Turtle Research team.

NESTING FIDELITY OF GREEN TURTLES (*CHELONIA MYDAS*) AT TORTUGUERO, COSTA RICA*

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Since 1959, the Sea Turtle Conservancy (STC) has been working in Tortuguero, Costa Rica. Decades of data collection have helped us learn about sea turtle reproductive biology and behaviour, at one of the most

important green turtle (*Chelonia mydas*) nesting beaches in the world. Nesting site fidelity on green turtle nesting beaches is something that is known from other studies, particularly in reference to natal beach homing by adult females (KJ Lohmann, BE Witherington, CMF Lohmann and M Salmon, 1997). The STC has been studying the green turtle population at Tortuguero for more than 55 years and data from the annual tagging program conducted throughout that time, the oldest marine turtle database in the world, with more than 100,000 registered turtle encounters, can be used to better understand nesting fidelity of green turtles and their amazing capacity to return to the same beach year after year. In addition, these data can answer many interesting questions about their nesting behaviour; such as, the minimum and maximum distance between encounters with the same turtle over the years, the maximum number of times that an individual turtle has been observed within a single season, and changes in nesting beach use over time. Tortuguero beach extends for 18 miles and is delimited by the Tortuguero and Jalova river mouths. For this study data were collected on the five northern-most miles of the beach, with additional data from the three southern-most miles (close to the Jalova lagoon) since 2010. Turtles encountered more than once were the focus of our study of nest site fidelity. With some individuals encountered up to 26 times, over a span of more than 30 years, they provide considerable information about nesting behaviour. Tortuguero beach is divided into 1/8 mile sections and nests are referenced using the closest mile marker to the north. For analysis, the distance from the original encounter site was categorized as 3 miles. Separate analyses were conducted to compare encounters with the same female within a single nesting season, and between different nesting seasons. Preliminary results suggest some interesting trends in nest site fidelity. For females encountered multiple times in a single season; 11.5% nested within 2/8 mile (ie. within 400m), 52% within 1 mile, 33.6% within 1-3 miles, and just 2.9% nested more than 3 miles from their original encounter site. Over 63% of turtles returned to within 1 mile of their original encounter site. Individuals observed in different nesting seasons showed a similar pattern; 8.4% nested within 2/8 mile, 38.8% within a mile, 44.6% 1-3 miles and 8.4% more than 3 miles away. That 47.2% of green turtles could navigate not only back to the same beach after several decades, but to the same 1 mile section of beach highlights their incredible migratory and homing abilities. These findings will be discussed in reference to potential conservation implications for this globally important green turtle population.

TREATMENT AND CAPTIVE MAINTENANCE OF PREMATURE HATCHLINGS OF *ERETMOCHELYS IMBRICATA*

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The predation of sea turtle nests varies according to the location of spawning and the depth of the egg chamber. Different types of predation may occur. In the study area, the most common predators are foxes, *Cerdocyon thous*, and anthropogenic predation. Thus, this paper aims to describe the maintenance of *Eretmochelys imbricata* hatchlings with yolk exposed in captivity until it was absorbed. On February 19,

2014, we recorded one hawksbill turtles nest on the Costa da Ponta do Tubarão, in the city of Macau / RN, Brazil. Forty-nine days later, on April 8, 2014, this nest was predated by foxes, and the information were collected during activities of Projeto de Monitoramento de Praias coordinated by the Projeto Cetáceos da Costa Branca/UERN. Thirty-one eggs were preyed upon, leaving alive and premature hatchlings with the yolk bag exposed. Another 28 hatchlings remained inside the eggs, but with the broken shell in some regions. The animals were rescued and transported to a rehabilitation base, where they received veterinary care. A treatment method was developed for premature hatchlings which consisted of cleaning with saline and subcutaneous hydration daily. All animals were kept warm and resting on moist gauze in plastic trays or pots large involved with foil, lined with gauze inside and covered with individual screens. Also, they were heated with an incandescent lamp, after which the light was turned off for them to rest. On the third day in captivity, the hatchlings were placed in the water, sank, breathed and swam usually for 1 hour and then were put at rest. The hatchlings that were rescued still inside the eggs, spent an extra day in treatment to be placed in the water. All hatchlings received in the morning and late afternoon, a topical application of iodine in the remnant membrane that was attached to the yolk bag. During maintenance in captivity, 14 animals died, these were kept intact in 70% alcohol. Forty-five hatchlings responded satisfactorily to the treatment applied, and were reintroduced on April 13, 2014, at 16h, in a state of ebb tide, at the beach of São José, municipality of Areia Branca/RN. Thus, this work can act as a guide for other studies on the management of premature hatchlings of sea turtles, assisting in the conservation of these animals.

NEST SITE SELECTION AND TEMPERATURE-DEPENDENT SEX DETERMINATION OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) IN MONDONGUILLO BEACH, COSTA RICA

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The leatherback turtle *Dermochelys coriacea* is a vulnerable marine reptile red-listed as critically endangered by the IUCN in 2004. Recently, protection efforts seem to have stimulated a slow recovery mainly centered in the Atlantic region. However, scarcity of knowledge on the biology of this species demands more research to keep up with suitable protection plans and the development of new strategies, laws and regulations. A vital stage in leatherback life cycle is the moment in which adult females come back to land to lay their eggs on beaches. Hatching success is, among others, dependent on the conditions under which incubation takes place, which is in turn (partly) determined by the site where nests are excavated. Nest site selection could be driven by a wide array of physicochemical properties of a particular area of the beach such as moisture content, temperature or grain size of the sand particles. Besides, it has been hypothesized the existence of a selective force pushing nest placement not too close to the water but not too far from it either. Choice of nest positioning could also be a random process, where scatter of nests would ensure the right placement of at least some of the nests. Sea turtles, like many other reptiles, exhibit temperature-dependent primary sex determination: high temperatures during the thermosensitive period in the second third of incubation give rise to females and low temperatures typically generate male hatchlings. Leatherbacks nesting in Pacuare Nature Reserve (PNR) preferred to lay eggs in some particular areas of Mondonguillo beach, but nests could be found all along the beach. High positioned nests in open sand were significantly more frequent, and females tended to place nests closer to the vegetation than to the sea. Mean nest site fidelity of the multiple nesters on the 6-km stretch of Mondonguillo beach (females that nest more

than two times within a nesting season) in the 2010 nesting season was 0.8 km, with a maximum fidelity of 0.1 km and a minimum fidelity of 1.7 km. Nest site selections of individual multiple nesters were random. Moisture content may be an element influencing hatching success but results suggested that other factors are of greater importance. Eight dataloggers were introduced in nests excavated by females in May to record incubation temperature and predict sex ratios. Four nests were predicted to have produced 100% of females while the other two would have generated 71.4 % female hatchlings. During the thermosensitive periods (TSPs) that determined the primary sex of the hatchlings inside the nests, weather conditions on the beach were the hottest and the driest of the entire season. Hence, this outcome elucidates sex ratios during the period of the nesting season when more females are potentially being produced. Predictions of sex ratios outside this period would be needed in order to know how balanced the proportions of sexes are in PNR nesting ground.

CHARACTERIZATION OF BEACHES AND NESTING SITES AVAILABLE FOR HAWKSBILL SEA TURTLE *ERETMOCHELYS IMBRICATA* ON ST. THOMAS, U.S. VIRGIN ISLANDS

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Sea turtles are marine species that have been around for more than 210 million years. There are seven sea turtle species worldwide, with three species found in the United States Virgin Islands (USVI). The Hawksbill sea turtle *Eretmochelys imbricata* is the most prominent species to use St. Thomas beaches as nesting habitats. Hawksbills face many threats, but habitat loss and exploitation have caused their population numbers to decline to 1% of that previously recorded and have led efforts to conserve this species to increase. As a result, the hawksbill is listed as endangered under the Endangered Species Act (ESA). Large portions of those conservation efforts are focused on preserving the nesting population. Driving factors of nesting habitat and nesting site selection and impacts of threats remain in the top 10 questions worldwide. With the hawksbill species being a vital portion of the ecological processes in maintaining coral reef health and act as a direct supplementary source of marine-derived nutrients keeping coastlines healthy, it becomes important to identify the underlying factors driving nesting site selection and available nesting beach persistence to further protect our hawksbill sea turtle population. During the peak nesting season months of July-December 2015, beach characteristics including length and width using a rolatape, elevation and slope using a range finder, species of vegetation within 1 meter on either side of a 10m transect along the vegetation line, substrate composition, threats, and wave action were recorded once a month for each available potential nesting beach. Each beach was monitored once a week for presence or absence of sea turtle nesting activity. Once located, GPS coordinates, expected emergence dates, date of nesting, distance to the high-water mark, distance to the vegetation line, threats, and characteristics of the substrate contents of sand, rocks, and vegetation species within a 1 meter radius circle surrounding the nesting location were recorded. It was found that hawksbill sea turtles tended to nest within 1 meter of the vegetation line usually consisting of sea grape or machineel trees. Threats of development were found to negatively impact the nesting habitats by increased predation on the nests. Nesting beach persistence showed that 2 of the beaches did not last through the nesting season. In an attempt to further protect the nesting population on St. Thomas, USVI, more research needs to be conducted to determine the most suitable way to protect the nests from development and predators.

FACTORS AFFECTING NEST SURVIVAL AND EMERGENCE SUCCESS OF THE GREEN TURTLE (*CHELONIA MYDAS*) AT TORTUGUERO, COSTA RICA

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Tortuguero, Costa Rica is the most important nesting ground in the Western Hemisphere for the endangered green turtle (*Chelonia mydas*). Each year thousands of sea turtles emerge from the ocean to lay their eggs at this beach, of which only approximately 1 in 1,000 hatchlings will reach adulthood. Emergence success, or the percentage of hatchlings that leave the nest, is dependent on a multitude of variables; these may include beach erosion, predation, as well as numerous anthropogenic factors. As part of the Sea Turtle Conservancy (STC) annual research program, the exact location of a sample of nests is marked at the time of oviposition. These nests are monitored daily throughout the incubation period to assess survivorship; following signs of hatchling emergence, the nest contents are excavated to determine hatching and emerging success. Our study will evaluate the effect of location on survivorship and emergence success rate of green turtle nests at Tortuguero beach. In 2010, through a collaborative agreement with Global Vision International, STC expanded monitoring activities to include a section of beach at the southern limit of Tortuguero National Park (TNP); providing an opportunity to compare survivorship and emerging success between nests laid in the five northern miles (Tortuguero) and those laid in the southern three miles of beach (Jalova). The Jalova section lies entirely within TNP, while Tortuguero encompasses both protected and public areas, thus it is possible that nests may be subject to different levels of human pressures at the two extremities of the beach, reflected in differences in survivorship and/or emerging success. Data collected during the STC's Green Turtle Program (June – October) for the last five years (2010-2015) were analyzed. Jalova had a higher average emergence success rate than Tortuguero (73.9% compared to 67.4%, respectively), possibly due to lower levels of anthropogenic threats. Poaching rates were higher in Tortuguero than Jalova (7.7% and 0.3%, respectively), possibly due to the fact that two communities (Tortuguero and San Francisco) are located at the northern end of the beach, with easy access to nests and/or turtles. Levels of predation by dogs, vultures and other animals were similar at both sites (4.4% and 4.4%, respectively). However, the average percentage of eroded nests in Tortuguero was lower than in Jalova (3.8% and 7.4%, respectively). Although both areas are subject to natural forms of erosion, it is likely that during the five-year study period, the Jalova section faced stronger currents and heavier rains which impacted nest survivorship to a greater degree. The STC will be able to share the findings of this study with Tortuguero National Park managers, to highlight principle threats to nest survivorship and identify potential hotspots that may require the implementation of additional conservation measures to address anthropogenic factors that may impact hatchling survival. In addition, understanding the role that beach erosion may play in nest survivorship and hatching success can help us determine whether intervention practices such as nest relocation should be considered as a potential conservation strategy to increase emergence success at Tortuguero.

WINTER WONDERS AND SUMMER SIZZLERS: OBSERVATIONS AT A YEAR-ROUND OLIVE RIDLEY NESTING ROOKERY

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Sea turtles present temperature dependent sex determination making a range of incubation temperatures vital for the production of viable populations. Global temperatures are estimated to increase up to 3.5ºC by 2100 due to climate change which will skew sex ratios further towards female biased primary sex ratios. Similarly, temperatures above 34°C will cause significant mortality during embryonic development. During 2015 we conducted research on Majahuas beach which represents the last 9 km of Playon de Mismaloya sanctuary (60 km) a previous arribada rookery. From February to December we collected 100 nests at random from olive ridley sea turtles nesting on Majahuas. Upon encountering a nesting female, carapace measurements (Curved Carapace Length, Curved Carapace Width), number of eggs per clutch and nest depth were measured to see if there were differences between winter and summer nesters. Nests were transported to a beach hatchery where we recorded incubation temperature profiles for each of the nests (N = 100). We recorded temperatures ranging from 18.80°C to 37.82°C at nest depth (45 cm). Seasons were separated as: Winter/dry season nests (November-May) and Summer/rainy season nests (June-October). Winter nests were cooler (mean 29.03 °C ± 0.54) than summer nests (mean 33.13 °C ± 0.99) To further evaluate the effects of different temperatures on turtles we conducted tests of locomotor performance (time to crawl 3 m and righting response) and phenotype measures (weight and straight carapace length, width and depth) of 20 hatchlings (when available) from each of the nests for which we collected temperature profiles. Hatchlings took a mean of 3.49 s to self right and a mean of 2.88 minutes to crawl 3 m. Mean hatchling weight (16.29g), SCL (40.69mm), SCW (32.86mm) and depth (17.8mm) were greater in winter than summer.

BASELINE DATA REVEAL IMPORTANCE OF RÍO ORO NATIONAL WILDLIFE REFUGE TO THE EAST PACIFIC OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) SEA TURTLE STOCK

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Previous studies had identified the Río Oro National Wildlife Refuge (RONWR), Osa Peninsula, Costa Rica, as a site of major solitary Olive Ridley nesting. Ease of access via a public road meant that these nests were especially vulnerable to being poached, and yet the refuge was left abandoned without routine protection for many years. A new program established by the Corcovado Foundation in 2015 aims to provide long-term monitoring and protection of the site. During the months of August through November 2015, 2,759 Olive Ridley nests were registered on Río Oro beach (density = 57.5/100m), corresponding to 72% of all nests registered for this species on the five major nesting beaches in the Osa Peninsula. Nesting peaked at the beginning of October, and nesting frequency was observed to increase markedly during the third quarter phase of three consecutive lunar cycles. Analysis of a sample of 137 nests revealed an eclosion rate of 74.0%, comparable to that of neighboring beaches, and much higher than that observed at beaches on which arribadas take place. These data demonstrate that the RONWR makes a greater contribution to the Olive Ridley sea turtle stock than any other site on the South Pacific coast of Costa Rica.

EVALUATION OF NEST TEMPERATURES ON DALYAN BEACH, TURKEY

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The temperature measurement of loggerhead turtle nests is one way of estimating the sex ratios of hatchlings produced from those nests. We have been recording the nest temperatures on Dalyan Beach, Turkey. The temperatures were recorded using data loggers and the temperatures during the middle third of the incubation period were analyzed when the sex of the hatchlings were determined. The temperature data were downloaded to a computer after the hatching completed and when the nest had excavated. The results were analyzed in terms of spatial and temporal variations. We compared the mean nest temperatures with incubation periods and found that around a 1°C change in the incubation temperature make changes in the incubation period of about 4 days. The temperature variation within the nest is also causing developmental differences of the hatchlings, with around 1°C differences within the nest causing a 7 day difference in the first and last hatching. The sex ratios of the hatchlings were female dominated during the middle part of the nesting season but relatively high male sex ratios were produced at the beginning and at the end of nesting seasons with relatively longer incubation periods. The overall sex ratios during the years of 2012-2014 were around 70% female dominated.

THE EFFECT OF RAINFALL ON GREEN TURTLE INCUBATION TEMPERATURES AND HATCHLING SEX

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Marine turtles have environmental sex determination (ESD), by which incubation conditions direct embryonic sex. Nest temperature, the primary environmental factor, can vary with other factors such as rainfall, shade, and sand type, thus affecting hatchling sex ratios. We measured relationships among nest temperatures, rainfall, and hatchling sex ratios of green turtle (*Chelonia mydas*) nests at a beach in Boca Raton, Florida across the 2010-2013 nesting seasons. Rainfall events were synchronized with the nest temperature profiles. We analyzed nest temperature data to identify any signal that rainfall events altered temperatures. A subset of hatchlings was sexed laparoscopically to provide empirical measures of the sex ratio for the beach. Nest temperatures and rainfall amounts were compared to sample sex ratios. The majority of hatchlings in the samples were female suggesting that across the four seasons most nest temperatures were not sufficiently cool to produce many males. However, in the early portion of the nesting season and in wet years, nest temperatures varied and significantly more males hatched. The results of this study were compared with a study that examined the same parameters in loggerhead (*Caretta caretta*) nests across the 2010-2013 nesting seasons. Sampled green turtle nests experienced lower temperatures than loggerhead nests and produced more males. Rainfall events caused smaller decreases in nest temperature in green turtle nests compared to loggerhead nests. The impacts of rainfall on nest temperatures and sex ratios may vary among species as a result of differences in nest depth and nest site location on the beach. The study suggests that rainfall events can lower the nest temperatures of both green (deeper) and loggerhead (shallower) nests, but also the embryonic sex response to the environment may go beyond temperature effects.

A NEW IMPORTANT NESTING BEACH FOR LEATHERBACK TURTLES IN THE CARIBBEAN

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For the last 20 years, beaches of the northeast and southeast of Puerto Rico were considered important nesting sites for leatherback turtles. However, 4 years ago, a new leatherback beach on the north coast of Puerto Rico was identified. The beach is known as Playa Grande (El Único) in the Municipality of Dorado. The local environmental organization known as Proyecto Tinglar Dorado (a member organization of Chelonia) and its volunteers, in direct collaboration with the Puerto Rico Department of Natural and Environmental Resources (DNER), have recently reported the largest leatherback nesting activity in Puerto

Rico at this site with approximately 341, 367 and 598 nests documented in 2012, 2013 and 2014, Nesting females haven been tagged and several leatherbacks from other beaches within Puerto Rico and from other rookeries outside of Puerto Rico have been reported nesting at this beach. The nesting season started from March to July with a peak in April to June. Hatchling success is one of the highest in Puerto Rico with an average of 53-66%. Although this beach is a dark, with no development, it is less than 10 km from one of the highest human populated areas in PR and less than 20 minutes from San Juan (Capital of Puerto Rico). Coastal development in Playa El Único could represent a serious threat to the ecological health of sea turtles and their habitats. The Department of Natural and Environmental Resources have decided to designated this beach as a Natural Reserve.

ESTABLISHING CONSISTENT MONITORING OF SEA TURTLE REPRODUCTIVE ACTIVITY ON THREE NESTING BEACHES SOUTH OF ZIHUATANEJO, GUERRERO, MEXICO

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Campamento Tortuguero Ayotlcalli, Mexico

Since September of 2011, Campamento Tortuguero Ayoltcalli has monitored reproductive activity of sea turtles and protected their nests on 25 km of nesting beach (including Playa Larga, Playa Blanca, and Barra de Potosi), located south of Zihuatanejo, Guerrero, Mexico. The majority of nests documented in this area are olive ridley (*Lepidochelys olivacea*) nests, but green sea turtle (*Chelonia mydas agazzisi*) and the critically endangered Eastern Pacific leatherback (*Dermochelys coriacea*) also utilize these beaches. The olive ridley population displays non-arribada nesting behavior, and nesting occurs from June until February, with the heaviest nesting observed in August and September. The nesting season for both green and leatherback turtles occurs from October to February. Over 2,000 olive ridley nests have been protected, with over 500 nests being observed during both 2014-2015 and 2015-2016 nesting seasons. The average clutch size was 88.99 ± 12.24 eggs, and the average curved carapace length and width were 64.25 ± 3.41 cm and 68.49 ± 3.71 cm, respectively. Both average clutch size and nesting female size are comparable to what has been reported from other non-arribada olive ridley populations. Only 5 green and 8 leatherback nests have been observed thus far. Most nests are relocated to a nest corral located near Campamento Tortuguero Ayoltcalli's headquarters due to the high risk of losing nests to poaching and beach erosion. Poaching represents the most immediate threat to these populations as illustrated by the percentage of total olive ridley nests observed that are illegally removed (approximately 10%). Nesting females are also captured and killed for their meat and eggs. During the 2015-2016 season, a mark-recapture study was initiated to examine additional aspects of reproductive ecology, such as site fidelity and inter-nesting period, and compare these data to other non-arribada populations. Additionally, dataloggers were inserted in the nest corral to examine incubation temperatures and their potential influence on hatching success rates. Rates have ranged from 58.1% (2014-2015) to 96.4% (2012-2013).

