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

NAVIGATING THE FUTURE

INTERNATIONAL SEA TURTLE SYMPOSIUM, 2019

Charleston, South Carolina, USA

1 to 8 February, 2019

Charleston, South Carolina, USA

Compiled by:
Kayla Goforth, Joseph Pfaller, Kris Williams, and Lisa Belskis

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

November 2024

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U.S. DEPARTMENT OF COMMERCE

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November 2024

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

PRESIDENT'S REPORT (Abridged*)
2019 INTERNATIONAL SEA TURTLE SYMPOSIUM

Kenneth J. Lohmann, President

The 39th International Sea Turtle Symposium was held in Charleston, South Carolina, USA from February 2-8, 2019. The theme of the Symposium was "Navigating the Future". This forward-looking theme encourages us to envision future conservation problems before they arise, acquaint ourselves with the emerging frontiers of sea turtle biology, and honor our covenant to the natural world by steering our way toward a bright future for sea turtles and humanity. The symposium featured a record number of workshops (25) encompassing a wide range of topics, as well as seven regional meetings, which allowed participants to discuss region-specific issues. The main days of the symposium featured over 400 oral and poster presentations. Numerous evening events were held, including an opening social at the South Carolina Aquarium, film night, the student mixer, speed-chatting with the experts, the dance-your-research competition, the sea turtle trading post, the live and silent auctions, and the traditional farewell dinner. The venue was the Charleston Marriott, which provided a spacious and comfortable environment for social and intellectual exchanges. The symposium attracted approximately 830 registrants from 52 different countries.

Main Symposium Program. The main symposium began with opening remarks from the 2019 ISTS President Ken Lohmann, followed by three keynote speakers. Elena Mustakova-Possardt, an educator, social scientist, and psychotherapist, addressed attendees on the topic of "Meeting the Future with Constructive Resilience". Her talk focused on the need to face political, social, and environmental challenges with a mindset that allows us to persevere through upheaval and setbacks. Colin Limpus, who serves as Chief Scientist of the Aquatic Species Program in Queensland, Australia, presented the second keynote address, titled "Fifty Years of Walking with Turtles: Looking Forward from Down Under". This talk highlighted important events in the history of sea turtle biology and conservation, as well as lessons for the future. Sally Murphy, former head of the South Carolina sea turtle program and a four-time ISTS president, concluded the opening session with a brief reading from her newly published memoir *Turning the Tide*. She also shared amusing anecdotes from the early days of the ISTS.

Symposium Program Chairs John Wang, Kate Mansfield, and Nathan Putman, along with Poster Chair Larisa Avens and 38 Session Chairs, developed an amazing symposium program consisting of 172 oral papers and 232 posters. Many of the presentations were within the traditional eight session categories, which include: (1) Anatomy, Physiology and Health; (2) In-Water Biology; (3) Nesting Biology; (4) Population Biology and Monitoring; (5) Fisheries and Threats; (6) Conservation, Management and

Policy; (7) Education, Outreach and Advocacy; and (8) Social, Economic and Cultural Studies. In addition to the traditional regular sessions, four special sessions were also held: Genetics and Genomics of Sea Turtles; Using Science to Inform Conservation Policy; Navigation, Migration, and Natal Homing; and The Future of Sea Turtle Conservation. The symposium closed with a special session featuring two keynote addresses. The first was by Blair Witherington, titled "What's the Point of Sea Turtle Conservation When We're All Going to Die?". The second was by Wallace J. Nichols, titled "Sea Turtles are Medicine". Final closing remarks were made by Ken Lohmann.

ISTS Awards 2019. Erin Seney, ISTS Awards Committee chair, and her committee (Shaya Honarvar, Sheryan Epperly and Irene Kelly) presented awards to an incredible group of recipients. 2019 ISTS Lifetime Achievement Awards were presented to Michael Salmon (USA), Eng Heng Chan (Malaysia), René Márquez-Millán (Mexico), and Jeffrey Miller (USA). Recipients of the 2019 ISTS Champions Awards were the Family Island Research and Education Foundation (Bahamas), Jeannie Martin (USA), Wallace J. Nichols (USA), and Jeanette Wyneken (USA). Roderic Mast (USA) was the recipient of the Ed Drane Award for Volunteerism. Additionally, ISTS President Ken Lohmann presented the 2019 President's Awards to the Bald Head Island Conservancy (North Carolina, USA) and to the University of Georgia Sea Turtle DNA Fingerprinting Project (USA).