FIRST GREEN TURTLE NEST IN GREECE AND THE WESTERNMOST RECORD IN THE MEDITERRANEAN

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We report herein the nesting of a green turtle *Chelonia mydas* on Rethymno beach on the northern coast of the Island of Crete, Greece. Rethymno is known to host an important nesting area for loggerhead turtles in the Mediterranean. This 12 km long beach has been systematically monitored by ARCHELON since 1990. Monitoring activities include identifying and protecting nests through fencing and/or relocating. Nests continue to be observed until hatching, and when complete, they are excavated to assess clutch size, hatching success, in-nest mortality and other parameters affecting incubation. On 11 October 2007, during the post-hatch excavation of a nest identified through hatchling activity, it was observed that all dead hatchlings and the developed embryos within unhatched eggs had different morphological traits than those known for loggerhead turtles. This nest was laid at the westernmost end of the site (35°23´25''N, 24°36´21''E) and had not been identified during the egg-laying season probably because that section was backed by a large hotel resort and the track may have been destroyed by a third party before the arrival of the ARCHELON team. The nest had been deposited 1.5 m from the back of the beach, at a distance 16.5 m from the shoreline. At 58 cm, the egg chamber was significantly deeper that those typically constructed by loggerhead turtles. Total clutch size was 62 eggs, of which 24 were unhatched. Of the unhatched eggs, 18 contained dead embryos and 6 had no visible embryo. Of the 38 hatched eggs, 19 hatchlings were found half-hatched (pipped) with 5 dead and 14 still alive inside the nest. Three more hatchlings were found inside the nest of which 2 were dead. All hatchlings found alive were helped to the sea by ARCHELON observers. Three of the dead hatchlings were preserved in alcohol and subsequent inspection of the morphological characters of the samples concluded that they were *Chelonia mydas*. All hatchlings had 3 infra-marginal scutes, as well as 4 post-ocular and 2 pre-frontal scales on either side. Two of the hatchlings had 4 costal scutes bilaterally (typical for green turtles) but the third one had 5 costals on its left side; it is known however that this deviation is frequently observed in green turtles. This is the first record of green turtle nesting activity occurring in Greece. In the Mediterranean, the known nesting range of green turtles is restricted to its easternmost basin (Levantine basin), presumably due to higher water temperatures. Specifically, green turtle nesting occurs in southeastern Turkey, Cyprus, Syria, Lebanon, Israel, and Egypt with the westernmost boundary being Fethiye beach in Turkey (36°40´53.55 N, 29°04´29.03 E), about 430 km east of Rethymno. This observed green turtle nest in Rethymno extends the known range for the species in the Mediterranean and may be another indication of the incoming climate change in the region.

COASTAL SARGASSUM ACCUMULATION AND SEA TURTLE NESTING IN THE CARIBBEAN: QUANTIFYING EFFECTS ON HAWKSBILL EMERGENCE PATTERNS AND INCUBATION TEMPERATURES ON JUMBY BAY, ANTIGUA

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Mass coastal stranding of Sargassum seaweed is a new reality in the Eastern Caribbean, a region host to many sea turtle nesting sites. An increase in floating sargassum mats could confer benefits to sea turtles in early life history stages, but the impact of coastal and nearshore buildup along essential nesting habitats and the specific effects on reproductive ecology are unknown. We monitored sargassum accumulation (height and width of onshore mounds and presence in nearshore waters) and nesting activity at a major hawksbill (*Eretmochelys imbricata*) rookery on Jumby Bay, Antigua, from June to November of 2015. We compared these data to historical (pre-sargassum) information and evaluated patterns of crawl distribution in 2015 against sargassum gradients. We also used temperature data loggers to measure sand temperatures under different sargassum treatments to simulate observed instances of sargassum covering nests. Our data suggest that sargassum buildup affects the spatial distribution of nesting activity, precluding emergence in heavily affected areas and compelling turtles to crawl where the seaweed is less abundant. Sand temperature data suggest that sargassum accumulation atop nests reduces below ground temperatures. Our results provide initial data on the impacts of coastal sargassum accumulation on sea turtle reproductive ecology, an emerging conservation and management issue. However, we underscore the need for further research in this area, including potential effects on the incubation environment (beyond temperature), hatchling emergence, and hatchling energy expenditure and survival during seaward crawls. Acknowledgments: The authors would like to thank the Jumby Bay Island Company for project support and we thank the International Sea Turtle Symposium, Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria, and World Wildlife Fund for student conference travel support.

HAWKSBILL (*ERETMOCHELYS IMBRICATA*) NESTING MONITORING IN CENTRAL COASTAL ECUADOR: A SEVEN YEAR MONITORING SUMMARY WITH INSIGHTS TO NEW NESTING SITES

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The Ecuadorian coast is an important nesting and foraging ground for sea turtles. Since 2007, we have been monitoring beaches in this area for nesting activities, especially in and surrounding the Machalilla National Park. In 2008, La Playita, an 800 meter long beach inside the protected area was confirmed as a nesting site for hawksbill sea turtles (*Eretmochelys imbricata*). To now, it is the only recurring nesting site for this species found in the country and in South America. Since then we have monitored the beach as part of a national sea turtle monitoring program with special emphasis during the nesting season (November to April). The objectives are to establish the nesting activities of this hawksbill population as well as the population's characteristics; we are aiming to establish trends in number of nests, their characteristics and hatching success, number of nesting females and their size trends, behavior, and population sizes. All females are tagged and once a year one female (or more, depending on resources) is equipped with a satellite transmitter as the nesting season is approaching it`s end. To date we have found an average of 30 nests with a hatching success of around 70% per year and have tagged a total of 34 nesting females. Of these, 10 have been equiped with satellite transmitters; the majority of them have migrated south to a mangrove area close to the border with Peru. The information we've collected has been of crucial importance to protect this population and its nesting beach, special measures have been applied to protect it and the nests from threats present such as erosion, sea level rise, and human destruction. We confirm two new nesting sites for this specie based on nests registered through day and night patrols and with capture-recapture of nesting females. In this study, we confirm nesting activities at Portete beach, in northern Ecuador; prior to this register we had only evidenced hawksbills in water. We also confirm nesting activities at the Reserva de Producción de Fauna Marino Costera Puntilla de Santa Elena (REMACOPSE) -a national protected area-based on the recapture of a female first tagged in La Playita by Equilibrio Azul, and then recaptured with a new tag belonging to the Ministry of Environment of Ecuador after she nested at La Lobería beach in the REMACOPSE, about 120km south of La Playita. These two new sites give hope for this species and emphasize the need to continue monitoring and researching in coastal Ecuador. This species is critically endangered, and this population was thought to be virtually extinct in the area before this study began. It is highly important to continue with the monitoring efforts to gather enough data about this population and to effectively protect the only known breeding population of hawksbills in South America.

PAST PRIMARY SEX-RATIO ESTIMATES OF 4 POPULATIONS OF LOGGERHEAD SEA TURTLE BASED ON TSP DURATIONS*

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Ectothermic species are supposed to be strongly affected by climate change and particularly those that exhibit temperature-dependent sex-determination (TSD). Actually, predicting the embryonic response of such organism to incubation-temperature variations in natural conditions remains challenging. In order to assess the vulnerability of sea turtles, primary sex-ratio estimates should be produced at pertinent ecological time and spatial scales. Although information on this important demographic parameter is one of the priorities for conservation purpose, accurate methodology to produce such an estimate is still lacking. The most commonly used method invocates incubation duration as a proxy for sex-ratio. This method is inappropriate because temperature influences incubation duration during all development whereas sex is influenced by temperature during only part of development. The thermosensitive period of development for sex determination (TSP) lies in the middle third of development. A model of embryonic growth must be used to define precisely the position of the TSP at non-constant incubation temperatures. The thermal reaction norm for embryonic growth rate have been estimated for 4 distinct populations of the globally distributed and threatened marine turtle *Caretta caretta*. A thermal reaction norm describes the pattern of phenotypic expression of a single genotype across a range of temperatures. Moreover, incubation temperatures have been reconstructed for the last 35 years using a multi-correlative model with climate temperature. After development of embryos have been modelled, we estimated the primary sex-ratio based on the duration of the TSP. Our results suggest that loggerhead sea turtles nesting phenology is linked with the period within which both sexes can be produced in variable proportions. Several hypotheses will be discussed to explain why *Caretta caretta* could be more resilient to climate change than generally thought for sex determination.

RELATING BEACH CHARACTERISTICS TO NESTING SITE CHOICE BY FEMALE HAWKSBILL (*ERETMOCHELYS IMBRICATA*), LEATHERBACK (*DERMOCHELYS CORIACEA*) AND GREEN (*CHELONIA MYDAS*) SEA TURTLES ON THE ISLAND OF BARBUDA, LESSER ANTILLES

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Sea turtle populations are declining throughout the world, and most species are currently listed as threatened or endangered by the International Union for Conservation of Nature (IUCN) Red List of Threatened Animals. These populations are being affected by over-development, beach erosion, beach nourishment and dredging, artificial lighting, coastal armoring, climate change and pollution. The Caribbean is home to many nesting and foraging sea turtles. Around the islands of Antigua and Barbuda, in the Lesser Antilles, there are four species of sea turtles documented: hawksbills (*Eretmochelys imbricata*), leatherbacks (*Dermochelys coriacea*), greens (*Chelonia mydas*), and loggerheads (*Caretta caretta*). Of these, hawksbills, leatherbacks, and greens nest on the island of Barbuda. However, a systematic study to map nesting sites and beach locations around the island has not been performed to date. The purpose of this study was to determine which beach locations around the island of Barbuda were being utilized by nesting turtles, determine which species were nesting, and further understand conditions leading to nest site selection of female sea turtles on this island. An understanding of the natural nesting behavior of female sea turtles will not only benefit future hatchling success, but will also allow for policy recommendations on future beach use and development around the island. Eight beach sites were surveyed on the island over a period of 6 years, covering approximately 70% of the total island coastline. At each site, crawls were mapped using GPS coordinates, and female size, species, and position of the nest were documented. Application of geographic information system (GIS) was used in this project. Shape files were brought into a GIS program (ArcMap 10.1) to create the map of Barbuda. GPS coordinates were imported to illustrate frequency and position of nesting females around the island. From crawls, measurements of total width, carapace width, distance from the nesting site to the high tide mark, beach slope, substrate and vegetation characteristics, were collected and analyzed. A chi-square test of independence was performed to analyze differences between species (greens, hawksbills, and leatherbacks) and beach selection. One-way ANOVAs (and post hoc tests) were used to analyze pH, temperature, grain size, and beach slope data. The island was found to be, overall, an excellent nesting area for female sea turtles. Physical beach characteristics (slope, sand, vegetation, and water access) appear to play a key role in beach selection. Hawksbills were one of the most prominent species observed nesting on the island. They were observed nesting at higher frequencies at beach sites that had good vegetation cover, low wave energy, narrow width, and reef protection. Greens appeared less particular about site characteristics, while leatherbacks nested at a lower frequency and on beaches that had open water access, wider beaches and no hazardous obstacles. Due to its underdeveloped status, Barbuda provides a significant amount of ideal nesting habitat for all species of sea turtles. Overall, there was a viable population of each species (hawksbills, greens and leatherbacks) represented on the island, yet significant conservation efforts will be necessary to preserve this unique island refuge.

PRESENCE AND DISTRIBUTION OF SEA TURTLES ALONG THE ANGOLA COAST

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This work aims to contribute to the knowledge about the presence and distribution of sea turtles along the coast of Angola between the latitudes S5°02 and S5°45 (coast of Cabinda) and between latitudes S6°14 and S17°15 (from the mouth of the Congo River to the mouth of the Cunene river). Aerial surveys were conducted between the mouth of the Congo River and the Cuio region, and ground surveys were done on almost all the beaches between the Cuio region and the mouth of the Cunene River. Other beach surveys were also carried out to ground-truth the data collected by the aerial surveys. These survey data were combined with data collected over the past four years at different permanent monitoring locations of the Kitabanga Project, which include the regions of Soyo, Kissembo, Palmeirinhas, Sangano, Longa, Cuio and Manono. Information for the Cabinda region is based on surveys carried out in 2008. Nesting by three species of sea turtles is confirmed on Angola's beaches, including the olive ridley (*Lepidochelys olivacea*), which is the most common, the leatherback (*Dermochelys coriacea*) and the green turtle (*Chelonia mydas*). The nesting distribution of olive ridleys extends from the coast of Cabinda in the north to the region of Ponta Albina in the south Nesting takes place between the months of October and March, with the peak in nesting between November and January. Leatherback nesting occurs from the beaches of northern Cabinda to the Bentiaba region; they have also been reported from Pipas Bay, south of Bentiaba / Manono Beach, but this remains to be confirmed. Nesting by this species also occurs between October and March, with a peak in January. The green turtle is confirmed to nest in the Ponta do Enfião region of Manono, Cuio, Kissembo and Soyo. The nesting season appears to occur between October and April, with peak nesting somewhere between February and March. It should be noted that large foraging congregations of hundreds of animals, including adults and juveniles, can be seen at the mouth of the Cunene River in the months of November and December. Loggerheads and hawksbills potentially forage along the coast of Angola, but are not known to nest. The northern coast may be an important developmental habitat for hawksbills given the presence of many juveniles.

SPATIOTEMPORAL PATTERNS OF OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*) NESTINGS IN PLAYA CEUTA, MEXICO, 2012 – 2015

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The location of nests on a beach plays an important role in hatchling success of sea turtles. Different biotic and abiotic factors define hatchling fitness and survival. This study investigates characteristics and preferences of the Olive Ridley turtle (*Lepidochelys olivacea*) regarding nesting site selection in the marine sanctuary Playa Ceuta in the north-western Mexican state of Sinaloa, one of the northernmost nesting areas of Olive Ridley turtles. The site is defined through its long and rather narrow beach that has a length of nearly 40 km. With annually around 500 to 600 nests deposited, nesting density per kilometer is lower than in other locations given the great elongation of the beach, however nests are not evenly distributed. The objective of this study was to investigate temporal and geospatial distribution of nests of Olive Ridley turtles in Playa Ceuta during the last four years (2012 – 2015) in order to determine nesting variations by analyzing three aspects: (a) the location of the nests along the sanctuary, (b) the distance of the nests from the tidal line as well as the beach zone of oviposition and (c) the temporal distribution of nests throughout the years. The free geographical information system QGIS and the free software environment for statistical computing and graphics R were employed to perform visualization, data management and analysis of nesting distribution. The investigation characterizes preferences regarding nesting site selection. Dunes and sandy beach zones were the preferred sites for oviposition. Nesting patterns along the beach were non-random and varied during different months of the nesting season. Temporal analysis showed nesting peaks in August and September during all the years, with 50 % of the number of nests deposited by mid-September. However, temporal variation with a trend towards greater number of nests during the later months of season could be observed. Acknowledgments: The author would like to thank the International Sea Turtle Symposium and its sponsors including the Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria y World Wildlife Fund for supporting her attendance at the symposium.

THE FIRST ETHOGRAM DESCRIBING GREEN TURTLE NESTING BEHAVIOR*

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An ethogram is a catalog of actions shown by an animal, providing objective definitions of behaviors described as to their latency, frequency, intensity, rate, and duration, as well as order and hierarchy. These descriptions are useful in the measurement of behavioral changes hypothesized to come from environmental changes or other stimuli, including anthropogenic threats. The usefulness of understanding the nature of sea turtle nesting behavior makes it surprising that no ethogram of green turtle nesting has been published. Thus, studies of effects on green turtle nesting behavior from barriers, sand compaction, disturbance, and other factors have not included changes in the complete array of measurable actions that take place during nesting. To develop a green turtle nesting ethogram, we recorded video images of green turtles that emerged to nest on beaches near Disney's Vero Beach Resort® and Archie Carr National Wildlife Refuge in southeastern Florida (USA). We used both a thermal imaging camera (passive, with sensitivity to long-infrared ~9—14 microns), and a night vision camera (active, with sources emitting short-infrared of 0.8—1.3 microns). In most cases, the camera was positioned on a 4-m pole raised above the turtle to reveal motions of head and all flippers. IR illumination, camera operation, and concealment of observers took place so as to be undetectable to the turtle being recorded. Video images were coded to provide structural (head, limb) motor and orientation components of seven principal action patterns associated with oviposition. We present qualitative (video images) and quantitative descriptions in the ethogram and comment on measurability of the behaviors for studies of effects on sea turtle reproduction.

MONITORING NESTING OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) IN SANCTUARY PLAYA DE ESCOBILLA (OAXACA, MEXICO), DURING 2008-2014 NESTING SEASONS

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In Mexico Olive Ridley turtles are categorized as endangered species under the official standard 059 (NOM-059-SEMARNAT-2010), they are also classified as vulnerable by the IUCN Red List. The Sanctuary Playa de Escobilla (Oaxaca, México) is considered one of the most important nesting sites for Olive Ridley turtles (*Lepidochelys olivacea*). The present work describes the monitoring plan of the overall nesting activity of the olive ridley turtle in Sanctuary Playa de Escobilla to estimate the number of nests and the assessment of the hatching success percentage carried during the nesting seasons 2008-2014 as well advances on the

results of season 2015. In 2008, the Valverde-Gates (1999) method was adopted as the standard methodology for surveying the mass nesting behavior in this beach. Results of the estimation of the total nests by years 2008 to 2015 are presented as well as the detailed spatial cycle nesting behavior in this period. During the last seven years, an average of nine arribadas occurred every season. The current estimate gives us about 1,000,000 nests each season. The average of hatching success for the 9 seasons was 12%. During the 2015 season, we estimated 1,146,895 nests and hatching success of 11%, so far. 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. To apply this method in field conditions, it requires a great human effort, so community participation has been important.

MODELING THE NESTING SUITABILITY OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN NORTH CAROLINA USING GEOSPATIAL TECHNOLOGIES (2005-2014)*

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Numerous environmental conditions may influence where a female loggerhead sea turtle (*Caretta caretta*) selects a nesting site. A combination of these variables, rather than a single environmental condition, may explain the variation in nesting geographic patterns. To evaluate the relationship between environmental conditions and sea turtle nesting, data have been collected and several variables have been analyzed along the entire stretch of barrier island beaches in North Carolina, USA: slope, width, elevation, aspect, distance to hardened structures (e.g. pier or jetty), distance from inlets, housing density, population density, proximity to the Gulf Stream, and location of beach nourishment. Field work consisted of gathering beach elevation data at a high spatial and vertical resolution using a survey-grade Trimble RTK GPS at multiple transect swaths on four beaches. These field data as well as a variety of existing geospatial data layers were analyzed using spatial and traditional statistical analyses. A nesting site selection model was created for 25 islands (515 km) over a ten-year period (2005-2014). Very little work has been done to merge the study of sea turtle conservation with Geographic Information Systems (GIS) as a way to analyze data statistically and geographically and the majority of studies are restricted both spatially and temporally. Therefore, the goals of this research were to: 1) determine which areas are the most prevalent and successful for nesting; 2) identify which environmental variables are significantly correlated with nest site selection; and 3) generate a nesting suitability predictive model. Results indicate that the following variables are statistically significant for nesting in North Carolina: distance to hardened structures, beach nourishment, house density, elevation, distance to inlets, slope, width and geographic location. Conversely, the following variables did not have a statistically significant effect on nesting: population density, slope, aspect, beach width, and proximity to the Gulf Stream. The negative binomial regression technique, which used interactions among the independent variables, performed better than multiple regression and other statistical techniques. Geographic Weighted Regression explained on average 75% of the variance, with the southern region explaining the most (83%) and Cape Lookout explaining the least (66%). Predictive modeling using statistics and geospatial statistics were compared and provided excellent results that can also be useful for identifying critical nesting locations. These techniques could be used by monitoring programs to improve management strategies and may have important implications for the designation of critical nesting habitats.

THE MATERNAL LEGACY: FEMALE IDENTITY PREDICTS OFFSPRING SEX RATIO IN THE LOGGERHEAD SEA TURTLE*

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In organisms with temperature-dependent sex determination, incubation environment critically determines key nest parameters, including offspring sex ratio. Given that global temperatures have warmed by approximately 0.6°C in the last century, it is necessary to consider if and how organisms will adjust to climate change. We used an extensive dataset collected over 25 years for a population of loggerhead sea turtles nesting on Bald Head Island, North Carolina to determine how maternal identity influences nest characteristics such as sex ratio, hatching success and incubation duration. Here we show that individual mothers produce significantly different nest sex ratio profiles despite striking spatial and temporal environmental variation. This meta-analysis revealed that individual mothers also significantly predicted the incubation duration and hatching success of nests. This suggests that phenotypic plasticity in a female's nesting preferences is limited, potentially reflecting an inability of these endangered species to behaviorally mitigate the effects of rapid environmental change. The results obtained utilizing this comprehensive dataset will be discussed within the broader context of environmental changes seen on Bald Head Island over the past 25 years.

MORPHOMETRIC ASSESSMENT OF GREEN, HAWKSBILL AND LOGGERHEAD TURTLE HATCHLINGS IN THE NATIONAL PARK "ARCHIPIELAGO LOS ROQUES", VENEZUELA

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Anatomical and biometrical studies are important tools for management and conservation of endangered populations. These findings provide a better perspective of the population baseline status; especially on sea turtle populations due to their migratory behaviour. Monitoring programs use these data to provide information of possible disturbances that may be affecting the sea turtle hatchlings under controlled or artificial conditions, such as hatcheries and captive rearing. Although many studies on morphometry and weight of hatchlings have been done in different locations around the world, there is a lack of published

baseline data in national park "Archipielago Los Roques", Venezuela, an important nesting area in the country for four sea turtle species. In addition, this national park started a head-starting project in the beginning of the 1980's which aims to protect the hatchlings to increase the probability of survivorship for repopulation purposes as to encourage the environmental education among the inhabitants and tourists. Thus, the aims of this study were to report the mean morphological measurements of hatchlings of *Chelonia mydas*, *Eretmochelys imbricata*, and *Caretta caretta* in the national park, an area which lack of this data since the 1980's; and compare this response measurements of the national park with other morphological data of other nesting sites in the Caribbean. Sea turtle nests of the studied species, under high risk of natural predation or illegal harvest, were transported to "Dos Mosquises Sur" biological station, in order to protect them and carry out this assessment from 2012 to 2014. Once hatchlings emerged, morphometric measurements were taken using manual calliper and digital scale, respectively. Descriptive statistic values were calculated. *C. mydas* hatchlings presented a SCL mean of 5.1 cm, SCW mean of 4.07 cm and weight mean of 23.13 gr; *E. imbricata* hatchlings presented a SCL mean of 4.34 cm, SCW mean of 3.27 cm and weight mean of 22.60 gr; *C. caretta* hatchlings presented a SCL mean of 4.43 cm, SCW mean of 3.47 cm and weight mean of 21.93 gr. These results are similar to other reports of hatchling weight, carapace length and width of other areas in the Pacific, Atlantic, Indian Ocean and Caribbean Sea. The data presented in this study only corresponds with a short period of time; therefore, a monitoring program for the nesting areas as the morphological characteristics of eggs, nests and hatchlings is required for further understanding of the population dynamics in the mid and long term, and to create baseline data.

SPATIAL AND TEMPORAL VARIATION OF *OMORGUS SUBEROSUS* IN AREAS OF MASS NESTING OF *LEPIDOCHELYS OLIVACEA*, SANCTUARY PLAYA DE ESCOBILLA, OAXACA, MEXICO

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The Sanctuary Playa de Escobilla is the most important nesting area of *Lepidochelys olivacea* in Mexico. According to López Reyes from 1990 within this beach, was found *Omorgus suberosus* consuming live eggs of *L. olivacea*. Despite the various efforts to understand the effect of *O. suberosus* in the nests of *L. olivacea*, currently there isn't a detailed analysis of the ecological role of this beetle inside the nests of *L. olivacea* to propose control measures that diminish damage caused by *O. suberosus*. In this work, we evaluated the density of adult beetles in relation to the resource type present in beach. During the season of arribadas 2013 - 2014 were collected a total of 5,106 adults of *O. suberosus* for direct collection. No significant differences were found in terms of the number of adult beetles collected throughout the season of study. However, the areas of high and medium density of nesting had a greater number of individuals of *O. suberosus* with respect to the low density of the turtle nesting area. The number of beetles increased with the number of old nests (> 45 days) and decreased in new nests. These results suggest that in the Sanctuary Playa de Escobilla, *O. suberosus* can behave as an opportunistic predatory species that occasionally feeds on freshly laid eggs mainly when the nest overlaps with old nests (> 45 days), which could represent another

mortality factor for the population of *L. olivacea* that nests in the Sanctuary. This leads us to propose the need for targeted studies to: 1) determine if *O. suberosus* is present in other mass nesting beaches, 2) determine local fluctuations in the abundance of this beetle in each nesting season, 3) assess the magnitude of the damage caused by the beetles in the clutches of *L. olivacea* in areas with different densities of nesting and 4) determine the factors that modulate the population size of *O. suberosus* areas of mass nesting of *L. olivacea* and 5) propose a control strategy for *O. suberosus*.

IS THE SEX DETERMINATION OF SEA TURTLES INDEPENDENT OF THEIR GEOGRAPHICAL ORIGIN? A CASE STUDY AT TWO DISTANT ROOKERIES OF *CARETTA CARETTA*

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Sexual differentiation in sea turtles is determined by the nest temperature in the middle third of the incubation period (TSD). This process is described using the pivotal temperature (temperature that produces a 1:1 sex ratio) and the transitional range of temperature (TRT), which is the range of constant temperatures, where both sexes are produced. The boundary limits of the TRT are the threshold temperatures of masculinization and feminization, which are used to characterize the sex production of a population. The hypothesis that the physiological response of sex determination as a function of nesting temperature of sea turtles is independent of clutch and geographical origin is tested. After a review of incubation experiments of several sea turtle species, only two sets of data covering a wide range of experimental incubation temperatures were found in order to test the hypothesis, the experimental data for *Caretta caretta* were used from two distant latitudes: Florida and North Carolina in USA, where the environmental conditions were different. This study proposes a standardized method for determining the thresholds temperatures, from a sigmoid curve that describes the relationship between the mean temperature during the middle third of the incubation period and the male proportion produced. These data statistically demonstrated the assumption and it is concluded that there were no significant differences between the nonlinear fittings of the Girondot curve to temperature and sex rate data of *Caretta caretta* from North Carolina and Florida. The shape of the curve are conservative parameters, independent of clutch and geographical zone. The resulting TRT is required to properly manage the temperature in the conservation protected areas.

INFLUENCE OF SAND COLOR ON LOGGERHEAD EMBRYONIC DEVELOPMENT AND HATCHLING SURVIVAL, SIZE AND SEX RATIO*

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Climate and beach characteristics can have a profound impact on sea turtle nest incubation. For example, temperature can affect embryo survival, growth and gender. Among other factors, sand colour significantly influences sand temperature and several studies have already shown differences in embryonic development just by comparing beaches with different sand tones. However, these studies cannot clearly show a cause-effect relationship between colour variations and embryonic development, because different beaches possess many other important factors apart from just the colour of the sand. To test whether the surface colour of a beach has a direct effect on embryonic survival, growth and gender, we conducted a field experiment on the Boa Vista Island (Cape Verde) loggerhead rookery during 2015. Forty-eight loggerhead nests were relocated to a beach hatchery and 16 of them were exposed to a different experimental treatment where sand colour was varied: light, dark brown and black. The first treatment was the control, whereas for the other two treatments 2-3 cm of sand from the surface was replaced with different coloured sands. A previous test showed that such thin sand layer of different color significantly affect sand temperature at the incubation depth. This was the only factor that was modified of all the other conditions in the nests. Experimental surface sand was replaced when it was blown/washed away. The hatchery provided protection from predation and flooding due to tides. By chance, hurricane Fred passed over the experimental plot causing severe flooding and temperature decrease which allowed us to test whether sand color helped reduce the impact of a change in incubation temperature. A TidbiT® Temp Logger was buried in each treatment at the medium incubation depth (40 cm) to record sand temperature and another logger was placed in the middle of a nest belonging to each treatment to estimate the metabolic heat. The main variables recorded during experiments were the incubation period, hatchling success and the mass, the straight length and width of the carapace, the behaviour and carapace abnormalities from each hatchling. Mean sand temperature varied significantly among treatments (light: 29.68 ± 1.07, brown: 30.48 ± 1.61: black: 31.45 ± 1.58 °C). The color of the superficial sand layer also had a significant influence on incubation duration, hatching success and hatchling behaviour. Nests incubated under darker sand hatched earlier (up to 7 days difference), had higher mortality (a 18% reduction) and hatchlings moved more slowly. Observing the differences in the incubation temperature and duration allowed us to estimate a significant impact on hatchling sex-ratio. The hurricane caused a fast and severe decline in incubation temperature (up to 6°C), which was similar in all treatments immediately after the conditions passed. Thus, dark and warmer sand suffered a higher temperature decrease than light sand. The time it took to re-establish the previous incubation temperature was similar in all treatments and was more than 10 days. Here we discuss the influence of these results on sea turtle ecology and conservation under global warming scenarios, and how manipulating surface sand color can be a mitigation tool for extreme incubation temperatures which would not alter other important factors such as water or gas exchange at the beach's surface.

MORPHOMETRIC TRENDS IN NESTING LOGGERHEAD TURTLES (*CARETTA CARETTA*) AT BEAR ISLAND, NORTH CAROLINA

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We examined the trend in the curved carapace length (CCL) of nesting loggerhead sea turtles (*Caretta caretta*) at Bear Island, North Carolina, from 1979 through 2015. On this island, which is part of Hammocks Beach State Park, nighttime monitoring of nesting females has been conducted in summer months since the late 1970s. The average size of turtles nesting on Bear Island throughout the study period was 101.2 cm ±0.4 SE (n=270). The range of sizes of the nesting females on Bear Island are similar to those reported in other nesting locations in the NW Atlantic, north of Florida. We divided the study period into thirds to better quantify maxima and minima in average CCL throughout the study period. The average size of nesting turtles differed significantly between the first third of the study period (mean = 101.6 cm ±0.6 SE, n=117), the second third of the study period (103.8 cm ±0.7 SE, n=90) and the final third of the study period (98.1 cm ±0.7 SE, n=63). There was an increasing trend in CCL from the beginning to the middle of the study period (y=0.4x-680.1, R-SQ=0.83), and a decreasing trend in CCL from the middle to the end of the study period (y=-0.5x+1057, R-SQ=0.72). Possible interpretations for the increasing and decreasing trends in turtle size on Bear Island are considered. Acknowledgments: The authors would like to thank the National Science Foundation, Duke University, and Oberlin College for supporting this research.

EFFECTS OF DAILY BEACH USE TO THE NEST-SITE SELECTION PREFERENCES FOR LOGGERHEAD TURTLES ON DALYAN-IZTUZU BEACH, TURKEY

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Dalyan-Iztuzu Beach is one of the major nesting site for loggerhead turtles in Turkey with a total length of 4.5 km. The beach is the end point of the Dalyan Delta and a lagoon is formed behind the beach which has a connection to the sea with an estuary. At the opposite shore of the estuary, there is a 500 m long small beach that loggerheads use for nesting. The beach has been protected since 1988 as a specially protected area and very good protection measures have been applied in the past 25 years. The beach is closed to public access from 8 pm until 8 am. The nesting zone is well defined and marked with wooden poles along the beach. Each pole has number and the distance between two wooden poles is 5 m for the first 100 and last 120 poles. The distance between two poles is 10 m for the remaining middle part of the beach. Two cafeterias are placed at the both ends of the beach and sun-beds and umbrellas are placed behind the wooden poles. Daily visitors mainly using these two part of the beach. No light sources are used during the night. The beach structure is quite stable and no topographic change was observed in the last two decades. The number of loggerhead nests laid on Dalyan-Iztuzu Beach increased in the last 8 years (min 277; max 522).

A total of 2873 nests were laid during this period. We have been carrying out conservation and monitoring studies since 2008 to date except 2009. During our study period, 2582 nests were observed (mean number of nests is 358.2 ± 89.7). In this study, we studied nest site selection and possible changes of dense nest sites along the beach for our 8-year study period. The beach was divided into 40 subsections by using wooden pole numbers and dense nesting sites were compared with the areas that people use intensively. Nest density showed a negative correlation with the areas intensively used by people during the day even though no disturbance factors are apparent during the night. This may suggest that even if the conservation measures are implemented in the best way on nesting beaches, daily use areas should be monitored and managed more carefully.

VIABILITY AND MANAGEMENT OF NESTING EVENTS AT HIGH LATITUDES: IMPLICATIONS ON THE REDUCTION OF THE IMPACT OF CLIMATE WARMING ON SEA TURTLES

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The sea and the beaches are warming worldwide causing diverse impacts on sea turtle populations. In terms of reproduction, adults can develop sperm and eggs at higher latitudes and hatchling feminization is already threatening the most important rookeries in tropical and subtropical areas. Sea turtles can respond to these environmental changes by dispersing their nesting habitats to colder areas. This strategy could be critical for some turtle populations, especially those very isolated or further away from other suitable habitats. However, the probability that sporadic nesting consolidates as new nesting rookeries is extremely low and could not be fast enough to overcome the global warming. Under this scenario, several relevant conservation questions arise, such as if we should spend efforts and resources to protect sporadic nests laid at suitable beaches at colder or higher latitudes or how we can aid sea turtles in colonizing these new habitats. There are an increasing number of examples of sporadic nesting events involving different sea turtle species, but there are no clear recommendations about their management. In the present study, we analyse this phenomenon along the Spanish Mediterranean coast. The western Mediterranean hosts important loggerhead feeding grounds with individuals of at least three populations (Northwest Atlantic, Northeast Atlantic and Mediterranean). Over the last 15 years, the number of reported sporadic loggerhead turtle nests or nesting events reported has increased in this region and in particular on the Spanish coast, thus raising the question of whether the new nesters are potential colonizers or remnants from past nesting

populations. From 2001 to 2014, a total of 7 loggerhead turtle clutches and several other attempts have been recorded in the Spanish Mediterranean beaches. Genetic analyses of these clutches showed the contribution of both Atlantic and Mediterranean parents, thus indicating that we are facing a colonization process in this basin. In 2015 these numbers have increased with two more nesting attempts and two more clutches recorded. Here we report all the information concerning these new nesting events, assessing their success, describing the management strategy applied and discussing their conservation implications. Both 2015 clutches were laid at about 140 km distance from each other and within two weeks of difference, and both presented similar clutch sizes and number of infertile eggs. Ongoing genetic analysis will determine whether these clutches were laid by the same turtle or not. Moreover, temperature recorders were placed regularly in beaches along the Spanish Mediterranean coast in June to determine beach profile temperatures along loggerhead turtle nesting season in the Mediterranean (occurring in warmer months). The present work also includes the prediction of success and potential sex ratio of present and future nesting events according to beach temperature profiles, and the analysis of the viability of this possible colonization in the western Mediterranean in a global warming scenario. Several management practices are discussed within this framework, such as nest relocation, artificial incubation or head-starting, in order to increase the success of these nesting events and their value for long-term sea turtle conservation.

OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) NESTING MONITORING AND CONSERVATION AT PORTETE, NORTHERN ECUADOR: FOUR YEARS OF MONITORING AND PROTECTING NESTS

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Portete is a 3 km long beach located on a small coastal island surrounded by mangroves in northern Ecuador. Its mangroves are part of the "Refugio de Vida Silvestre Manglares Estuario del Rio Muisne" - a national protected area - and the island as well as the beach were virtually untouched by urban development, but this has changed over the last couple of years. This beach is of great importance for nesting olive ridleys (*Lepidochelys olivacea*), however, despite its remote location, nesting females and their nests face multiple threats due to the presence of dogs that run freely at night, the growing development of tourism in coastal Ecuador, and the erosion of nesting areas due to sea level rising caused by climate change. Before this study and the conservation efforts undertaken, there was very little information regarding sea turtle species nesting at this beach, numbers of nests, behavior of nesting females, nesting seasons, or hatching success. From previous data, we can convey that between 90 to 100 percent of the nests at this location were destroyed by dogs (that belong to the local community) every nesting season. For this study, we conducted daily and nightly patrols between March 2012 and October 2015 to define seasonality, species nesting and their nesting behavior, and measure hatching success. To counter the threats posed by dogs and rising sea levels, we developed several methodologies to protect nests, both in-situ: building protection fences around and over the nests, as well as ex-situ: moving the nests to safer zones or hatcheries. In almost four years we have identified year-round nesting activity with important peaks between June and December. We have so far identified two nesting species, with the most common being olive ridleys (*Lepidochelys olivacea*), and one register of a hawksbill sea turtle (*Eretmochelys imbricata*) nest. We have on average registered 80 nests per year and we have managed to protect between 50 and 60 percent of those from predation every year. We have so far built 5 hatcheries and have measured the hatching success of most nests, with a mean success

ratio of around 90%. All the project's activities have involved several members of the local population as part of an education and training program. Thanks to the nesting data collected in this project the Ministry of Environment of Ecuador is proposing the inclusion of this beach as part of the surrounding protected area. This study needs more time to gather significant data and the nest protection work has to continue until a definitive solution is found for the dogs present at the beach. Acknowledgments: The authors would like to thank the ISTS for providing a travel grant for one of the authors of this study.

EVALUATION OF NESTING PARAMETERS VS. NESTING SUCCESS OF LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*) IN NORTH PAM BEACH COUNT, FLORIDA

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Nest success in sea turtles is affected by many biological and physical parameters associated with the nesting site. In this study, we attempt to identify the physical nesting site parameters that affect the nesting success of leatherback sea turtles (*Dermochelys coriacea*) at north Palm Beach on Florida's east coast. We evaluated data collected from 2010 to 2013 during the nesting season that runs from late February/early March to late July/early August. The statistical analysis of the multi-year data set allows for the identification of the best nest location parameters for increased hatching success. The data was collected as part of the 'The Leatherback Project' in collaboration with Loggerhead Marinelife Center (LMC). This is the longest monitoring program for leatherback sea turtles in the United States and monitors the beaches at Juno and Jupiter/Carlin. For this time frame, 30.9% (764 nests) of the total Florida leatherback nesting population nested in Palm Beach County. Of this population, 13.3% nested on the beaches that we monitor (43.1% of the total nesting population in the county). Nesting success was measured as the total number of hatchlings able to leave the nest without human intervention. The nesting dimensions and location were evaluated as part of a model that also includes precipitation and air temperature. Exponentially weighted moving averages of precipitation, low temperature, and high temperature, were tested against percent hatched for highest correlation. We determined that the nest location with respect to the high-water line and the toe of dune, as well as the depth of the nest, are important parameters in determining the success of a nest (p < 0.001). In many cases, it is necessary to relocate nests that are laid too close to the water line or in areas in which it would not be feasible for the nest to survive. It is expected that this information on leatherback nesting success parameters will benefit conservation efforts and increase hatching success on relocated nests.

NESTING HABITAT DEGRADATION OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) IN CENTRAL COAST OF VENEZUELA: EIGHT YEARS ASSESSMENT

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All marine turtles present in Venezuela are endangered. Several threats affect their entire life cycle, especially in the nesting stages. Hence, improving our understanding of what, how, and where these impacts affect these populations is critical to mitigate them, in order to recover the natural level of the species. Since 2008, due to an evident deterioration which has been impacting the central coast of Venezuelan Caribbean, especially in the surrounding areas of the Petrochemical complex in Moron (Carabobo state), we monitored (by participant observation and beach patrol) the status of the marine turtle nesting populations which use this area as habitat nesting. Using monthly and diurnal patrols (by foot and/or by road quad bike). We evaluated 11 kilometres of coastline in one of the most impacted areas all year round. We recorded all nesting activity in the area, and evaluated reproductive success parameters. The threats and natural hazards were documented. Habitat loss was calculated using remote sensing. We found nests of four species of marine turtles: *Dermochelys coriacea*; *Eretmochelys imbricata*; *Caretta caretta*, and *Chelonia mydas*. Our findings show a notable decrease in nesting activity, from 42 nests/year in 2008, to 33 nests/year in 2013, and falling to only 17nests/year in 2014. All these, coupled with decreasing numbers in the nesting success, from a 97.6% to 53.1% for all the species. The leatherback turtle was the most affected species with the lowest nesting success (18.75%) reported in the area. We identified an increase in the effect of inundated nests with seawater, from 6.1% (2008) to 35.3% (2014) for all the species; moreover, 100% of leatherback turtle nests were eroded by tides. Thus, we found that the habitat availability was affected due to the convergence of changes in the nesting habitat. Loss of nesting habitat was registered from an average 76,702 m^2 (2009-2013) to 69,430 m^2 in 2014, increasing pollution density in the sand beach (from 0.09 km/m^2 to 0.18 km/m^2), and a relevant rise in the energy of the beach, which allows the impact of the wave washing from 2.40 meters (average, SD=0.36) in 2008-2013, to 3.45 meters in 2014. This research describes for first time the habitat loss in marine turtles on the central coast of Venezuela. We acknowledged the lack of baseline data, however it shows clearly the next steps towards marine turtle mitigation strategies in the area.

SEA TURTLE NESTING IN PERU*

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Sea turtle nesting in Peru is poorly known and it has recently start to be investigated. Because of the lack of information there are no management measures or regulations in place to protect nesting females, nests and beaches. This study aims to describe and characterize the nesting activity of two sea turtle species *Chelonia mydas* and *Lepidochelys olivacea* on the beaches of northern Peru and to evaluate the biological and other aspects related to the nests success of these two species. Nests events were classified as: false

crawls, nests and hatchlings. The following data was recorded for nests and false crawls: species, date, location, distance from the high tide line and distance from the vegetation. Nest depth and hatching success were recorded for nests. For hatchlings we recorded: species, date and location. In addition, all existing natural and anthropogenic threats as well as for females to nests and hatchlings were recorded. At the time of writing, 112 nesting events were recorded on the beaches of Piura and Tumbes. In 31 events, the species could not be identified, but for the rest, 75.3% belonged to *L. olivacea* and 24.7% to *C. mydas*. We identified two peaks in nesting: from August to December for *L. olivacea* and from January to March for *C. mydas*. The beach with the higher number of nesting events was Bravo (58), probably due to its vast size (13 km) and low human impact. Proper management of the beaches is required by the local and central government to protect nesting habitat in the Southeastern Pacific. Therefore, this project will provide important information for the government to propose management measures.