Archie Carr Awards. Chairs Matthew Godfrey and Andrea Phillott organized a team of judges to evaluate 121 student presentations (53 orals and 68 posters) for student awards. Eight students were recognized for outstanding presentations. In Biology: Boris Tezak (oral winner), Kayla Goforth (oral runner-up), Robert Johnson (poster winner), MacKenzie Tackett (poster runner-up). In Conservation: Alessandra Bielli (oral winner), Emily Duncan (oral runner-up), Katie Mascovich (poster winner) and Mia El-Khazen (poster runner-up).

Exhibitors and Vendors. Chair Janet Hochella coordinated 25 exhibitor and vendor displays that attendees visited throughout the week.

Going Green – Zero Waste. Efforts were made to make the symposium more environmentally friendly. A team of students from the College of Charleston's Zero Waste Program, coordinated by Ashley Lavender, volunteered for the symposium with the goal of making the 2019 ISTS a zero-waste conference.

In Memorium. Donna Broadbent (1957-2020) was the event planner for the 2019 symposium. During the past two decades she planned many of the major sea turtle conferences in North America, both for the ISTS and for the Southeast Regional Sea Turtle Network. Donna's exceptional organizational skills contributed greatly to the success of the Charleston symposium. She will be remembered by the sea turtle community and deeply missed.

*The full text of the 2019 President's Report is available in the Marine Turtle Newsletter on page 28 of Issue 159 (available at http://www.seaturtle.org/mtn/PDF/MTN159.pdf)

COMMITTEES, CHAIRS, AND KEY ORGANIZERS

EXECUTIVE COMMITTEE

Executive Committee Role	Member
President	Kenneth Lohmann
Secretary	Manjula Tiwari
Treasurer	George Balazs
President Elect	Diego Amorocho
Past President	Yoshi Matsuzawa

ORGANIZING COMMITTEE

Organizing Committee Role	Member
Event Coordinator	Donna Broadbent
Auction Coordinator	Marina Zucchini
Auctioneer (Live Auction)	Larry Wood
Auction Support Team	Debbie Sobel, Hector Barrios-Garrido, Cody Mott, Rebecca Mott
Exhibitor/Vendor Chair	Janet Hochella
Speed Chatting Coordinators	Hector Barrios-Garrido, Vanessa Bezy, Emma Harrison
Nomination Committee Chair	Natalie Wildermann
Nomination Committee Members	Connie K-Yan Ng, Kartik Shanker, Jesús Tomás, Kate Mansfield
ISTS Awards Committee Chair	Erin Seney
ISTS Awards Committee	Irene Kinan-Kelly, Shaya Honarvar, Sheryan Epperly
Program Officer (Fundraising)	Ingrid Yañez (assistance from Larry Wood)
Registrar	Nicholas Blume
Webmaster	Laura Gibbons (Blue Salamander Solutions, LLC)
Student Awards Committee	Matthew Godfrey, Andrea Phillott
Student Committee	Katherine Shaw, Itzel Sifuentes-Romero, Christopher Gatto

Grassroots Conservation Award Committee	Ingrid Yañez, Majula Tiwari, Angela Formia, Alejandro Fallabrino, Colum Muccio, Milagros Lopez, J. Nichols, Jack Frazier
Workshops Committee	Nathan Putman, John Wang, Kate Mansfield
Volunteer Co-Chairs	Joseph Pfaller, Ashley Lynn Lavender
Film Night Chairs	Tom Backof, Christian Gredzens, Katherine Comer Santos
Dance Your Research Organizers	Kate Mansfield, Neca Marcovaldi
Sea Turtle Trading Post Organizer	Kate Mansfield
MTSG Group Meeting	Rod Mast, Paolo Casale
Social Media Support	Andrea Phillott, Alejandro Fallabrino, Hector Barrios-Garrido
Photography	Gregory A. Mauger (P&G Studios)
Greening the Symposium	Juan Pablo Muñoz-Pérez
College of Charleston Zero Waste Program	Neyle Steadman, Natalie Dick, Mikayla Drost, Becca Eaton, Marybeth Grimes, Katie Kurtz, Natalie Reider, Alejandra Rios, Sara Russell, Sofia Toya Zambrano
I.T. Liason	Aliki Panagopoulou