THE EFFECT OF NEST SIZE ON THE ECLOSION RATE AND ON THE INCUBATION PERIOD LENGTH OF OLIVE RIDLEY EGGS IN GUATEMALA

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The marine turtle *Lepidochelys olivacea* plays important roles in the biological, cultural, socioeconomic and economic levels worldwide. It is listed as a vulnerable species on the International Union for Conservation of Nature (IUCN) Red List due to a population decrease. On the Pacific coast of Guatemala, hatcheries are the most common conservation strategy for this species. Hatcheries are areas where sea turtle eggs are incubated and protected from predators and poachers. However, only a portion of the eggs that are buried in the hatchery manage to hatch. To create effective conservation programs, it is necessary to study the difference techniques in use in order to determine the optimal hatching success rate. The role that nest size (or density) plays on the hatching rate (HR) and on the length of the incubation period (IP) is still poorly understood. In the hatchery of Hawaii (Santa Rosa, Guatemala), we analyzed the effect of different nest sizes on the hatching success and the time elapsed between the burial of the nest and emergence of the hatchlings. To our knowledge, this is the first attempt in Guatemala to understand the effect of nest size on hatching rate and incubation period in *L. olivacea* and further research is necessary to support these results. Nest sizes of 40, 60, 80 and 100 eggs were analyzed. Each nest size had four replicates. In the time lapse of 20 days, 16 nests containing 1180 eggs were buried. After the emergence of the offspring, during nest exhumation, we calculated the HR by counting the number of empty eggshells, undeveloped eggs, partially developed eggs and the depredated eggs. The length of the IP was determined by calculating the number of days elapsed between the burial of the nest and the emergence of the first hatchling. The nests containing 60 eggs showed the highest average HR (95.4%). The nest sizes of 40, 60, 80 and 100 eggs showed an average IP of 48, 49, 50 and 50 days, respectively. From the analysis of variance (ANOVA) of the data, we obtained a p-value of 0.3343 and 0.8723 for HR and IP, respectively, which suggests that the nest size does not have any influence on the hatching rate or the incubation period of *L. olivacea* in Hawaii's hatchery. In Guatemalan hatcheries, different theories exist regarding the influence the nest size has on the hatching rate but no theory has been established by a scientific study before. This study helps in understanding whether it is necessary to establish a standard for the nest size in order to create an effective management protocol that can be followed in all the hatcheries on the Pacific coast of Guatemala. Acknowledgments: The author would like to thank the International Sea Turtle Symposium, Whitley Fund for Nature, Columbus Zoo and

Population Biology and Monitoring

SURVIVAL OF REINTRODUCED POST-NEONATES LOGGERHEADS USING SATELLITE MONITORING

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In recent years, sporadic nesting of loggerhead turtles (*Caretta caretta*) have been recorded on the Mediterranean coast of Spain, out of the known nesting range for the species in the Mediterranean. Several clutches of these nests have been relocated to protected beaches or to rehabilitation centers for artificial incubation. In those cases, hatchlings were kept in a head-starting program for a year to increase post-hatch survival and after this period they were released from the beach. However, post-hatchlings kept in captivity, when reintroduced to their natural habitats may suffer high mortality rates. This is especially true during the first weeks after the reintroduction. Therefore, there is a need to evaluate the survival of the released neonates and the viability of this management measure. Moreover, since post-hatchlings come from sporadic nesting out of the range, it is important to elucidate dispersal of these individuals to identify foraging and development areas used. In the present study, we tracked 8 post-hatchling loggerhead turtles from a nest laid in San Juan beach, Alicante, East Spain (38.37261°N-00.40932°W) in July 2014. Part of the clutch was relocated into a protected beach and part taken to the rehabilitation center ARCA del mar (Oceanogràfic de València, Spain). The eight loggerheads were tagged with small platform transmitting terminals (PTT, model SEATAG-TurtleTag, [Desert Star]) and tracked their movements using ARGOS. The PTT tag weights ranged 21-26 g. The weight of tracked animals ranged 490-970g. The tags are solar powered and do not have a duty cycle. We assessed survival at sea through the information from the tracks. Since there were days with no location data received we analyzed apparent daily survival using capture-recapture techniques based on the Cormack-Jolly-Seber model (software MARK 7.1). The survival estimates are apparent survival because we cannot separate mortality from tag detachment, therefore they must be considered as a minimum survival probability. The estimated daily probability of obtaining a message from the PTT assuming that the loggerhead was alive, was 0.85 ± 0.02. After one month, at least 5 of the loggerheads were alive (minimum survival rate of 62.5%). The estimated mean daily probability of survival was 0.986 ± 0.008 (95% Conf. Inter 0.95-0.99). Extrapolating these estimates, the monthly survival probability was 0.66 (range 0.62 – 0.87). We may conclude that the measure of rearing the neonates during one year was successful when considered it in terms of short term survival. These results will be useful to evaluate management of future possible loggerhead turtle nesting events.

WHAT ABOUT MALES? TWENTY YEARS MONITORING OF A FORAGING GREEN TURTLE POPULATION AT MAYOTTE ISLAND

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Photo-identification and conventional flipper-tagging methods, combined with underwater surveys, are used to obtain life history information on different age classes of green turtles in a foraging area at Mayotte Island, South West Indian Ocean. The tagging method is done using Monel and Titanium flipper tags, and the photo-identification method is based on the coding of left and right head profiles according to the position and shape of facial scutes. Since 1996, a photo-library has been created at the local scale. Since 2015 each photographed turtle was given a facial profile ID code and entered into the regional database (TORSOOI), either as a new individual or as a re-sighting. This process holds great potential to track turtles over time, and to estimate population sizes and residency times. More importantly, it allows one to reveal information about the ecology of males, for which knowledge is limited as unlike females, they rarely come ashore. Photo-identification is also an efficient tool to engage citizen scientists and to increase data collected and awareness about turtles. Today, our database compiles ~1,000 photographs and ~8,000 flipper tags return data over a twenty-year study period. The data analysis shows that green turtles display a high fidelity to their foraging area, especially for males, for which individuals could be tracked for up to 15 years. Such innovative information about the population structure and ecology of foraging green turtles is fundamental to identify the components required for the conservation of this vulnerable species.

A SPATIO-TEMPORAL EVALUATION OF SOMATIC GROWTH DYNAMICS OF WEST ATLANTIC HAWKSBILLS*

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Hawksbill sea turtles (*Eretmochelys imbricata*) are long-lived, major consumers in coral reef habitats that move over broad geographic areas. We assessed spatio-temporal effects on hawksbill growth dynamics (3541 growth increments) over 24 study sites throughout the West Atlantic during a 33-year period (1980-2013). We also explored relationships between growth dynamics and climate indices. We used generalized additive mixed model analyses to evaluate 10 covariates, including spatial and temporal variation, that could affect growth rates. Growth rates throughout the region responded similarly over space and time. The lack of a spatial effect or spatio-temporal interaction and the very strong temporal effect reveal that growth rates in West Atlantic hawksbills are likely driven by region-wide forces. Between 1997 and 2013, mean growth rates declined significantly and steadily. Regional climate indices have significant relationships with annual growth rates with 0- or 1-year lags: negative with Caribbean sea surface temperature and positive with the Multivariate El Niño Southern Oscillation Index. Declines in growth rates between 1997 and 2013 throughout the West Atlantic most likely resulted from warming waters through indirect negative effects on foraging resources of hawksbills.

FIESTA AT THE ROOKERY: UPWARD TREND IN THE HAWKSBILL NESTING POPULATION IN BARBADOS

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The nesting population of hawksbill turtles (*Eretmochelys imbricata*) on Barbados has been monitored since 1992 and survey data suggest that it is one of the largest rookeries in the Wider Caribbean. In the ten year period between 2006 and 2015, annual island-wide totals of females tagged increased by an average of 9.3% per year, but increased by 24.8% between 2006 and 2007 and by 60.5% between 2014 and 2015, to a total of more than 900 females by the middle of October 2015. The possible causes of the abrupt increase in numbers in 2007 and again in 2015 were assessed. Data from the index beach monitoring programme (saturation tagging from June 1-September 30 each year), were used to investigate whether the increases were more likely due to differences in annual survey effort island-wide or the alignment of females on different inter-nesting intervals coinciding. The overall trend of increasing numbers of hawksbills nesting in Barbados over the past few decades is discussed in relation to changes in fishing pressure on foraging grounds in the insular Caribbean, and possible climate-related decreases in average inter-nesting intervals and increasingly female-biased sex ratios.

GENETIC DIVERSITY OF LOGGERHEAD TURTLES (*CARETTA CARETTA*) STRANDED ON THE URUGUAYAN COAST; CONTRIBUTIONS TOWARDS THE CONSERVATION OF THE SPECIES IN THE SOUTHWESTERN ATLANTIC OCEAN

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As in other sea turtles, the life cycle of loggerheads (*Caretta caretta*) occurs between nesting beaches and feeding and development areas, exhibiting long generation times and large-scale migrations. Uruguayan waters are an important feeding and development area for this species, where individuals in the juvenile and subadult stages dominate. Turtles from various geographical origins converge in the area, forming a mixed stock dominated by hatchlings from Brazilian nesting colonies. In turn, the highest rates of turtle

bycatch by industrial fisheries in the Southwestern Atlantic Ocean (SWAO) have been recorded in Uruguayan waters; making this region a priority where conservation efforts on the species should be focused. In order to identify the geographical origin and dispersal patterns of the individuals present in Uruguayan waters, a sample of 65 loggerhead turtles that stranded along the Uruguayan coast between 2001 and 2011 was genetically characterized using –for the first time in Uruguay– an expanded 822 bp sequence control region (Dloop) of mitochondrial DNA. Most individuals were classified as juveniles or sub-adults (juveniles or sub-adults = 59%; adults = 15%; indeterminate = 26%). Seven haplotypes defined by 45 polimorphic sites (CC-A2.1; CC-A4.1; CC-A4.2; CC-A4.3; CC-A24.1; CC-A25.1; CC-P1.1) were identified, and the expanded sequence of haplotype CC-A25.1 –present in Brazilian nesting colonies– was characterized for the first time. Almost all individuals analyzed (n= 63) came from nesting colonies in Brazil; although other haplotypes like CC-A2.1 (Mediterranean Sea/South Africa) and CC-P1.1 (Australia) were found in low frequencies. In this sense, recruitment of individuals in Uruguayan waters seems to be largely influenced by marine current systems, where the warm Brazil current acts as a north to south migratory corridor for individuals born in the nearest nesting colonies located in Brazil. These results show the importance of the area for the sustainability of Brazilian populations, providing support for the designation of the SWAO as a Regional Management Unit (RMU). Likewise, the presence of haplotypes from distant origins shows the importance of the area for populations on a global scale, and demonstrates the need for conservation actions in the SWAO that consider the complex population dynamics of the species. In this context, a joint effort between Argentina, Brazil, and Uruguay is needed in order to advance in the design and implementation of a regional conservation plan for the species in the Southwestern Atlantic Ocean. The author would like to thank the Whitley Fund for Nature, the Columbus Zoo and Aquarium, the National Fisheries Society and the World Wildlife Fund, as well as the organizers of the International Sea Turtle Symposium for all the help I have received in order to attend this meeting.

LONG-TERM TRENDS IN LOGGERHEAD (*CARETTA CARETTA*) NESTING IN FLORIDA: REVERSAL OF THE POST-1998 DECLINE*

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Currently, the most reliable estimates of sea turtle population size and trends are obtained from long-term, standardized annual nest counts. The Northwest Atlantic Ocean (NWA) loggerhead population is divided into at least five subpopulations, and represents one of the two largest nesting assemblages of loggerheads in the world. Over the past two decades, large fluctuations in annual nest counts have been observed in the NWA loggerhead population and negative trends have been detected for all the subpopulations. Florida (USA) accounts for approximately 90% of the NWA nesting population and hosts at least four distinct subpopulations, making it of pivotal importance for the persistence of the NWA loggerhead population and the species as a whole. We analyzed a 27-year time series of Index Nesting Beach Survey (Index) nest count data to describe temporal trends in loggerheads nesting on Florida beaches. We updated the previous trend analysis of Florida Index nest count data by including nine additional years of data. We followed the same methodology which allows the calculation of an effort-adjusted nesting count. The Index data were highly

resolved: 368 fixed zones (329 km) were surveyed daily during annual 109-day survey seasons. Spatial and seasonal coverage averaged 68% of estimated total nesting by loggerheads in Florida. We carried out trend analysis on annual nest-count totals (N=27). The trend line was estimated by fitting a 4-knot restricted cubic spline curve (RSC) to the effort-adjusted counts via negative binomial regression. The detailed analysis of Florida's long-term loggerhead nesting data revealed three distinct annual trends. Following an increase between 1989 and 1998, nest counts declined sharply over nearly a decade (1999-2007). However, nest counts showed a strong increase from 2007 to 2015. Examining only the period between the high-count nesting season in 1998 and the most recent nesting season (2015), we found a slight but non-significant increase, indicating a reversal of the post-1998 decline. The overall change in counts from 1989 to 2015 was significantly positive. However, it should be noted that wide confidence intervals are associated with this complex data set. We explore possible reasons for the reversal of the decline in loggerheads nest counts. Monitoring trends in loggerhead turtle populations is critical to assessing population status and to developing and evaluating conservation strategies. Data used for the trend analysis were collected by thousands of individuals who have participated over the years in the Florida sea turtle nest monitoring program coordinated by the Florida Fish and Wildlife Research Institute.

DEFINING APPROPRIATE "UNITS TO CONSERVE" FOR SEA TURTLES: TOWARDS A METAPOPULATION PARADIGM*

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The focus of conservation genetics applications for sea turtles has been primarily to help identify population "units" to conserve and delineate geographic boundaries of those units. Evolutionarily Significant Units (ESU) and Distinct Population Segments (DPS) are broader units, generally shaped by processes on evolutionary timescales and global geographical scales and are relatively easy to detect with standard genetic markers, such as mtDNA. Finer scale structuring within ESUs or DPSs, often shaped by environmental or behavioral processes on ecological timescales, comprises groups of animals that are demographically independent. The level of connectivity among these smaller scale groups, typically defined as Management Units (MUs), or Demographically Independent Populations (DIPs), is important to characterizing the overall population structure and vulnerability to threats. Recent advances in genetic tools have improved the ability to detect genetic variation through use of longer mtDNA sequences, and increasingly larger arrays of informative nuclear markers (microsatellites and SNPs). Despite these advances, challenges remain to detecting low levels of differentiation that characterize DIPs, and failure to detect demographic independence when it exists may lead to inappropriate management policy. As a case study, I will review recent advances in population genetics for leatherback turtles that is a culmination of 25 years of research with extensive network of collaborators in order to illustrate the limitations to using current genetic approaches for identifying demographically independent groups. Understanding the processes that shape patterns of genetic variation and ultimately diversity for the species is fundamental to determining the species' ability to persist as local and global environmental conditions change. Recent insights into the demographic structure of leatherbacks in the western Pacific suggest that a metapopulation framework could be useful for understanding how this critically endangered species can respond to deep global threats such as climate change.

STOCK ORIGIN OF LEATHERBACK, LOGGERHEAD AND GREEN TURTLES FORAGING IN THE SOUTHEASTERN PACIFIC: INSIGHTS INTO THEIR TRANS-OCEANIC CONNECTIVITY

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Five species of marine turtles inhabit the waters off Chile and Peru in the southeastern Pacific. In particular, leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*) and green turtles (*Chelonia mydas*) use these waters as foraging grounds where they regularly face anthropogenic threats such as fishery interactions. Sea turtles are caught incidentally in commercial and artisanal longline and gillnet fisheries operating throughout the Pacific. This bycatch has created a growing concern for the recovery of sea turtle populations in this region, especially Eastern Pacific leatherback nesting populations. These have been severely depleted and have become an international conservation priority. Understanding habitat use and population structure can provide important insights to the trans-oceanic connectivity of these marine turtles for risk analysis and better species management. We used molecular genetic approaches to determine the nesting stock origin of leatherback, loggerhead and green turtles foraging off the coast of Peru and Chile in the southeastern Pacific. Tissue samples were analyzed from 74 leatherbacks, 117 loggerheads and 154 greens caught in longline and gillnet fisheries, as well as from stranded turtles along the coasts of Peru and Chile. DNA was isolated from each sample and ~800 base pairs of the mitochondrial control region were sequenced. The haplotype frequencies were compared with data from potential source populations to estimate the stock composition of the foraging aggregations using mixed stock analysis. Results indicate that approximately 12% of the leatherbacks analyzed originated from the western Pacific breeding stock, indicating that not all leatherbacks foraging in the southeastern Pacific are from the eastern Pacific breeding stock as previously assumed from satellite tracking studies. This study illustrates the importance of integrating genetic data with other studies and taking into account males, non-nesting females and juveniles that may also be using these foraging areas. Preliminary results indicate all of the green turtles we sampled are from Eastern Pacific nesting stocks, although other studies have found rare instances of green turtles from distant nesting populations at foraging grounds further north in Galapagos and Colombia. Loggerheads were from the Southwest Pacific breeding population (Australia and New Caledonia) and occurred in waters off southern Peru and northern Chile. These results have important fisheries management and conservation implications for these turtle populations across the Pacific.

FINE SCALE DEMOGRAPHIC STRUCTURE OF THE GABON LEATHERBACK NESTING POPULATION: INSIGHTS FROM NUCLEAR AND MtDNA GENETIC ANALYSIS*

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The majority of leatherback nesting in the eastern Atlantic occurs in Gabon, with several key nesting sites along the extensive coastline of this West African country. Nevertheless, this region has been inadequately represented in population genetic studies to date. We conducted a comprehensive genetic study using a combination of mtDNA and nuclear DNA (microsatellite) analysis of a total of 529 samples collected from female nesters on primary nesting sites representing the three main nesting regions in Gabon; Mayumba (n=281) in the south, Pongara (n=211) in the north, and Gamba/Loango (n=37) in the middle. We sequenced 763bp of the mtDNA control region and genotyped each sample with an array of 17 microsatellite loci in order to conduct fine-scale population structure analysis. Our analysis identified 9 different mtDNA haplotypes based on 763bp sequences, including 3 new variants of Dc1, and 2 variants of Dc3, both common haplotypes in all Caribbean as well as African rookeries, but previously indistinguishable based on the shorter 496bp haplotypes. We also found one nester in Pongara with Dc9.1, a haplotype previously only observed in the Western and Indo-Pacific nesting populations. Stock structure analysis based on mtDNA haplotype frequencies found that the Pongara nesting population was significantly differentiated from Mayumba (FST = 0.009, p<0.05) are required to reliably detect relatively weak stock structure that characterizes fine scale differentiation (FST0.05) with our microsatellite data. Given the results of the power analysis for our genetic markers, we conclude that the statistical power of the pairwise comparisons between Pongara and Mayumba nesting populations are reliable; the results suggest that these two populations are demographically differentiated in terms of female (mtDNA) lineages, and indicate that natal homing by nesters is sufficient to shape this structure. In contrast, the lack of differentiation based on our microsatellite data indicates high degree of nDNA connectivity, most likely due to ongoing male-mediated gene flow. Power analysis of our microsatellite markers indicated that our assay would have reliably detected very low levels of genetic differentiation (FST+ FST analogs = 0.001), if they had existed. Although there has been speculation of ongoing connectivity between the eastern Caribbean (Guianas) and the large nesting populations in Gabon, our results refute this and demonstrate that these regional populations have been demographically isolated for thousands of years, based on the divergence of unique haplotypes that have arisen in both regions, and the levels of population differentiation of our nuclear markers. We discuss the conservation implications of our study given that concerns over the threat of rapid

decline of local nesting populations in Gabon may lead to fragmentation of the leatherback population currently thought to be the largest in the world.

GREEN TURTLES NESTING ON THE MAIN HAWAIIAN ISLANDS; INSIGHTS FROM GENETIC RELATEDNESS ANALYSIS

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Within the Hawaiian archipelago, green turtle nesting has occurred mainly at French Frigate Shoals (FFS) in the northwestern Hawaiian Islands. However, an increase in occasional nesting has recently been observed on the main Hawaiian Islands (MHI). Monitoring the nesting activity on the MHI has been limited to nest documentation because of logistical constraints, and without systematic tagging of the nesting females it is not clear how many are nesting there. We used mitochondrial (mt) DNA sequencing combined and nuclear (n) DNA analysis based on 14 microsatellite markers to infer the number of individual nesters. Genotypes were determined for 384 dead embryos and hatchlings salvaged from 146 nests laid on Maui, Molokai, Kauai, Lanai, and Oahu, along with those of 81 nesting females that were sampled on FFS, 14 captive adults currently residing at SeaLife Park (SLP) and ~350 hatchlings that we born and released from SLP since 2003. MtDNA results showed that 62% of the MHI clutches were laid by females with a relatively rare haplotype only reported in 16% of the FFS nesting population. Nuclear DNA results indicate that the nests in the MHI are from a relatively small number of females that appear to be related to each other. We were able to reconstruct genotypes for nesting females from hatchling profiles and we estimate that 25 different females were responsible for clutches laid on the MHI. Taken together, results from the mtDNA and nDNA suggest that the nesting population at the MHI may be the result of a few founders that originated from FFS, possibly facilitated by captive rearing and release of FFS juveniles locally from Oahu. We suggest that this regional range expansion may buffer against the loss of current nesting sites at FFS due to sea level rise. Our results show the potential for genetic tools to be incorporated into population assessment, particularly in areas where access to reproductive females is difficult and population size is unknown.

IMPROVING IN-WATER ESTIMATES OF TURTLE ABUNDANCE BY ADJUSTING AERIAL SURVEY COUNTS FOR BIASES*

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Aerial surveys are often used to estimate wildlife abundance. The probability of detecting an animal during a survey involves two processes: (1) availability bias when animals present in the search area are not available for detection and (2) perception bias, when some animals potentially visible to observers are missed. Estimating these two sources of bias can lead to improved abundance estimates. However, to date, no marine turtle aerial survey has quantified both biases. To improve in-water marine turtle abundance estimates from aerial counts we estimated: (1) perception bias using independent tandem observers and mark recapture models, and (2) availability bias by quantifying the effect of turtle diving behavior and environmental conditions on the detection probability of turtles. We compared unadjusted and adjusted abundance estimates to evaluate the effects of these detection biases in aerial surveys. Adjusted data produced a substantially higher estimate of turtles than the unadjusted data. Adjusting for availability bias increased the estimates 18.7 times; adjusting for perception bias resulted in a further 5% increase. These results emphasize the need to consider availability and perception corrections to obtain robust abundance estimates. This approach has application for aerial surveys for other marine wildlife including marine mammals and large sharks.

MALE PHILOPATRY IN GREEN TURTLES OF THE CARIBBEAN AND WESTERN ATLANTIC*

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Animal behavior and population structure are fundamental fields within ecology, evolution, and conservation. Natal homing in female green turtles has been the focus of much research, and is known to limit gene flow and increase demographic isolation among rookeries. However, the extent of this behavior in males, which occupy cryptic marine habitats and are usually aquatic, is less understood than in more accessible nesting females. This study offers a rare opportunity to investigate male philopatry, and its influence on population differentiation and susceptibility to local threats. We studied two groups of males from mating grounds near nesting beaches in the Caribbean and Western Atlantic: one in Aves Island (AVm), Venezuela (n = 87), and another in Rocas Atoll (RAm), Brazil (n = 30). To establish haplotype frequencies at nesting beaches across the region, we obtained new sequences from females from Aves Island (AVf) (n = 225), Rocas Atoll (RAf) (n = 19) and a rookery in Aruba (n = 16), and combined these with previously published data from nesting females or eggs throughout the Atlantic Ocean / Mediterranean Sea. With new mtDNA control region sequence data (~800bp) we conducted global and paired differentiation tests, as well as analysis of molecular variance. Additionally, mark-recapture data for males from Aves Island were used for comparative analyses. We found that Aves Island males and females shared three identical haplotypes at similar frequencies, while Rocas Atoll males had eight haplotypes and shared only two with females from the same location. However, fixation indexes revealed significant and similar genetic structuring between males from Aves Island and Rocas Atoll (FST (AVm-RAm) = 0.60), as well as, females from these sites (FST (AVf-RAf) = 0.71), and males and females were not significantly different at either site (FST (AVm-AVf) = 0.00), and FST (RAm-RAf) = 0.01), although this may have been due to small sample sizes at RA. Capture and recapture data indicated that males consistently returned to Aves Island mating grounds every year or two to reproduce. Our results suggest that, like females, males of Aves Island and perhaps Rocas Atoll are philopatric, supporting findings of the only other study of this kind in Australia. These data are important for understanding demographic independence among populations, and hence their vulnerability to extinction.

A NEW METHODOLOGY TO ANALYZE THE INTERANNUAL SPATIO-TEMPORAL DATA FOR NEST NUMBERS TAKING INTO ACCOUNT MISSING OR PARTIAL INFORMATION*

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Counting nests or tracks is a common methodology tool to assess the trend for a population of marine turtles. It is cheaper than capture-mark-recapture methodology and complementary. Recent statistical tools allow production of annual estimates with good precision based on as few as 20% monitored nights. However, the aggregation of several beaches with different survey effort into a single model is challenging. In some regions, marine turtles from a single population can use hundreds of beaches and the complete view for the trend must include all the available information. Furthermore, data for some beaches may be completely absent due to logistic or financial difficulties. I will show how to aggregate such heterogeneous data (presence of data with different quality of estimates or complete absence of data) into a single framework to: 1/ Produce a regional trend, 2/ Describe the temporal change of relative use of different beaches within the region, and 3/ Delimit rookeries based on common temporal trend for nest numbers. The statistical tools used are non-linear fitting of conditional multinomial models using a Bayesian framework or maximum likelihood. The model will be applied to several situations in South America and Africa to demonstrate its power. It is already freely available within the R package "phenology." It could be applied to any segment of a population, for example, for in-water surveys.

ADULT LOGGERHEAD (*CARETTA CARETTA*) AND GREEN TURTLE (*CHELONIA MYDAS*) CAPTURES AT TWO GEOGRAPHICALLY DISTINCT HABITATS IN FLORIDA: NEARSHORE WATERS OF HUTCHINSON ISLAND AND THE FLORIDA KEYS

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The Florida Power & Light St. Lucie Power Plant is located on South Hutchinson Island, Florida. Since 1976, when power generation first began, data has been collected from over 16,000 sea turtles captured in the plant's intake cooling canal system. Morphometric data were taken from each turtle before it was tagged and released, and compiled into a database that has been maintained since the plant went on-line. From 1988 to present, capture data of adult loggerhead (*Caretta caretta*) and green turtles (*Chelonia mydas*) at the plant intake canal were compared to capture data from a long-term monitoring project beginning in 2002 in the Key West National Wildlife Refuge, which encompasses foraging grounds for adult loggerhead and green sea turtles. Of particular interest was the comparison of males captured at both study sites, as adult males are rarely encountered in research projects. Data were analyzed to examine sex ratios, seasonality of occurrence, recapture rates, morphometric trends, tag recovery information, and injuries and

abnormalities. These long-term monitoring projects continue to provide insight into the population structure of turtles utilizing the near-shore waters adjacent to the St. Lucie power plant and foraging grounds in the Key West National Wildlife Refuge.

MARINE TURTLE ABUNDANCE AND DEMOGRAPHICS IN AN IMPORTANT FORAGING GROUND IN FLORIDA*

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Using in-water surveys to study marine turtle populations is a valuable way to identify critical foraging grounds and understand species recovery. We used vessel-based surveys and rodeo methods to estimate turtle abundance and quantify demographics in the Key West National Wildlife Refuge, which prior to its protective status, had been an area where turtles were commercially exploited. Over a ten-year period from 2003 – 2012, we recorded 1,954 marine turtle observations including 1,087 green turtles (*Chelonia mydas*), 789 loggerheads (*Caretta caretta*), 65 hawksbills (*Eretmochelys imbricata*), 1 Kemp's ridley (*Lepidochelys kempii*) and 12 unidentified to species. Sighting data were analyzed using the program DISTANCE and described by a probability of detection model containing a hazard-rate key function with a cosine series expansion. The effective strip width (ESW) on either side of the vessel was 9.1 m with an estimated density for all species and areas of 46.4 turtles/km^2. Marine turtle densities were significantly clumped within three hotspots: the eastern Quicksands, Mooney Harbor and the Barracouta – Archer Keys; the latter two areas where located in shallow, protected basins in the lee of mangrove islands. A multi-factor analysis revealed that sea state had the largest influence on our ability to sight turtles. The mean straight carapace length (SCL) was 74.2 cm for captured loggerheads (n=393), 54.3 cm for captured green turtles (n= 201) and 46.7 cm for captured hawksbills (n = 28). Green turtles constituted a larger range of size classes and exhibited significant partitioning associated with water depth; sub-adult and adult turtles were found in deeper water (> 3 m) and juveniles in shallower water (< 3 m). Recaptured turtles were found an average of < 1 km from their initial capture location, which indicated a high degree of site fidelity. The proportion of green turtles with the tumor bearing disease fibropapillomatosis (FP) was relatively low (6%) compared to foraging grounds in other parts of Florida where the FP rate is often ≥ 50%, however, propeller strike injuries were common and these were found mostly on loggerheads. The green turtle diet was largely made up of *Thalassia testudinum* (62%), but also included a smaller percentage of other seagrasses and red algae. This study successfully combined vessel-based surveys with capture methodology to describe multiple size classes in what may be one of the most important marine turtle foraging grounds in the wider Caribbean.

GROWTH RATES OF GREEN SEA TURTLES (*CHELONIA MYDAS*) IN PUNTA ABREOJOS, BAJA CALIFORNIA SUR, MEXICO

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Green sea turtles (*Chelonia mydas*) are subject to a number of anthropogenic threats including illegal hunting and incidental fisheries bycatch. These threats are particularly prevalent in coastal foraging areas, such as the coastal waters of Baja California, Mexico in the eastern Pacific Ocean, which are essential to the growth and development of juvenile turtles. In order to better understand how anthropogenic threats might impact sea turtle populations, we must first understand green turtle demographic parameters such as growth rates. Few studies have examined growth rate of turtles in the eastern Pacific, though this information is necessary to obtain metrics such as age at maturity, model and monitor population trends, and develop effective management strategies for conservation. The objective of this study was to use sea turtle mark-recapture data collected as part of a bycatch reduction technique study from 2006-2014 to calculate growth rates for green turtles in Punta Abreojos, Baja California Sur, Mexico. Turtles were captured with monofilament gill nets 1.5m in depth with stretched diagonal mesh from 16.5 to 20cm. Nets ranged in length from 90 to 100m. Once captured, turtles were tagged on both rear flippers using Inconel metal tags, measured for various body size parameters, and released at their capture site. Body size parameters included straight carapace length, straight carapace width, curved carapace length, curved carapace width, and body depth. Of the 730 turtles captured, 64 were recaptured at least once. Intervals between recaptures ranged from one day to approximately five years, and only turtles with a recapture interval of over 11 months were used for growth rate calculations. Recaptured turtles ranged from 26.6 - 91.4 cm straight carapace length. Growth rate was calculated and compared to growth rates obtained for green sea turtles in previous studies from the Eastern Pacific and Caribbean. The results of this study contribute to the overall growth rate data for Eastern Pacific green turtle populations, and can be used to gain valuable insights on population status and develop management strategies for the future.

DEFINING BOUNDARIES OF GREEN TURTLES ACROSS THE PACIFIC USING MTDNA AND OCEAN MODELLING*

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Across large parts of the Pacific Ocean, green sea turtles (*Chelonia mydas*) have received less research and monitoring compared to other regions (e.g. the Caribbean). Many populations in the Pacific are relatively small and their distribution is scattered across hundreds of remote atolls and Islands. Studies of mitochondrial DNA (mtDNA) stock structure of more than 36 green turtle rookeries across the Pacific have

shown that most rookeries separated by >500 km are genetically distinct, and mtDNA has been used to define conservation units on various scales (e.g. Management Units (MU), Regional Management Units (RMU) and Distinct Population Segments (DPS)). In addition to identifying stock structure of nesting populations, the use of mtDNA also provides an effective tool for tracing back the stock origin of turtle sampled away from the nesting beach (e.g. foraging areas or fisheries by-catch). Recently, several studies have determined the connectivity of turtles at individual foraging areas to regional rookeries providing information about the boundaries needed for effective management of this endangered species. However, these studies are often limited to studying one or a few regional foraging grounds and do not consider the broad implications on the meta-population as a whole. Here we present the most comprehensive assessment of connectivity in Pacific green turtles. We reanalyze data from 30 feeding grounds and 36 rookeries across the Pacific Ocean in combination with ocean particle drift modelling to show that green turtles display complex patterns of connectivity within regions (DPS, RMU) but limited connectivity across broader regions. These patterns can be largely explained by a combination of distance and rookery size but most importantly ocean currents. The combined use of genetic data and particle drift modelling provide an efficient alternative to traditional tagging and satellite tracking. This approach improves our understanding of stock boundaries and the connectivity between nesting grounds and foraging areas across the Pacific Ocean. The results from this study are important to efficient management of marine turtles and may help better assess the impact that anthropogenic mortality on feeding grounds has on regional rookeries.

ASSESSING THE IMPACTS OF CHANGING GROWTH RATES ON FORAGING GROUND RESIDENCE TIMES FOR JUVENILE GREEN TURTLES (*CHELONIA MYDAS*)

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The green sea turtle (*Chelonia mydas*) has a complex life history with multiple ontogenetic shifts. Once hatchlings emerge from their natal beaches, they race offshore and eventually reach pelagic waters, finding habitat in Sargassum patches. Years later, green turtles in the Northwest Atlantic recruit to distinct coastal areas, forming multiple foraging populations. Here they feed mostly on available algae and sea grass. Juveniles utilize a network of foraging habitats until they reach maturity and recruit to their adult foraging habitat. Time spent at coastal foraging grounds as juveniles provides a key period of growth for green turtles. However, growth rates within a particular foraging ground could shift over time due to changes in food availability, population size, or other environmental factors. Changing growth rates could affect the residence times of turtles at their juvenile foraging grounds, but this relationship has yet to be studied. We formed two hypotheses for the effect of changing growth rates on turtle residence time. The null hypothesis predicts that growth rate does not affect residence time, with slower growing turtles leaving the foraging ground at a smaller size and vice versa. The alternate hypothesis is that growth rate does affect residence time, and slower growing turtles will stay at the foraging ground longer, until they reach the size at which turtles historically leave. To test these hypotheses, we investigated the temporal relationships between growth rates and residence times at two juvenile foraging habitats on the east central coast of Florida, USA. These locations included the central Indian River Lagoon (IRL) and the Trident Submarine Turning Basin at Cape Canaveral Air Force Station (Trident). Long-term mark and recapture data sets exist for both sites (32 years and 22 years, respectively). Previous research showed that long-term somatic growth rates are increasing in the IRL, but declining at Trident, making these sites ideal to test our hypotheses. With nesting

populations of green turtles in the Atlantic on the road to recovery, the dynamics of central Florida foraging grounds may change as juvenile populations increase. Maintaining a network of suitable juvenile foraging habitat is critical for the continued recovery of green turtle populations. Results from this study will provide insight into how marine turtle populations will adjust to changing growth rates at juvenile foraging grounds. This information can be used to make conservation decisions regarding the protection of juvenile foraging habitat.

DENSITY AND POPULATION ESTIMATES FOR HAWKSBILL AND GREEN SEA TURTLES AT TINIAN AND PAGAN ISLANDS, COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

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A preliminary assessment of sea turtles and their nearshore habitats was conducted in July 2013 at Tinian and Pagan Islands, Commonwealth of the Northern Mariana Islands. This survey included the first population assessment at remote and uninhabited Pagan Island, and the first complete assessment of Tinian Island since 2001. Sea turtle demographics remain poorly understood throughout the Mariana Archipelago, and this survey represents a substantial effort towards a greater understanding in this region. Over a 23-day period, we conducted towboard, cliffline, vessel platform, and swim transect surveys across 76% of Tinian's and 72% of Pagan's coastlines, including employing multiple survey methods in areas of particular interest. Based on our observations, sea turtle densities were similar across much of Pagan, while densities along Tinian's coast varied substantially. Sea turtle densities on Tinian appear highest along the northeast, southeast, and southwest, with high density pockets of turtles in sheltered waters of the western coast (e.g., Dumpcoke, Turtle Cove). Hawksbill turtles generally constitute a minor fraction of the sea turtle population relative to green turtles in the Central and Western Pacific, including populations in the Southern Arc Islands of the Marianas Archipelago. Hawksbill turtles were rarely observed on Tinian, but appear to constitute one-third of the turtle population on Pagan. Juvenile turtles constituted the majority age class at both islands. While this survey occurred during the peak nesting season, only 3% of the observations were of adult turtles. These results are being compared to previous unpublished data sets and past published studies to identify any changes in the local population of turtles on these islands.

USING NEXT GENERATION SEQUENCING FOR GENOTYPING AND EVALUATING POPULATION STRUCTURE IN MARINE TURTLES*

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Advances in next generation sequencing (NGS) technologies have rapidly expanded the genetic tools available to investigate evolutionary and ecological questions in non-model species. However, determining and adapting the 'best' NGS approach to address conservation questions in species of concern often remains a major hurdle, especially for species with limited genomic and funding resources. In particular, high-throughput approaches that consistently amplify the same loci and can be repeated in new samples over time at low cost are often needed to meet conservation genomics research goals. We combined multiplexed capture array (targeted loci enrichment) and NGS to discover single nucleotide polymorphisms (SNPs) and conduct genotyping by sequencing (GBS) in green (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*). We compared GBS to SNP determination by Ampliflour SNP genotyping (a previously validated method employing quantitative PCR) in green and hawksbill turtles. To maximize the utility of these new platforms, we also tested the ability of a hawksbill-specific array to be used for capture enrichment in a closely related species, the loggerhead turtle (*Caretta caretta*). Finally, we use a subset of identified candidate SNPs to examine preliminary population structure in Pacific hawksbills as a case study to demonstrate the utility of this new set of nuclear markers. Our approach discovered over 300-900 potential SNPs depending on species, and determined that GBS generally performed as effectively as Ampliflour genotyping when applied using best practices. We were able to perform GBS for a subset of newly identified SNPs on average of 41.6%-68.4% of multiplexed individuals (depending on species), indicating that multiplexing has great potential to make this approach economically feasible for conducting GBS on large sample sets, but needs to be further optimized to reduce high variability in coverage. Loggerhead turtle samples hybridized effectively to the hawksbill capture array to conduct SNP discovery, however, only a small number of SNPs were common to both species. Analysis of 32 SNPs in Pacific hawksbills revealed evidence of population structure, indicating that many of the discovered SNPs can be used as informative genetic markers when applied to larger sample sizes. Our approach capitalizes on NGS advances to produce cost-effective, repeated sequencing of large numbers of loci and samples, providing high throughput genomic tools for application in species of conservation concern.

QUANTIFYING PROMISCUITY TO IDENTIFY MATING SEX RATIOS

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Describing key life history traits is critical to understanding production and recovery of threatened or endangered organisms. Marine turtles are often challenging to access and their mating behavior cannot be

directly observed. It is only nesting females that are relatively easy to observe during nesting season, but reproductive males remain cryptic from a demographic perspective. Sex ratios, population size and relatedness of individuals are important metrics of population status. Typically, adult sex ratios differ from those estimated for hatchlings. Adult sex ratios are primarily estimated through census counts of nesting females. This method leaves the number of adult males to be enigmatic. Alternative assessment techniques include using molecular markers to identify parentage of individuals as well as fundamental relationships among males and females within a population. From the perspective of addressing failure in adequate production, successful male and female breeding numbers are important. Male counts can be estimated using exclusion analysis (by comparing maternal genotypes to offspring genotypes). We are increasing the accuracy of current adult sex ratio estimates in Florida to add to our understanding of effective population size. We compare the successful breeding sex ratios (the number of males and females contributing to a population) for three species of sea turtles nesting in Florida to (i) characterize mating behavior, (ii) assess diversity in two growing populations and (iii) refine understanding of management units beyond nest counts.

NATAL-HOMING PRECISION AND AGE TO MATURITY IN CARIBBEAN HAWKSBILL TURTLES

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Hawksbill sea turtle (*Eretmochelys imbricata*) populations have declined by more than 80% in the last century, leaving remnant populations scattered throughout the world's tropical and subtropical oceans. Chronically small effective population sizes and the inbreeding depression that can ensue leave these fragmented populations less equipped to adapt and further endangered with extinction. Despite considerable efforts focused on marine turtle biology, many details remain unknown about their life history patterns, breeding behavior and fine-scale population structure. Natal-homing is a well-established behavior for marine turtles, yet the precision of homing behavior remains unclear. Similarly, age at maturity has been estimated by analyzing growth rates, but no empirical evidence exists for this fundamental life history trait due to the difficulty of tagging hatchlings and tracking them during their early years. The long-term mark-recapture program at Jumby Bay (JB), Antigua, presents a unique opportunity to investigate fine-scale population structure in a stable nesting aggregation of hawksbills. The primary objective of this study is to evaluate the relatedness of hawksbills nesting at JB using polymorphic microsatellite markers. We anticipate significant fine-scale structure (i.e. first order relationships such as mother-offspring, full-sibling and half-sibling pairs) within the nesting aggregation due to the high degree of inter-annual nest-site fidelity exhibited at JB based on tag returns. By combining microsatellite data with maternally-inherited mitochondrial DNA and individual mark-recapture histories, we estimate mother-daughter pairs and assess (1) the likelihood of natal homing to JB's nesting beach and (2) the maximum age to maturity of JB hawksbills. Results indicate high levels of relatedness at JB, natal-homing to a kilometer-long nesting site and age to maturity as short as 15 years. Future directions will also be presented, including the use of a

genetic network analysis to better characterize and visualize the genetic associations within the nesting population. The network analysis will incorporate individual characteristics, such as nesting experience or extent of nest-site fidelity, with these genetic associations. In addition to shedding light on natal-homing at a fine scale, this study will provide information on levels of inbreeding and recruitment rates in this remnant nesting aggregation – necessary to better understand the ability of fragmented populations to recover from a recent bottleneck event and to inform comprehensive management strategies.

ASSESSING POPULATIONS OF MARINE TURTLES, REEF SHARKS, MANTA RAYS AND CETACEANS USING FIVE DECADES OF AERIAL SURVEYS FROM MICRONESIA*

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Long-term data are critical for assessing the status, trends, abundance, and distributions of wildlife populations. However, such data streams are often lacking for protected species, especially highly mobile marine vertebrates. This is particularly true for the insular Pacific, making it important to explore datasets in which marine megafauna were surveyed incidental to a primary objective (e.g. quantifying fishing effort). We present a case study in which we used unique long-term monitoring data to assess megafauna populations on the insular coral reef ecosystem of Guam (Marianas Archipelago in Micronesia). These data were collected on semimonthly aerial surveys conducted by the Guam government over five decades. The surveys were initiated to quantify inshore fishing effort, but the collection of megafauna sightings data was an important byproduct from the start. The data allowed estimates of relative abundance, trends, and geographic distributions for several important taxa: marine turtles (green and hawksbill), reef sharks, manta rays, small delphinids, and large delphinids. These surveys occurred in 32 years from 1963-2012 amounting to 632 flights lasting 809 hours over a 70.16 km^2 area. Over this span, surveyors recorded 10,622 turtles, 1,026 sharks, 60 manta rays, 7,515 small delphinids, and 95 large delphinids. Since the 1960s, turtles increased an order of magnitude (r = 0.07) and sharks decreased five-fold (r = -0.03). Turtle increases were largely restricted to one geographical area (a marine protected area established in 1997), and shark observations declined proximate to human population centers. Trends for the other taxa were less informative, but each taxon had geographic foci. These results are consistent with ease of human access to shoreline reefs, as inaccessible coasts typically had higher densities of the above five taxa and heavily fished areas had lower densities. The observed increase in turtles (the majority of which are green turtles) provides important conservation information for this data deficient region. The recent global green turtle status review under the U.S. Endangered Species Act placed Guam within the Central West Pacific distinct population segment (DPS). This DPS is proposed to be listed as endangered due to low nesting abundance and various threats facing green turtles in this region. It is difficult to attribute the increase in Guam to a particular cause, as the population consists primarily of juveniles from distant rookeries, but local conservation efforts likely play a role. Future efforts to resolve the spatial population structure and origin

of turtles in Guam will help explain the observed increase. Long-term analyses of vulnerable marine megafauna in this data-limited region are uncommon, and should be used to guide more focused studies that inform management.

FIVE YEARS OF MONITORING THE NESTING AND IN-WATER POPULATION OF BLACK SEA TURTLES (*CHELONIA MYDAS*) AT LA PLATA ISLAND, MACHALILLA NATIONAL PARK WITH THE FIRST EVIDENCE OF CONNECTIVITY WITH THE GALAPAGOS ISLANDS

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Coastal Ecuador is an important nesting and foraging area for sea turtles, however there is little information regarding the status of the populations, both at the nesting grounds and in the water. In Machalilla National Park, along the central coast, there is evidence of important sea turtle populations for several species. Specifically, La Plata Island, a coastal island inside the national park, is an interesting aggregation site for green/black sea turtles (*Chelonia mydas*). Here they gather to feed and nest on the available beaches – Bahia Drake and Playa Grande. Between 2008 and 2013 we have collected information on this population from individuals in-water by capturing, tagging and collecting morphometric data, and also from nesting females. Before this study, there was no information regarding the status of black sea turtles in-water, their nesting behavior or their migratory routes. During this time period, we managed to tag, measure and identify 360 individuals in-water and we also repeatedly recaptured several of them. As for nesting females, we managed to tag 81 individuals and count between 20 and 40 nests each year. In 2015, the first evidence of connectivity between La Plata Island and the Galapagos Islands was recorded as a female that was originally tagged in Bahía Drake, in the continental island, by Equilibrio Azul, was recaptured nesting at Quinta Playa beach in Isabela Island, Galapagos. This preliminary study presents the results of a limited amount of time; the study needs to be continued in order for statistical significance. However, due to decisions of the directorate of the National Park, our work has been interrupted indefinitely here. With these results, we highlight the importance of the work achieved and we urge the continuation of data gathering in order to provide the authorities with critical information on the conservation of this endangered species. We hope to learn more about this population, as much is still unknown.

SEA TURTLE NESTING IN CUBA: RESULTS FROM THE "ARCHIPIELAGOS DEL SUR" PROJECT (2010-2014)*

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Of the seven sea turtle species that exist in the world, three regularly nest in Cuba: the green turtle (*Chelonia mydas*), loggerhead (*Caretta caretta*) and hawksbill (*Eretmochelys imbricata*). The primary sea turtle nesting beaches are found along the southern coast of the Cuban archipelago. Even though some of these sites have been monitored for more than a decade, it was the implementation of the project entitled "Application of a regional focus in the management of coastal marine protected areas in the southern archipelago of Cuba" (Archipélagos del Sur), that contributed to the consolidation and standardization of monitoring activities from 2010 – 2014. This coordinated monitoring program facilitated an increase in the understanding of the nesting status of sea turtle species in Cuba. Principal nesting sites for each species have been identified as: Cayo Largo (green turtle), Cayos de San Felipe (loggerhead) and Jardines de la Reina (hawksbill). From systematic monitoring conducted during this five-year period, it was possible to determine that green turtle nesting was the most abundant of any species in the entire archipelago. Nesting success was also highest for green turtles, followed by loggerheads and then hawksbills. The findings from this project have been indispensable in establishing conservation and management initiatives for sea turtles throughout the Cuban archipelago. This work will present a summary of the results of the "Archipelagos del Sur" program from 2010 – 2014. Acknowledgments: The authors would like to thank the generous support of the Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria, the World Wildlife Fund and the International Sea Turtle Symposium Travel Grant Committee.

A NEW LOOK AT AVERAGE: THE POTENTIAL IMPACT OF EXCEPTIONAL GROWTH RATES IN ACHIEVING LARGE SIZES FOR SEA TURTLES

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The population of Hawaiian green sea turtles (*Chelonia mydas*) has steadily increased since its protection under the Endangered Species Act of 1978. However, a more complete understanding of the state of recovery of Hawaiian green turtles is stymied by lack of certainty regarding age structure of the population. Based on the observed slow growth rates of juveniles, current assessments place age to maturity in Hawaiian green sea turtles at 35-40 years. However, it is possible that dynamics such as growth spurts associated with

the maturation process have been missed. Studies such as skeletochronology provide data on growth rates and maturity of marine turtles, but analysis determining growth spurts has never been completed. Growth spurts occurred throughout the life span of Hawaiian green turtles, but peak lower for males between 50-60 cm than at 70-80 cm in the females, and it indicates that relying on mean annual growth rates may overestimate age to maturity.

LONG-TERM MONITORING OF IMMATURE GREEN TURTLE FORAGING AGGREGATIONS AT PUERTO RICO: POPULATION DYNAMICS AND IMPACTS OF FIBROPAPILLOMATOSIS*

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Understanding conservation needs relies on the assessment of key population parameters, such as survival, abundance and somatic growth. Neritic bays are important developmental habitats for green turtles, where their resident behaviour allows for long-term capture−mark−recapture (CMR) programs to generate data for the robust estimation of these parameters. At the Culebra archipelago, east of the main island of Puerto Rico, two foraging aggregations of immature green turtles have been monitored since 1997: at Puerto Manglar and Tortuga Bay. From 18 years of in-water surveys we compiled the CMR history profiles of 361 individuals through 764 captures. Recaptures ranged from 1 to 7 times, and the longest period of residency recorded was 10 years. Fibropapillomatosis (FP), a neoplastic disease of marine turtles, was first observed in 2000 and 2005, at Puerto Manglar and Tortuga Bay, respectively, and has persisted since. Here we present results on population demography studies, trends and FP dynamics. A Cormack-Jolly-Seber (CJS) model showed no difference in survival probability among sites. There were, however, significant differences between size-classes, juveniles having higher survival probability (0.83, 95%CI = 0.79 to 0.87) than subadults (0.53, 95%CI = 0.39 to 0.67). Mean somatic growth rate was site-specific, and we found a high growth rate for green turtles in the wild (6.1 ± 1.7 cm.yr^{-1}, at Puerto Manglar). Minimum ages at maturity of 14 and 22 years were inferred for Puerto Manglar and Tortuga Bay, respectively. Annual abundance was estimated using the recapture probabilities of the CJS model and we detected a positive trend at Puerto Manglar (mean annual increase of 11%), not observed at Tortuga Bay. This long-term study has further enabled us to monitor FP prevalence and record transitions between health states within individuals, i.e. healthy to FP, FP to recovered. There was a spatiotemporal variation in FP prevalence, potentially modulated via individual site-fidelity. Disease expression was residency-dependent, and FP-free individuals were observed to develop tumours after 1.8 ± 0.8 years (mean ± SD) in the infected area. Disease recovery was likely, with complete tumour regression occurring in 2.7 ± 0.7 years. At neither site were annual survival or somatic growth rates significantly affected by FP. We have estimated population parameters valuable for local and regional assessments of the conservation status of the green turtle, and established important baselines, critical to assess future impacts and adaptation capacity. Our work highlights the importance of Tortuga Bay and Puerto Manglar for green turtles and the need to protect these habitats, as current pressure for development may jeopardize their existence. We interpret the low apparent survival estimated for the subadults as a likely consequence of their permanent emigration to other foraging

sites, suggested both by previous studies and tag returns from distant areas in the wider Caribbean. Juveniles are resident, and their survival rate can be a reference value for viability analysis. Our study captured the influence of geography and habitat quality on somatic growth rates. Importantly, we predicted an earlier than expected age-at-maturity. Lastly, whereas the scarcity of robust long-term data on disease prevalence has limited interpretations of impacts on wild populations, we were able to assess the direct impact of a FP pandemic on population parameters.

ESTIMATING SURVIVAL AND ENCOUNTER RATES AT A HIGH DENSITY LOGGERHEAD NESTING BEACH

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Flipper and PIT tagging are common marking techniques for female sea turtles observed on the nesting beach. When implemented consistently over time, these tagging efforts result in valuable capture-mark-recapture datasets that allow us to estimate population parameters including annual survival and population size through statistical modeling. These modeling techniques are especially valuable for high density nesting beaches, where the probability of seeing each individual turtle is low and saturation tagging is impossible. For this study, we analyzed tagging records from the Archie Carr National Wildlife Refuge (ACNWR) on the east coast of Florida. The ACNWR is one of the highest density loggerhead (*Caretta caretta*) nesting beaches in the world, with 550 nests per kilometer in 2015. Using the statistical software package Program MARK, we estimated population parameters for the Brevard County, Florida, portion of the ACNWR using a multi-state open robust design model. We focused on the most recently available five-year period of tagging data for ACNWR loggerheads, from 2010-2014. This period included 3,225 turtle encounters and 2,709 unique tag combinations representing individual female loggerheads. One turtle was observed six times total (in 2010 and 2013), the highest documented recapture rate in this dataset. Two turtles were observed five times, one of those spread across 2010, 2012, and 2014 and the other in 2012 and 2014. A majority of the tagged loggerheads (2,292 of 2,709) were observed only once over the five-year period. Our results suggest a single survival estimate over the five-year dataset and a probability of encounter, and thus recapture, varying both throughout the season and among years. More broadly, our results demonstrate the importance of long-term tagging programs, even on beaches where saturation tagging is impossible. These high density nesting beaches are often centers for research and reference points for regional populations, and capture-mark-recapture techniques are essential for identifying and analyzing population trends to evaluate conservation efforts.

THE LEATHERBACK TURTLE IN COLOMBIA: DISTRIBUTION, USE, THREATS, AND FUTURE RESEARCH AND CONSERVATION

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The leatherback turtle, *Dermochelys coriacea*, is one of five sea turtle species to occur in Colombia. Globally it is classified as Vulnerable by the IUCN, and in the next Red Book of Reptiles of Colombia, it will be classified nationally as Endangered. The leatherback is found along both Colombian coasts, but primarily in the Caribbean. There, the nesting season begins in February and extends until July, with two peaks in April and May. In the Pacific, nesting activity is scarce; leatherbacks are mainly sighted by artisanal fishermen in this region. Although the leatherback is widely distributed in the Colombian Caribbean, most nesting activity is concentrated in the Gulf of Uraba in western Colombian (near the Panama border). The leatherback turtle rookery that exists in the Gulf of Uraba produces approximately 2800 nests each year. This rookery is part of a regional population that is in decline in the western Caribbean coast of Central America, including Costa Rica, Panama and Colombia. Even so, the leatherback is the most abundant sea turtle in the Colombian Caribbean and also is the most studied. However, leatherbacks there face severe threats. There is a small but demonstrable by-catch of leatherbacks, with local fishermen accidentally killing 5–20 individuals per year: Throughout the Caribbean coastal area, eggs and adults also are harvested for consumption or to extract oil. Existing environmental legislation protecting the species should be enforced, management plans congruent with the life history of the species should be developed, and environmental education efforts designed to heighten awareness in local communities should be continued. There is an urgent need to develop measures to protect adults, especially nesting females, and nests in the Colombian Caribbean, and to conduct research and monitoring using standardized protocols of all nesting beaches, to quantify the number of females nesting each year, movement patterns, survival rates, sex ratios, and inter-nesting behavior. Genetic studies of leatherback colonies in Panama, Colombia, and Venezuela are also needed to identify management units and refine ongoing conservation actions with a regional focus.

GENETIC FINGERPRINTING REVEALS NATAL ORIGINS AND DISPERSAL OF MALE LEATHERBACKS ENCOUNTERED IN THE ATLANTIC OCEAN AND MEDITERRANEAN SEA

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Information on the population dynamics of sea turtles tend to be biased toward female individuals due to their accessibility for study on nesting beaches. Males are encountered only at sea; there is little information about their migratory routes, residence areas, foraging zones, and population boundaries. In particular, male leatherbacks (*Dermochelys coriacea*) are quite elusive; little is known about adult and juvenile male distribution or behavior. The at-sea distribution of male turtles from different nesting populations is not known. Here we assigned 112 captured or stranded male leatherback turtles from the USA, Turkey, France and Canada to one of nine Atlantic-basin populations using genetic microsatellite assignment. We found that all turtles originated from western Atlantic nesting beaches. Most male leatherbacks assigned with high probability to Trinidad or French Guiana. Costa Rica was also identified as a source of males. Although there were other nesting populations including St. Croix (Northern Caribbean), Costa Rica and Florida in the western Atlantic, no turtles assigned there. Additionally, none were assigned to South Africa, West Africa, or Brazil. Remarkably, one stranded turtle from Turkey assigned to French Guiana, while another that stranded in the Bay of Biscay, France, was from the Trinidad breeding population. For some leatherbacks in our dataset, genetic natal origins from the assignment tests were compared to satellite and flipper tag information to provide evidence of natal homing for male leatherbacks. This work represents the first time that adult male leatherbacks have been assigned to breeding populations using genetics and this method should provide a guideline for future studies, with the ultimate goal of improving management and conservation strategies for threatened and endangered species by taking the male component of the breeding population into account.

TEMPERATURE-DEPENDENT SEX DETERMINATION CONFERS RESILIENCE TO HIGH TEMPERATURES BUT EFFECTIVENESS IS OVERRUN BY CLIMATE CHANGE*

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All sea turtle species have temperature-dependent sex determination (TSD) by which females are produced at high temperatures and male hatchlings at low temperatures. High temperatures also increase mortality of eggs and hatchlings. We explored the relationship between early mortality and sex ratios and simulated the effects of increasing temperatures on the viability of a population of leatherback turtles (*Dermochelys coriacea*). Then, we compared the results to those of a virtual population with similar characteristics but with fixed sex ratios, as if it had genotypic sex determination (GSD). TSD populations were more resilient to increased nest temperatures than simulated GSD populations. Temperature in the TSD populations increased production of female offspring and future fecundity, which compensated for the increased mortality of early stages and buffered the negative effect of high temperature on the population growth rate (λs). However, TSD was only effective over a range of temperatures and populations declined as temperatures surpassed the TSD-effective limit of the population. The leatherback population is projected to decline under all current scenarios of climate change and may become extirpated in ~50 years due to climate change alone, under the high gas concentration scenario.

ASSESSING THE EFFECTS OF SITE FIDELITY ON CLUTCH FREQUENCY ESTIMATION THROUGH SUBPOPULATION-SCALE GENETIC CAPTURE-RECAPTURE OF LOGGERHEAD TURTLES*

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Population monitoring for marine turtles is often limited to assessing trends in nest counts, but reproductive data on individual turtles are required to better assess the population dynamics underlying these nesting trends. For some species and populations, nest site fidelity may be low relative to the scale of tagging effort at individual nesting beaches, resulting in sparse recapture data and potentially biased reproductive parameter estimates. Genetic tagging via egg sampling offers an alternative approach of identifying individuals that alleviates the requirement of physically intercepting females on the nesting beach. Through cooperation of federal and state projects, researchers, and volunteer groups, we have collected a single egg from each loggerhead clutch detected on the Atlantic coast beaches of the southeastern USA north of Florida, effectively encompassing the nesting range of the Northern Recovery Unit (NRU) subpopulation. Approximately 20,000 clutches from the 2010 – 2012 nesting seasons were assigned to 5,688 females. Nest site fidelity (NSF) was measured as beach extent (BE), the distance between the northernmost and southernmost clutches per female, as well as the mean distance between successive clutches (DBC). To assess NSF in a finer scale, spatially explicit context, we assigned females to 50 km latitudinal bins based on their median nesting latitude. Results indicated considerable variation in NSF among individuals as well as across the study area. Several females deposited four or more clutches on less than one km of beach within a season, whereas the lowest site fidelity females had BEs in excess of 600 km. Mean BE was 33.4 ($\pm$ 74.6) km and mean DBC was 22.1 ($\pm$ 29.9) km. At the 50 km bin scale, mean BE ranged from 12.3 ($\pm$ 23.8) to 157.0 ($\pm$ 213.0) km, and mean DBC varied from 6.8 ($\pm$ 10.8) to 122.9 ($\pm$ 30.6) km. NSF was significantly weaker for females nesting in North Carolina and Virginia relative to those nesting in Georgia and South Carolina. This pattern was apparently driven by a larger proportion of low site fidelity females in the northern portions of the nesting range, consistent with retention of a higher frequency of "straying" behavior in more recently colonized nesting beaches. Analysis of females nesting on the tagging beaches of Wassaw Island and Jekyll Island, Georgia indicated that approximately 50% of females distributed some nesting effort off island, and that of these, approximately 80% did not return to their initial nesting beach over the remainder of each nesting season. Observed clutch frequencies from flipper-tag only observations were downward biased by 26% to 49% relative to those from genetic capture-recapture data for the same individuals. Clutch frequencies estimated using an open robust design modeling approach were less biased, but were still 16% to 38% lower for flipper-tag only data compared to the genetic capture-recapture data.

This bias indicates that the "permanent" emigration present at the scale of individual tagging beaches cannot be fully accounted for through standard modeling, and that regional approaches that consider the scale of NSF are critical for generating robust parameter estimates.

JUVENILE GREEN TURTLE (*CHELONIA MYDAS*) SURVIVAL RATES AT TRIDENT BASIN, FL, USA

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Demographic parameters are difficult to obtain for many animal populations, often due to unknown migratory behavior or difficulty in capturing or locating a species. Determining these parameters for long-lived and highly migratory marine species is even more challenging, as researchers, rarely have the opportunity to monitor individuals over extended time periods. Capture-mark-recapture (CMR) programs have been shown to be effective for understanding population dynamics. In marine turtle research, a majority of CMR studies are conducted on nesting beaches, not only due to the importance of such data but also because of the convenience of data collection. These studies provide estimates from a life stage when survival rates are generally high and less variable than lesser-studied juvenile turtles. Any changes in juvenile mortality would occur decades before trends could be detected in a reproductive population. Aiming to understand aspects of coastal ecology, density, and survival rates of juvenile turtles, the UCF Marine Turtle Research Group (MTRG) has conducted a CMR study since 1993 at the Trident Submarine Turning Basin at Cape Canaveral Air Force Station, Florida, USA. The Trident Basin is a man-made embayment with shallow, calm water and rock riprap around the edges. Algal growth on the rocks provides an unusual feeding ground for juvenile green turtles (*Chelonia mydas*). The MTRG monitors and samples the Basin's green turtle populations twice annually via tangle nets and dipnets. Between 1993 and 2014, we captured 834 individual juvenile green turtles 1,692 times. Using a combination of Jolly-Seber and Cormack-Jolly-Seber models, we estimated survival, capture probability, population size, and the number of new individuals entering the population during the study period. Results from this analysis will provide a better understanding of juvenile green turtle population dynamics and rates of juvenile recruitment to reproductive populations. While a majority of current research efforts focus on adult females, adequate demographic parameters for juveniles are needed to build more robust endangered species assessments and guide management for population recovery. Acknowledgments: This project was supported in part by the US Army Corps of Engineers, the US Air Force and US Fish and Wildlife Service. Many thanks are due to L. M. Ehrhart, W. E. Redfoot, D. A. Bagley, and the many students and staff of the UCF Marine Turtle Research Group. This study was conducted in accordance with NMFS Permit 14506-03, and Florida Marine Turtle Permit 186.

IN-WATER SEA TURTLE DENSITY AND ABUNDANCE ESTIMATES AT GLOVER'S REEF ATOLL, BELIZE*

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The decline of marine turtle populations in the Caribbean has led to intensive recovery efforts. In Belizean waters, highly endangered hawksbill turtles (*Eretmochelys imbricata*) are seemingly making a comeback. At Glover's Reef Atoll, estimates of abundance and trends over time were obtained to inform conservation management and to assess the importance of this site for sea turtles in the regional context. This is the first study known to utilize distance sampling techniques during in-water surveys of sea turtles. We used this method to estimate absolute density and abundance from 2009 to 2013 for hawksbill turtles, as well as for the less frequently encountered green and loggerhead turtles. In addition, capture-recapture information collected during in-water surveys was combined with hawksbill turtle counts using a mark-resight analysis under a robust design to provide another source of abundance estimates for hawksbills from 2007-2011 at Glover's Reef. Our results indicate that the fore-reef habitat at Glover's Reef, where sampling efforts were focused, supports a large aggregation of juvenile hawksbill turtles and an order of magnitude fewer green and loggerhead turtles. The results of the two estimation methods (distance sampling and mark-resight analyses) were highly congruent and indicate the existence of a healthy population of juvenile hawksbill turtles in Belize. Furthermore, survival probability estimates for hawksbills were also high, suggesting low human-induced and natural mortality at this site, and highlighting the importance of this area for hawksbill populations in Belize and the Caribbean region.

PHYLOGEOGRAPHY OF LEATHERBACKS AND GREENS IN THE SOUTH ATLANTIC USING THOUSANDS OF NUCLEAR LOCI

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Mitochondrial DNA is by far the most popular genetic marker for population structure in studies of sea turtles. Due to rapid evolutionary rate and the biology of sea turtles (e.g. phylopatry), it can easily

distinguish between close nesting sites, and therefore mixed-stock analyses can be performed for rookeries. On the other hand, nuclear loci usually do not show any population structure, either due to male gene flow and/or slow evolutionary rate. Here we propose the use of thousands of SNPs derived from RAD (Restriction site associated DNA) loci as a complementary tool to mitochondrial sequences. We compare the genomic divergence among species and the usefulness of these markers for phylogeography in sea turtles.

DETERMINING SEASONAL AND ANNUAL VARIATION IN ADULT AND SUBADULT GREEN TURTLE ABUNDANCE USING STANDARDIZED TRANSECTS ON THE EASTERN QUICKSAND FORAGING GROUNDS, FLORIDA, USA*

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Surveys of green turtles (*Chelonia mydas*) in Florida are typically classified into one of two demographic patterns: in-water studies of juveniles, found year-round in neritic habitats; and nesting beach studies of reproductively active females. The focus on these populations limits studies to a small segment of this species life history. While information from this work has provided a great deal of information on these life history stages, there is still a large portion of the subadult and adult life stages that remains understudied. Locations of foraging areas for these size classes were not known in the southeastern United States until their discovery by Inwater Research Group in 2004. Located in an area known as the Eastern Quicksands, these foraging areas are located approximately 37 kilometers (km) west of Key West, Florida. This area is characterized by seagrass pastures interspersed with large patches of sand devoid of bottom structure in 3-6 meters of water. A set of standardized transects has since been placed over these foraging areas along six predetermined lines oriented east-west. Each line is six km long and is situated one km from adjacent transect lines. This grid encompasses areas where numerous adult and subadult green turtles have been encountered during previous non-standardized visual transects. Surveys along the transect grid are conducted via boat with two observers atop a two-meter elevated central tower, while a helmsman marks sightings with a Garmin Global Positioning System. Green turtles observed during these surveys are identified to life stage, while distance from the transect line and the animals position in the water column are noted. Environmental factors such as depth and water temperature are also recorded. These transects have been run 14 times in the last 12 years, covering both seasonal and annual changes in abundance. From these surveys 1033 green turtles have been spotted (531 subadults, 502 adults). Preliminary results from these surveys have shown that two particular transect lines consistently hold significantly higher ($p < .005$) numbers of both adult and subadult green turtles when compared to the other four transect lines. The software Program Distance was utilized to determine if environmental factors such as cloud cover, depth, water visibility and sea state affected detectability of individuals during these transects and, in turn, biased results. Abundances can then be corrected based on these sighting conditions. While abundance appears to fluctuate both annually and seasonally, areas of highest abundance do not vary in location. This suggests that there is a core area roughly one quarter of the size of the survey grid where greater than 50% of sightings occur. Since these high-density areas appear to remain static both seasonally and annually, the installation

of an acoustic array surrounding these areas may provide further information on residency times and fine scale movements of green turtles on these foraging grounds.

MORPHOLOGICAL AND GENETIC VARIATION IN HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) POPULATIONS AROUND THE WORLD*

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We analyze the morphological and genetic variability within and between populations of *Eretmochelys imbricata* from throughout its range using landmark-based geometric morphometric and mitochondrial DNA control region, with particular emphasis on the Eastern Pacific hawksbill. The landmark-based analyses were conducted on three views (dorsal, ventral and lateral) from the skull of 119 museum specimens from different populations and the molecular analyses were conducted using genebank sequences. Molecular analysis based on 40 haplotypes of 740 base pairs revealed two significantly different haplotype groups, corresponding to the Atlantic and Indo-Pacific basins, while the populations within each group kept a moderate gene flow. This differentiation pattern was supported by analysis of the skull shape from three views of the skull, where it was found that the variation is concentrated in the front, corresponding to the nasal region. This phylogeographic pattern seems to be related to different nesting and foraging behavior and may be due to factors such as short-range migrations, habitat characteristics of each population and even cycles or geological and climatic changes. These results can be a useful tool in conservation programs for this species.

Social, Economic and Cultural studies

HOW ENDANGERED ARE ENDANGERED SPECIES? PERCEPTIONS OF EGYPTIAN FISHERMEN ON CONSERVATION OF MEGAFAUNA SPECIES IN THE MEDITERRANEAN SEA*

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Global and regional assessments, like the IUCN Red List, are meant to establish the risk of extinction of marine species like turtles, dolphins and sharks based on population trends and threats to their survival. Species that are considered at risk are then the subject of conservation management practices promoted at

national, regional or international level. However, the way researchers and other resource users like fishermen perceive 'endangered' species can vary substantially. Understanding how fishermen perceive endangered species is essential to implement more effective conservation practices. This pilot project aimed at evaluating how fishermen perceived their role in marine conservation, specifically in relation to marine turtles, dolphins and sharks. Semi-structured surveys were conducted at three harbors used by artisanal fishermen in Alexandria and Port Said, Egypt. The surveys included agreements to statements and open-ended questions. For agreement to statements, we used a 4-point Likert scale (1=Strongly disagree to 4=Strongly agree). Interviewees were approached randomly, and were given a little briefing about the survey before being asked if they wanted to take part in the study. Sixty-two fishermen were interviewed. Fishermen noted a change over time in the abundance of species like sharks (n=62, 2.05±0.90) and turtles (n=62, 1.79±0.75), with older fishermen more strongly confirming the negative trend for marine turtles (Q2 = 2.76 - 0.02*Age; p=0.0036). Fishermen were conscious that certain practices have a negative impact on marine life (e.g. overfishing and catching small sized animals), and that they have a primary role in preserving marine resources (n=62, 3.65±0.58). While fishermen were aware that sea turtles are endangered, illegal fishing still occurred and not just occasionally (n=60; 1.78±0.85). While the role of sharks as apex predators is well understood (n=41, 2.61±1.09), the importance of marine turtles for healthy ecosystems was not clear and conflicts were reported with turtles destroying or damaging fishing nets (n=59; 2.88±1.05). This type of conflict had been reported also in other areas of the Mediterranean, with loggerhead turtles notoriously destroying crab traps. Sharks on the other hand were not seen as negatively affecting catches or believed dangerous (n=59, 1.90±1.12), however older fishermen tended to disagree with the statement (n=59, Q17 = 0.61+ 0.03*Age, p=0.0114). Qualitative analysis of open-ended questions revealed that most people have consumed turtle and shark meat, however drinking turtle blood is not a common practice as it is forbidden by Islam. Although protected, turtles are still caught directly or as lucky by-catch and are sold in the market: green turtles are preferred over loggerheads for their better taste and represent approx. 63% of the total catch of marine turtles reported by the interviewed fishermen. While further research is needed to better understand how fishermen interact and perceive their resources, this pilot study showed that targeted awareness programs highlighting the role of marine turtles for healthy seas, and trying to reduce turtle-fishermen conflicts could contribute to reduce substantially the killing of turtles. Acknowledgments: Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesquería y World Wildlife Fund and the International Sea Turtle Symposium for their travel grant.

A LIFELONG RELATIONSHIP WITH HAWAIIAN AND FRENCH POLYNESIAN GREEN TURTLES, 1963-2016

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The story of green turtles being restored in the Hawaiian Islands during recent years has been heralded in several scientific and popular publications, but perhaps most eloquently in "The Book of Honu" and on the Turtle Trax web page authored by Peter Bennett and Ursula Keuper-Bennett. Less known to most are the past and present complexities of the green turtles of French Polynesia, where they are also called honu. The bond between the native peoples and honu of the far-flung islands of French Polynesia continues to be deep-rooted, diverse, and intense, likely as previously existed in Hawaii, and may happen again, as the honu population of Hawaii proceeds ever upward and the tumor disease continues in decline. My relationship

with green turtles began in French Polynesia in 1963 and evolved, through a series of lucky events, into a 43-year endeavor focused in the Hawaiian Archipelago. In 1963, my wife Linda and I sold our few possessions, emptied our small bank account, and left California to experience life in the South Seas among the people of Tahiti. Our journey there included a week in Hawaii before flying to the newly-opened jet airport near Papeete. Through the kindness of strangers, for seven months we subsisted in the then-outlier District of Paea in Tahiti. Visa limitations eventually returned us to California on a cargo ship via Nuku Hiva in the Marquesas and Panama. A few months later, we were back in Hawaii building a life, family, and careers that endure to the present. I saw my first sea turtle in Tahiti, a juvenile honu that would have been dinner if not for my poor aim as a spear fisher. Later, walking the shoreline of Bora Bora with Linda, I saw my second sea turtle kept as a pet in a pen on the reef flat. I regularly still dream about French Polynesian people, islands, and turtles, as the natives still dream at night when an ancestor tells them where a turtle can be caught the next day on the reef. Since leaving in 1964 I've returned to French Polynesia on six short trips, five by invitation to assist with sea turtle studies, and once with Linda for a brief stop on a cruise vacation to Sydney. The most memorable visit was in 1991 to remote Manuae (Scilly Atoll) to work with Rene Tuputu and family, Rene being one of the most knowledgeable turtle hunters of the region. My most recent visit was in October 2010 as part of the "First International Symposium on Sea Turtles in French Polynesia" where Rene Tuputu and I met again after 20 years. There is great potential for traditional ties with the honu to persist, on a sustainable basis, among the people of French Polynesia. The status of the stocks and the sustainability of the harvest need to be examined within the cultural context of island communities. I am committed to playing a role in aiding both the honu and the people in their interwoven relationships.

HAKUNA MATATA AND AYAAWATAA AA'U WAYA: INDIGENOUS TRADITIONS AND BELIEFS TOWARDS MARINE TURTLES*

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Marine turtles (MT) and human communities have maintained a relationship for centuries. This relationship is evident on all of the continents, as shown by archaeological evidence and current discoveries. Although MT are now protected by international treaties, the remains of these reptiles are still commonly found in fishermen's houses or local garbage dumps, especially in developing countries. The use of MT represents a complex scenario that is influenced by the legal framework, economic level, and local idiosyncrasies of these regions. In some cases, their use is also related to ancestral traditions and beliefs. Several authors

describe the traditions and beliefs of Indigenous people with regards to MT in different countries, but there is still a lack of information for several locations. Therefore, this research aims to improve our understanding of the traditions and beliefs related to MT within these countries. We used multiple sources (participant observation, peer reviewed articles, and open-ended interviews) to investigate the general perspectives towards MT of the Wayuu people in Venezuela and the Ndowe (Kombe and Benga tribes) people in Equatorial Guinea. Using NVivo10 software, we analysed both content and theme, as well as evaluated nodes in the gathered information using open-ended questionnaires. Indigenous knowledge regarding MT is regarded very highly in both Venezuela and Equatorial Guinea. It includes the relationships between MT, natural elements (sun, moon phases, stars, and marine ecosystems) and environmental conditions (tides, rain, winds, thunder, and lightning). The MT also play a key role in the transference of ancient wisdom among generations. Similar magical-religious beliefs, ancient rituals, and traditional ceremonies related to MT were found in both countries. The perception of turtles as divine animals, including the belief that extinction of these species is not plausible as they are seen as gifts from God and/or the universe, is shared among the two countries. There is also great mysticism –including the perspective towards natural elements– that relates to MT in both Wayuu and Ndowe cultures. Additionally, respondents clearly described the value of marine turtles for human health, as well as the use of its products in the ancient pharmacopeia. We also identified some differences in the perspectives between cultures. For Ndowe people the MT is a significant resource of food, but it is not the most important animal for their culture. In contrast, Wayuu people consider it to be the most vital animal within their traditional and current livelihoods. This difference is evident when we compare the traditional annihilation rites of turtles which were described by the interviewees. The geographical environment also has an impact on each culture's perspectives, where the Wayuu's oral stories are described with MT, but the Ndowe people have stories and beliefs related to marine and forest elements. Through this study we undertook a first step to understand the relationships between these ancient cultures and MT. These relationships are complex and strong, and have shaped, on different levels, their livelihoods throughout generations. Hence, it is recommended that future management strategies to protect these species in both areas must include the human dimensions of the Indigenous stakeholders, to guarantee the encouragement and identification of the local communities with the conservation initiatives.

SOCIO-ECONOMIC INSIGHTS OF MARINE TURTLE CONSERVATION STATUS WORLDWIDE

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The history of human settlements worldwide has been related with coastal environments since ancient times. In many of these areas marine turtles used to be abundant. However, the effect of the exploitation of marine resources by human societies has impacted the status of these reptiles in many areas. Currently, marine turtles are still widely distributed in the tropical and sub-tropical regions of the planet, but their relationship with humans varies greatly. Social and economic differences among the countries and regions

are palpable in marine turtle conservation and management strategies. The aim of this research was to assess how the effect of the economic level of regions and countries has impacted the conservation status of marine turtle populations among regions. We used the Regional Management Units (RMU) framework provided by previous authors, and overlapped the Combined Economy Index (CEI) which integrates the Economy level by country (Developed: 3, Emerging: 2, Developing: 1, and Least Developed: 0), provided by the United Nations database, with the Human Development Index (Very high: 3, High: 2, Medium: 1, and Low: 0), provided by the World Bank database. CEI values are ranged from 0 to 6, where higher values infer better capacity for implementation of conservation initiatives. Median values by RMU were calculated. We mapped all the information in layers using ArcMap 10.2 in order to evaluate the regional status of marine turtle populations in relation to the economic situation of the region by RMU. Then we focused our findings in the world's 11 most endangered RMUs. Critical levels of CEI (median values were smaller than 3) were calculated for four of the evaluated RMUs: two in the Indian Ocean basin, specifically within the Indian sub-continent, and two in the western region of the Africa (Atlantic Ocean basin). Of these critical CEI RMUs, our results show that *Eretmochelys imbricata* and *Caretta caretta* were the most affected species, thus RMU codes are (lowest to higher): "Ei_rmu11"; "Cc_rmu23"; "Ei_rmu16"; "Cc_rmu32". Further research is needed to improve our assessment; however, it is a step towards a better understanding of a socio-economic aspect which may impact the conservation status of marine turtles.

SOCIAL PERCEPTION OF BLACK TURTLE (*CHELONIA AGASSIZII*) CONSERVATION ACTIVITIES IN COLOLA BEACH, MICHOACAN, MEXICO

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This study evaluates the perception and social participation of the indigenous coastal community of Colola, in the state of Michoacan, Mexico, on conservation activities of the black turtle (*Chelonia agassizii*) conducted at the beach. To assess social perception a questionnaire with 12 questions was conducted with 50 residents of Colola. Participants were selected through stratified random sampling by age, and placed into one of three age categories; 'child' 9-15 years, 'youth' 16-25 years or 'adult' 30-60 years. The interviews were analyzed interpretively based on answers to each of the 12 questions. It was found that the social perception of the inhabitants of the town of Colola towards the activities of black turtle conservation is favorable. They consider that the conservation activities have improved and increased the number of nesting females significantly in recent years due to the participation of people from the community (mostly children) and biologists from the University of Michoacan. Villagers recognize that conservation activities have had a direct or indirect benefit to residents with paid temporary jobs, increased tourism activity and changes in the way people relate to the marine turtle resource.

THE ECONOMIC VALUE OF SEA TURTLES TO SCUBA DIVERS IN TOBAGO*

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Sea turtle nesting tours are a viable eco-tourism product in Trinidad and Tobago and around the world, from which considerable economic benefits are derived. Sea turtles also add value to SCUBA dives which is more difficult to quantify as they are one of many attributes which add value to a composite good. The value of sea turtles to recreational SCUBA divers (non-consumptive use) was estimated using a choice experiment (CE) administered to 172 scuba divers in Tobago. We used a CE model design with five attributes of particular importance to divers and local environmental policy, each with four levels of condition that reflected actual observed levels in Tobago. Respondents were asked to make choices between bundles of dive attributes. The willingness to substitute for other attribute levels and price was used as a measure of value or willingness-to-pay (WTP) for the chosen attribute level. Turtle encounters were the most important attribute in the CE model, and mean WTP was >US$62 per two tank dive for the first turtle encounter. The results highlight the significant non-consumptive use value of sea turtles encountered during SCUBA dives, and can be used as a tool to communicate with and convince the public and policy makers of the importance of supporting the conservation of sea turtles in Tobago, including the foraging aggregations resident on near-shore habitat. Acknowledgments: Funds to support field research for this study were provided by the Government of the Republic of Trinidad and Tobago Research Development Fund and the US National Fish and Wildlife Foundation. A travel grant to participate in this meeting was provided by the Campus Research and Publication Fund, The University of the West Indies, St. Augustine.

FINANCIAL SUSTAINABILITY OF A COMMUNITY-DRIVEN SEA TURTLE CONSERVATION PROJECT AT REKAWA TURTLE SANCTUARY, SRI LANKA

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Turtle Conservation Project (TCP), Sri Lanka

The green turtle, leatherback, olive ridley, loggerhead and hawksbill turtles all nest on Sri Lankan beaches. Rekawa village is located on the Southern coast of Sri Lanka where all five species known to nest in Sri Lanka occur on a four kilometre stretch of beach. The fishing community of Rekawa harvested all turtle eggs until the Turtle Conservation Project (TCP) initiated its pioneering community-based in-situ nest protection programme in September 1996. The programme employed former turtle egg poachers as nest protectors and carried out scientific research to understand the turtle population at Rekawa. This programme was interrupted by the 2004 tsunami but recovered well. As an alternative livelihood to turtle egg collection, TCP introduced the "Turtle Night Watch" nature tourism programme and trained the local nest protectors as tour guides. A community-based organisation was formed, consisting of the Rekawa turtle nest protectors and it was named 'Nature Friends of Rekawa' (NFR). Rekawa beach was officially declared as a 'Sea Turtle

Sanctuary' by the Department of Wildlife Conservation in May 2006. This was a direct result of TCP's conservation efforts and campaigns. In 2012, the programme was handed over to the NFR and they were invited to run the programme as a community-driven project with the assistance of TCP and the Department of Wildlife Conservation. Currently the members of the NFR conduct beach patrols to protect sea turtle nests in-situ and tourists pay to participate in the Turtle Night Watch programme. They pay 1000 Sri Lankan Rupees per person (139 LKR = 1US $) if they see a turtle. Eighteen NFR members patrol the beach 24 hours a day in a shift rotation and conduct tourist activities at night. Two NFR members were recruited as permanent tour guides. TCP allows the members of the NFR to use its turtle information centre at Rekawa for their tourism project. During the period of 20th June 2013 to 30th April 2015 a total of 16,800 tourists participated in the Rekawa Turtle Night Watch programme. Of these, 2030 visitors were not charged as they did not see a turtle. 14,770 tourists saw turtles and paid the fee, generating 14,770,000 Rupees (US $ 106,258). These funds were used to pay the salaries of nest protectors. In addition, 10% of the income was allocated to the wildlife officers working at the sanctuary. Furthermore, NFR allocated money from their tourism income to repaint the Rekawa temple and also supported some community events. The Rekawa community-based turtle conservation project has finally reached financial sustainability after 16 years (1996-2012), as a direct result of TCP's dedicated efforts.

ASSESSING THE KNOWLEDGE AND PERCEPTIONS OF BAHAMIANS CONCERNING SEA TURTLES AND THEIR CONSERVATION*

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The shallow banks environment of The Bahamas is an important foraging ground for juvenile and sub-adult individuals of four of the seven species of sea turtle. Green, loggerhead, hawksbill, and leatherback sea turtles frequent coastal habitats such as tidal mangrove creeks, seagrass beds, and coral reefs throughout the archipelago. Mating and nesting individuals have also been anecdotally documented in certain locations, yet little data exists on these events. Sea turtles were traditionally harvested for their meat and shells, and were considered to be a valuable resource for fishermen and an important local food source. In 2009, the Department of Marine Resources of the Bahamian Government implemented a nationwide ban on the take and sale of all sea turtle species and products in response to global declines in sea turtle populations. This major conservation milestone was not accompanied by any significant awareness or education and outreach initiatives. Despite the ban being in place for six years, there is evidence of continued poaching of sea turtles throughout the islands. Studies have shown that local community participation and support is essential to the success of a conservation program, and this can be encouraged through educational training. No studies have investigated how extensive knowledge of the sea turtle harvest ban in The Bahamas is, nor how those who are aware of the regulation perceive the ban and sea turtle conservation efforts in general. The goal of this study was to determine the extent to which Bahamians in Eleuthera know about the harvest ban and sea turtles in general. Overall, 71 individuals from 9 settlements participated in a 12-question, semi-structured interview. Questions were designed to collect quantitative and qualitative data through the use of yes/no, Likert Scale statements, and open-ended questions. 61.9% (n=44) of respondents were aware of the ban on the harvest of sea turtles; 12.7% (n=9) agreed with the ban, but did not know why the ban was

in place, while 5.6% (n=4) disagreed with the ban, claiming turtles are an important food source that does not need to be regulated. 12.7% (n=9) believe it is important to protect populations for future generations, while 5.6% (n=4) believe that a seasonal closure should exist for sea turtles, much like those for Nassau grouper and crawfish in The Bahamas. The most commonly reported food source for sea turtles was conch (28.2%, n=20). It is possible that because loggerheads eat conch, Bahamians are associating that diet with all species of sea turtles found in the Bahamas, including the relatively abundant and herbivorous green sea turtle. Overall, it appears that Bahamians are accepting of the ban and support the regulation, with 95.8% (n=68) of interviewees stating that it is important to protect sea turtles. This research provides an opportunity to determine the knowledge gap between conservation planners, resource managers and local community stakeholders. The information collected to date is encouraging for the successful development and implementation of education and awareness programs that will motivate the environmentally responsible behavior essential for the conservation of endangered species. Acknowledgments: RM would like to acknowledge the Cape Eleuthera Institute, Whitley Fund for Nature, Columbus Zoo and Aquarium, Sociedad Nacional de Pesqueria, World Wildlife Fund, and the International Sea Turtle Symposium for their financial assistance in my attendance.

ENCOURAGING SEA TURTLE CONSERVATION THROUGH A VOLUNTARY CERTIFICATION PROGRAM IN ST. KITTS AND NEVIS, WEST INDIES*

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The Caribbean nation of St. Kitts and Nevis is host to four species of sea turtle. Nesting populations of leatherback, green, and hawksbill turtles are documented annually, while green, hawksbill, and loggerhead turtles forage in the surrounding waters. This Small Island Developing State has experienced significant development, including on its coastline, since the transition from sugar production to tourism as the main economic driver of the national gross domestic product in 2005. In many cases, this development has threatened the survival of nesting, hatchling, and foraging sea turtle populations in St. Kitts and Nevis. As tourism is essential to the nation's economy, it is important to find a solution which protects and accommodates sea turtles while encouraging sustainable tourism. Here, we elucidate the design, planned implementation, and intended purpose of the certification program, TURTLE APPROVED, as a method of enhancing sea turtle survival and community awareness of conservation issues through a voluntary shift in business practices and standards to become more sea turtle friendly. TURTLE APPROVED will provide educational training in sea turtle conservation and the criteria necessary for a business to demonstrate compliance and earn CERTIFIED TURTLE APPROVED status, affording them promotional benefits. From June to September 2015, we conducted consumer surveys, held individual government and business

stakeholder consultations, sent the CERTIFIED TURTLE APPROVED criteria out for review and comment, and identified potential pilot businesses. In 2016, we will continue to refine the program, begin training sessions, and continue to consult with and mentor the designated pilot businesses. The primary goal of this program is to educate businesses and encourage voluntary sea turtle friendly practices in order to better accommodate and support the sea turtle population of St. Kitts and Nevis. Additionally, we aim to increase awareness about sea turtles, their conservation, and the valuation of these living natural resources while encouraging more sustainable development of the local tourism industry. Lessons learned throughout the process will better inform other nations looking to utilize a similar method to boost sea turtle conservation efforts and promote sustainable tourism. Acknowledgments: The authors would like to thank The GEF Small Grants Programme, The St Kitts Sea Turtle Monitoring Network, Ross University School of Veterinary Medicine, Wildlife Friendly Enterprise Network, Ramapo College of NJ, and WIDECAST for their financial contributions and technical assistance.

PERCEPTION OF COMMUNITY MEMBERS INVOLVED IN HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) CONSERVATION PROJECTS IN ESTERO PADRE RAMOS AND ASERRADORES, NICARAGUA*

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The estuaries of Aserradores and Estero Padre Ramos are two of the most important nesting areas for hawksbill turtles (*Eretmochelys imbricata*) in the eastern Pacific Ocean. Both sites are located along the northwestern coast of Nicaragua and share similar ecological conditions, including consisting of mangrove-lined, brackish water estuarine systems where hawksbill turtles enter to nest; and social conditions where small-scale fisheries and agriculture are the main economic activities. In addition, historically, both areas have suffered from intensive poaching, with virtually 100% of turtle eggs being collected and sold on the black market as a source of income. Despite their similarities, these areas have important differences that impact local resource management strategies. For example, they are under different management and property regimes: Estero Padre Ramos is a national protected area (Nature Reserve), governed under a co-management system with an important degree of community participation in decision making, while the nesting beaches of Aserradores are located within the limits of a large private land concession granted to a marina project, where locals have traditionally had limited input into land management decisions. Fauna & Flora International (FFI) and the Eastern Pacific Hawksbill Initiative (ICAPO) have lead the development of hawksbill conservation projects at both sites, beginning in 2010 in Padre Ramos and 2013 in Aserradores. Both projects have implemented a financial incentive scheme to facilitate the support of former egg poachers, an approach underlying the extremely successful protection achievement to date, including protection of approximately 95% of hawksbill nests in Padre Ramos and 41% in Aserradores, a rigorous night patrol monitoring program and the establishment of hatcheries operated by local community

members. Each project has developed strong environmental education programs that target elementary school kids and teachers, as well as former poachers, including annual Hawksbill Festivals and the Hawksbill Cup competition. Each year these educational activities reach nearly 1400 children and 50 teachers. Despite the operational similarities between the two sites, each project has different coordination mechanisms with stakeholders, due to the differences in the management regimes and realities present. The project in Estero Padre Ramos hosts international volunteers as part of its financial sustainability strategy, while the Aserradores project has focused on bringing national university students via internships and to fulfill university "field practice" requirements. Overall, both projects have achieved tremendous success in terms of the percentage of nest protected and the number of hatchlings released. However, the consolidation of these initiatives requires greater integration with their respective socio institutional frameworks. Understanding the social context of local communities and including these perspectives in the management of conservation programs is paramount to their long-term success. This presentation will combine the results of a survey designed to measure local community member perceptions towards turtles and the project itself, as well as the empirical experience accumulated by project staff. Finally, we will offer a set of lessons learned and recommendations for future steps.

RESOLVING CONFLICT ISSUES AMONG SEA TURTLE CONSERVATION RESEARCH, COMMUNITY INTERESTS, AND GOVERNMENT AGENCIES

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The idea that research is fundamental to resource management is one that can result in conflict. Conflict between sea turtle research and community interests may arise from different priorities for turtles in the area. Likewise, conflicts may arise between conservation research and government agencies, because government priorities may be on implementing regulations, generating laws, and complying with conventions, while supporting decision-making with research findings may not be considered important. There is a need to resolve conflicts for the benefit of sea turtles and all parties involved. In 2014 and 2015, ProTECTOR Inc. faced conflicts with community dive operators within an MPA in the Bay Islands, Honduras, resulting from misinformation and misconceptions about standard methods for in-water research. The conflict appeared rooted in a fear that research methods would disturb turtles and cause them to leave the area, resulting in lost income to the dive industry. ProTECTOR Inc. also faced conflicts in obtaining research permits from the Honduras National Institute for Protected Areas. Delays in issuing research permits resulted from the lack of published permit application procedures, a lack of understanding basic research methods by the agents evaluating permit applications, and a lack of experience utilizing literature to evaluate research proposals. We aimed to resolve these separate, yet related conflicts by: 1. Developing a "Fact File". To address misinformation and misconceptions, we compiled an information folder verifying permits, explaining standard best-practices of in-water turtle research, and giving evidence demonstrating persistence of sea turtles from other in-water studies throughout the Caribbean. 2. Providing opportunities to meet with community interest leaders. We met with community members to discuss their beliefs and concerns about standard research methods for in-water studies, and provided them with case study benchmarking. Additionally, we worked with them to propose a preliminary study where four turtles would be hand captured, receive standard work-ups and be released, giving dive operators opportunities to

verify subsequent sightings and behaviors of these turtles. 3. Meeting with all government agencies. To disseminate factual information about the need for dedicated research efforts, the research methods, and the need to streamline and facilitate the process for obtaining research permits, we met with representatives from the National Fisheries Directorate, the Secretariat of Agriculture and Ranching, the National Institute for Protected Areas, the Department of Biodiversity, the Ministry of Environment, CITES, WWF Honduras, and the National University. Resolutions included: Clarifying ideas about research methods used by ProTECTOR Inc.; Prioritizing research for management of marine turtles in Honduras; Defining responsibilities of actors for the proper management of marine turtles; Deciding to standardize and institutionalize research protocols in Honduras; DIGEPESCA resolving to renew permits for continued research of sea turtles. In both conflict cases, special attention was made to discuss the benefits of the research and the low impact it would have on turtles with community and government agencies. Developing understanding of concerns of community and government allowed ProTECTOR Inc. to reaffirm its commitment to sea turtle conservation in Honduras.

THE EARLIEST PUBLISHED NEW WORLD SEA TURTLES – MARK CATESBY'S THE NATURAL HISTORY OF CAROLINA, FLORIDA AND THE BAHAMA ISLANDS

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Catesby's now famous work, "The Natural History of Carolina, Florida and the Bahama Islands", was the first published account of North America's flora and fauna, illustrating 220 hand-colored plates, including three marine turtles, the first ever published from the New World. This presentation examines these images, comparing them to later works and the original watercolors from which they were engraved. Mark Catesby (1682 – 1749) published his two volume (plus a supplement) pioneering work drawing from several expeditions beginning in 1712. In 1712, the English-born artist and naturalist Mark Catesby came into a small inheritance and embarked on a series of expeditions to the New World over seven years, discovering a plethora of flora and fauna previously unknown to Europeans. The Secretary to the Governor of Virginia was married to Catesby's sister and provided him with introductions and references to the British Colonies leading scientists. His initial mission was to gather samples of the flora and their seeds throughout the southern colonies of British North America collectively known as Carolina. Primarily known as a botanist, his paintings of American native flora and fauna so impressed numerous Fellows of the Royal Society, that they sponsored his five-year return to America. He expanded his studies to both flora and fauna in other areas of the Americas and the West Indies, making sketches and elaborate notes as well as collecting specimens and seeds, primarily traveling by foot, through parts of today's Virginia, Georgia, the Carolinas and the Bahamas. His specimens were sent, not only to England, but throughout the scientific world. He returned to England in 1726 after his second stay and, over a twenty-year period, put together his illustrations (drawn from life) and written observations, consolidating his discoveries in text and illustrations. Although there were problems obtaining sponsors, he persevered and produced what became his *magnum opus* and it was shortly recognized as such. In order to maintain control over the process of rendering his drawings into print, he learned to engrave and etch the copper plates for printing himself. With the exception of two of the plates, he engraved the remainder after painting the watercolors as a model. As he became more accomplished, the images became more refined, adding backgrounds and plants with

the animals. Shortly after completion, he passed away. There were few artists who devoted themselves so wholeheartedly to their work and it is clear that Catesby must have been extremely involved and enamored with this project, today considered the pinnacle of eighteenth century scientific illustration. His original illustrations were purchased in 1768 for £120 (approximately £200,000 in today's currency) by King George III. The British Royal Family still retains ownership and they are housed in Windsor Castle's Royal Library. Catesby was widely respected in his day. He is mentioned prominently in Bartram's diaries and correspondence and a great deal of data from his Natural History was utilized in Linnaeus's 10th edition of Systema Naturae (1758).

USING EXPERTS' OPINIONS TO FILL THE GAPS: A CASE STUDY OF THE CONSERVATION CONTEXT IN MOZAMBIQUE

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Limited research exists for the regional populations of sea turtles that use Mozambique's coast. Although robust and consistent long-term datasets are lacking, it is commonly accepted that these populations face significant human threats whilst using Mozambique's coastal habitats. Whilst multiple threats have been identified, their relative impact – and thus the ability to prioritise limited conservation resources – is unknown. Three key factors limit our understanding of Mozambican sea turtle populations: 1) there is little research on the population ecology and conservation status of local sea turtles, 2) there is currently low government interest in improving their conservation status and 3) there is a lack of skilled personnel or institutional capacity within government at national, provincial and local levels. In-light of these limitations, we designed a semi-structured survey (24 questions) to solicit expert information on these issues, identify and prioritize threats, management and conservation actions to summarise the current state of knowledge of Mozambican sea turtle populations and provide suggestions for directing future research and funding. Experts were asked to identify key threat criterion and to complete pairwise comparison matrices to determine the relative weight (W) of each threat. Experts could assign seven different scores to each comparison of threats ranging from 'extremely more important' to 'equal importance'. Weights for the perceived impact of identified threats were calculated from scores given in the pair-wise matrix using Analytic Hierarchy Process (AHP). We averaged the weights and rank value of each threat criterion to obtain an overall weighting and threat ranking. Additionally, experts were asked to document the current conservation and management efforts underway (and their perceived contributions/value) and which agencies are currently and should be involved in such efforts. A total of 73% of potential experts identified (n = 18), responded to our surveys. By-catch from trawling (W = 13.65), artisanal fishing (W= 12.30) and hunting of nesting turtles (W = 11.33) were the top threats identified by experts. Responses to open-ended survey questions were thematically coded using Nvivo 10. Here we will discuss common themes identified among experts regarding the current context of conservation and management of marine turtles in Mozambique. We found that, given the lack of baseline or published data, soliciting expert opinion was a resource effective way to identify emergent threats, successful and limiting factors to sea turtle conservation in a developing nation and suggest this technique may provide valuable results in locations with similar socio-economic environments.

SWIMMING OUT OF THE PAST: RECONSTRUCTING SEA TURTLE POPULATIONS THROUGH ETHNOGRAPHY AND ARCHIVAL RESEARCH*

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Systematic monitoring of sea turtle populations in temperate feeding areas is relatively recent, having been carried out for less than 20 years in much of the world. However, many sea turtle stocks were subject to intensive commercial exploitation and were severely depleted before scientific monitoring began. As a result, there is a lack of solid estimates of abundance prior to commercial exploitation. The lack of data on past population size can lead to over- or underestimation of past abundance which, in turn, affects conservation and management goals. This in turn can result in two possible scenarios: populations being characterized as stable or increasing, although they may in fact be depleted in respect to historical abundance levels, or, on the other hand, establishing unrealistic conservation goals by overestimating past abundance.

TURTLES IN TIME: RECOVERING THE LOST DIMENSION IN MARINE TURTLE RESEARCH AND CONSERVATION*

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Associations between humans and marine turtles likely date back to the first time that a human got close to a turtle, but certainly interactions have occurred since at least the Middle Stone Age in South Africa, ca. 60,000 before present (BP). Since then, there have been numerous manifestations of relationships between our remote ancestors and these marine reptiles; examples are many. In Neolithic Oman, ca. 6000 BP, human burials included parts of marine turtles – especially crania – in more than half the graves excavated from one site, sometimes with dozens of turtle skulls or mandibles in a single grave. Later Bronze Age sites in Oman reveal evidence of large scale exploitation of turtles, apparently killed for rendering oil. Egyptian expeditions ventured into the Indian Ocean ca. 4500 BP, and tortoise-shell was evidently brought back. Greek and Roman import markets left abundant remains from tortoise-shell workshops on the Egyptian Red Sea coast more than 2000 BP; warehouses in Alexandria were so full of tortoise-shell when Julius Caesar conquered Egypt, he proposed this as the principal ornament of his triumph. Before Christ, well-established maritime trade networks extended from southern Europe to SE China, and tortoise-shell was the most commonly mentioned commodity in a traders' handbook that dates to about 2000 BP. Trade in tortoise-shell – particularly imports – was extensively documented during Sung and Ming periods (960-1644 AD), showing that this commodity was of immense economic, social, and political importance in Imperial China. The dominance of marine turtle remains at pre-Columbian sites from the SE of present-day USA was termed the "sea turtle harvesting constellation". Islands and coasts of the Caribbean Basin also show clear, widespread archaeological evidence for pre-Hispanic marine turtle exploitation, comparable to

the situation on Islands throughout the South Pacific. Active trade in tortoise-shell and green turtles continued throughout, and after, the European Colonial Period. In summary: around the world, archaeological sites and historical records show that marine turtles have been commonly – often intensely – exploited for millennia. This archaeological and historical information raises critical questions: to what extent has the abundance and distribution – even basic biology – of marine turtles been affected by past human activities, not only from before the industrial revolution, but from many millennia before the present? Historic records indicate that marine turtle populations that were subjected to intense exploitation declined, frequently to the point of "economic extinction." Zooarchaeologists report marine turtle remains to be less common in the younger strata of certain sites, including the Arabian/Persian Gulf, South Pacific Islands, Pacific Mexico, and the Caribbean, indicating a reduction in relative abundance over time. Hence, widespread archaeological evidence indicates that past human societies depleted marine turtle populations. From this, it is logical to assume that both geographic and temporal distributions were impacted by past humans. If that happened, then turtle behavior, physiology, and other basic biological functions may have been shaped by human activities. In terms of conservation, this begs the fundamental question: what is the "natural" state of a marine turtle population? What are we studying? What should be "conserved"?

ARCHIVO GENERAL DE INDIAS DE SEVILLA. RESEARCH POTENTIAL OF HISTORICAL ARCHIVES*

Daniel González-Paredes

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Sea turtles have interacted with humans since ancient times. These reptiles have been open-access, natural resources for human needs with different values. But it was in the 60s, when the scientific community started to pay attention and carry out substantial research in this field. Nowadays, one of the most important challenges is to understand changes in global sea turtle populations over time. Thus, historical archives are an essential tool for the comprehension and study of the past, present and future of sea turtles. These archives offer interesting data about turtles such as exploitation levels, consumption, trade and traffic, economic incomes, as well as indirect information about population size, distribution, migratory routes, and population health, among others. The Archivo General de Indias in Seville, Spain, represents an exceptional resource for historic studies, containing valuable documents about the management, riches, and trade in overseas Spanish colonies. The significance of this archive is because it contains the most complete and documented historical data about Spain's vast empire during the 16th, 17th and 18th centuries, which has generated an impressive amount of research in different fields. Currently, several studies are being conducted in the field of sea turtle science at the Archivo General de Indias. It is known that sea turtles were an important food resource during this period, not only for the local coastal communities but also for the numerous ships' crews crossing transoceanic trade routes. At the same time, Europe was one of the biggest consumers of tortoise-shell (hawksbill turtle shell), where Spain was considered as having some of the main ports of entrance for this product. The results expected from these studies should shed light on population sizes of sea turtles in the Caribbean area between 16th to 18th centuries and reveal exploitation levels of the trade of tortoise-shell from the colonies. This historical archive, which was designated as a UNESCO World Heritage Site in 1987, belongs to the Spanish Ministry of Education and Culture, and it is open access for any research or person interested in it. The information available in the Archivo de Indias is unique, but an underlying problem comes from the difficulty in finding relevant data in this type of

database. Out of more than 80 million pages of documents and 8,000 maps and nautical charts (around 43,000 files) belonging to Archivo de Indias, only 20% of them are digitalized. Thus, it is necessary to dive into the archives, document by document, in order to find the needed information. Nonetheless, the Archivo de Indias represents an immeasurable data resource. The sea turtle scientific community should recognize and achieve the full potential of the historical archives as a resource of information over time. Human history is written in these historical archives. Only by understanding the past, can we comprehend the present and build a better future for sea turtles and ourselves.

Video Presentations

A SHINING LIGHT FOR SEA TURTLES

Organizer: Disney's Animal Kingdom

AHEAD OF THE TIDE: FLORIDA'S LIFEBLOOD

Organizer: Sea Turtle Conservancy

AL RESCATE DE LA TORTUGA LAÚD

Organizer: Fundacion Lince S.C.

CONOCIENDO Y PROTEGIENDO LAS TORTUGAS MARINAS Y SU HABITAT EN BAHIA SALADO

Organizer: Qarapara

EXPERIENCE ARCHELON

Organizer: ARCHELON, the Sea Turtle Protection Society of Greece

EYE OF THE TURTLE

Organizers: MPA French Agency, Kelonia: the observatory of marine turtles and French Research Institute for Exploitation of the Sea (Ifremer)

FIRST-PERSON VIEW OF A LOGGERHEAD TURTLE CAPTURE BY HAND (RODEO) IN BAJA CALIFORNIA SUR, MEXICO

Organizers: Universidad Autonoma de Baja California Sur, México and Centro de Investigaciones Biologicas del Noroeste (CIBNOR)

GREETINGS FROM ALL FO US HERE AT THE HAWKSBILL PROJECT

Organizers: ICAPO Iniciativa Carey del Pacifico Oriental and Eastern Pacific Hawksbill Initiative

HE KNEW NO MAN WAS EVER ALONE ON THE SEA

Organizers: Grupo POPA Por la Pesca Artesanal de Piriápolis and POPA Group, For Artisanal Fisheries in Piriapolis

IN-WATER BEHAVIOUR OF LOGGERHEAD SEA TURTLES, ZAKYNTHOS, GREECE

Organizer: Humboldt University of Berlin

JOIN US AS WE PROTECT SEA TURTLES FROM PLASTIC POLLUTION

Organizer: The Leatherback Trust

LILA: HISTORIA DE UNA TORTUGA MARINA, EN LENGUAJE DE SEÑAS

Organizer: Tourtugas Foundation

LOGGERHEAD MARINELIFE CENTER'S PROJECT SHIELD

Organizer: Loggerhead Marinelife Center

PERHENTIAN ISLANDS SEA TURTLE RESEARCH AND CONSERVATION

Organizer: Perhentian Turtle Project, Fuze Ecoteer

PEZ CACHETON DE CHINA

Organizer: Pro Delphinus

PROJETO TARTARUGAS NO MAR

Organizer: NGO NEMA (Núcleo de Educação e Monitoramento Ambiental)

SAVING SEA TURTLES: PREVENTING EXTINCTION

Organizer: InterChange Media Art Productions. Directed & Produced by Michele Gomes & Jenny Ting

SNIFFER DOGS: A SEA TURTLE'S BEST FRIEND

Organizer: Disney's Animal Kingdom

THE OCEAN IS FULL OF OUR PLASTIC. GALÁPAGOS IS NOT AN EXCEPTION

Organizer: Universidad San Francisco de Quito USFQ, Extensión Galápagos USFQ, Galápagos Science Center GSC, Ecuador

TORTUGAS MARINAS EN LA CIUDAD DE LA ETERNA PRIMAVERA ARICA, CHILE

Organizers: Arturo Prat University and Tortumar Chile

TURTLE RODEO: A DIFFERENT PERSPECTIVE OF A GREAT EXPERIENCE

Organizer: TropWATER, College of Marine and Environmental Sciences – James Cook University, Universidad del Zulia, Centro de Modelado Científico, and Zona Siete

UN DÍA EN EL PROGRAMA DE VOLUNTARIADO DE ONG KARUMBÉ

Organizer: ONG Karumbe Tortugas Marinas del Uruguay

WILDLIFE IMAGES PROCESS FOR A WIDER EFFECTIVE BIODIVERSITY PROTECTION

Organizers: WIPSEA, Parc Naturel Marin de Mayotte, Agence des Aires Marines Protégées, Kélonia

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