PROGRAM COMMITTEE

Program Committee Role	**Member**
Printed Program	Larisa Avens, Kate Mansfield, Nathan Putman, John Wang
Program Chairs	Kate Mansfield, Nathan Putman, John Wang
Session Chairs	Camryn Allen, Phillip Allman, Mike Arendt, Hector Barrios-Garrido, Ray Carthy, Kara Dodge, Peter H. Dutton, Tomo Eguchi, Daniel Evans, Nancy Fitzsimmons, Mariana Fuentes, Bruno Giffoni, Matthew Godfrey, Tomo Hirama, Sandra Hochscheid, Yakup Kaska, Catherine Kilduff, Lisa Komoroske, Ann Marie Lauritsen, Ken Lohmann, Zoe Meletis, Rebecca Mott, Shawn Murakawa, Brad Nahill, Connie Ng, Andrea Phillott, Wendy Dow Piniak, Nathan Putman, ALan Rees, Paul Richards, Jeff Seminoff, Erin Seney, Brian Shamblin, Kelly Stewart, Yonat Swimmer, Manjula Tiwari, Carrie Upite, John Wang, Amanda Williard, Ingrid Yanez
Poster Chair	Larisa Avens
Proceedings Coordinator	Joseph Pfaller
Proceedings Compilers	Kayla Goforth, Joseph Pfaller, Kris Williams, Lisa Belskis

TRAVEL GRANT COMMITTEE

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 ORGANIZERS

Regional Meeting Committee Role	Member
Africa	Manjula Tiwari, Angela Formia, Andrews Aguekumhene, Jacques Fretey
IUCN Marine Turtle Specialist Group (MTSG)	Rod Mast, Paolo Casale
Indian Ocean & Southeast Asia (IOSEA)	Lalith Ekanayake, Zahirul Islam
Latin America Meeting (RETOMALA)	Alejandro Fallabrino, Juan Manuel Rodriguez-Baron, Hector Barrios-Garrido
Mediterranean	Sandra Hochscheid, Yakup Kaska, Aliki Panagopoulou
East Asia Meeting	Yoshi Matsuzawa

BOARD OF DIRECTORS AND THEIR END OF TERM

Mariana Fuentes	2019
Joanna Alfaro	2019
ALan Rees	2019
Frank Paladino	2020
Andrea Phillott	2020
Laura Prodoscimi	2020
Jeanette Wyneken	2021
Andrews Agyekumhene	2021
Andres Estradas	2021
Marc Girondot	2022
Felix Moncada	2022
Richard Reina	2023

ISTS AWARDS

Chair: Erin Seney
Members: Irene Kinan-Kelly, Shaya Honarvar, Sheryan Epperly

Life Time Achievement Award
Michael Salmon (USA), Eng Heng Chan (Malaysia), René Márquez-Millán (Mexico), Jeffrey Miller (USA)

Champions Award
The Family Island Research and Education Foundation (Bahamas), Jeannie Martin (USA), Wallace J. Nichols (USA), Jeanette Wyneken (USA)

President's Award
Bald Head Island Conservancy (USA) and to the University of Georgia Sea Turtle DNA Fingerprinting Project (USA)

Ed Drane Award for Volunteerism
Roderic Mast (USA)

STUDENT AWARDS

There were 53 oral presentations and 68 poster presentations entered by students in the Archie Carr Student Awards.

Program Chairs: Matthew Godfrey and Andrea Phillott

Judges of the presentations in Charleston, South Carolina: Aliki Panagopoulou, Amanda Southwood-Williard, Ana Barragan, Bibi Santridian Tomillo, Craig Harms, Daphne Wrobel Goldberg, Jennifer Lynch, Marc Girondot, Mark Dodd, Mark Roberts, Mike James, Qamar Schuyler, Rupika Rajakaruna, Shaya Honarvar, Yakup Kaska, and 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 ISTS39, Charleston, South Carolina:

Category	Prize	Student	Institution	Presentation Title
Biology Poster	Winner	Robert Johnson	University of Florida	GREEN TURTLE GRAZING CAUSES A CONSISTENT RESPONSE IN SEAGRASS ECOSYSTEM METABOLIC CARBON CAPTURE ACROSS CARIBBEAN MEADOWS
	Runner up	MacKenzie Tackett	University of Central Florida	ARE DIET SAMPLES CONSISTENT BETWEEN DIFFERENT SECTIONS OF THE GREEN TURTLE DIGESTIVE TRACT?
Conservation Poster	Winner	Kate Mascovich	University of Georgia	TALKING TURTLES: EXPLORING THE RELATIVE EFFICACY OF DIFFERENT VISITOR EDUCATION PROGRAMS AT JEKYLL ISLAND, GEORGIA
	Runner up	Mia El-Khazen	University of Central Florida	EVALUATING HARMFUL ALGAL BLOOM EFFECTS ON GROWTH RATES OF JUVENILE GREEN TURTLES
Biology Oral	Winner	Boris Tezak	Florida Atlantic University	USING BLOOD SAMPLES TO IDENTIFY THE SEX OF HATCHLING LOGGERHEAD SEA TURTLES
	Runner up	Kayla Goforth	University of North Carolina at Chapel Hill	FORMATION OF FORAGING SITE ATTACHMENT IN MIGRATORY SEA TURTLES
Conservation Oral	Winner	Alessandra Bielli	University of Exeter	AN ILLUMINATING IDEA TO REDUCE BYCATCH IN THE PERUVIAN SMALL-SCALE GILLNET FISHERY
	Runner up	Emily Duncan	University of Exeter	MICROPLASTIC INGESTION UBIQUITOUS IN MARINE TURTLES

OPENING REMARKS AND KEYNOTE PRESENTATIONS

WELCOME TO THE 39TH ANNUAL SEA TURTLE SYMPOSIUM

Kenneth Lohmann
President, International Sea Turtle Society and University of North Carolina at Chapel Hill

MEETING THE FUTURE WITH CONSTRUCTIVE RESILIENCE

Elena Mustakova-Possardt
Author, social scientist, psychotherapist

FIFTY YEARS OF WALKING WITH TURTLES: LOOKING FORWARD FROM DOWN UNDER

Colin Limpus
Chief Scientist, Aquatic Species Program, Queensland, Australia

A BRIEF READING FROM THE NEWLY PUBLISHED MEMOIR TURNING THE TIDE AND A GLIMPSE AT THE ORIGINS OF THE ISTS

Sally Murphy
Former head of South Carolina sea turtle program and the only four-time ISTS president

MARINE TURTLE CONSERVATION GENOMICS

Lisa Komoroske
University of Massachusetts at Amherst, MA

OCEAN WAVES AND ANIMAL MAGNETISM: HOW LITTLE TURTLES KNOW WHERE TO GO

Catherine Lohmann
University of North Carolina, Chapel Hill, NC, USA

NATAL HOMING AND GEOMAGNETIC IMPRINTING: HOW ADULT TURTLES FIND THEIR WAY HOME

Roger Brothers and Kenneth Lohmann
University of North Carolina, Chapel Hill, NC, USA

FACING THE UPHEAVALS AHEAD: SCIENCE AND RELIGION AND THE CONSERVATION OF PLANETARY LIFE

Earl Possardt
Marine Turtle Program Officer at U.S. Fish and Wildlife Service

WHAT’S THE POINT OF SEA TURTLE CONSERVATION WHEN WE’RE ALL GOING TO DIE?

Blair Witherington
Inwater Research Group

SEA TURTLES ARE MEDICINE

Wallace J. Nichols
Research Associate, California Academy of Sciences; author of Blue Mind

SPECIAL SESSIONS

THE FUTURE OF SEA TURTLE CONSERVATION

Chairs: Ken Lohmann, Nathan Putman, and John Wang

GENETICS AND GENOMICS OF SEA TURTLES

Chairs: Peter H. Dutton, Nancy Fitzsimmons, Lisa Komoroske, and Brian Shamblin

USING SCIENCE TO INFORM CONSERVATION

Chair: Ann Marie Lauritsen

NAVIGATION, MIGRATION AND NATAL HOMING

Chairs: Nathan Putman and Ray Carthy

SPECIAL FEATURES

SPEED CHATTING WITH THE EXPERTS

Chairs: Hector Barrios-Garrido, Vanessa Bezy, and Emma Harrison

Panel: Jesse Senko, Lisa Komoroske, Camryn Allen, Dan Evans, Natalie Wildermann, Catherine Lohmann, Nathan Putman, Marc Girondot, and Carlos Carreras Huergo

FILM NIGHT

Chairs: Tom Backof, Christian Gredzens, and Katherine Comer Santos

22 short films highlighting elements of sea turtle research, conservation and outreach from diverse geographic areas, including Florida, Surinam, Italy, California, Papua, Ghana, Argentina, Gulf of Mexico, Texas, Brazil, and Costa Rica, were shown publicly during one evening of the symposium.

WORKSHOPS

SEA TURTLE REHABILITATION AND VETERINARY MEDICINE WORKSHOP
Organizers: Shane Boylan, Daniela Freggi, Mariluz Parga, Antonio Di Bello, Greg Lewbart, and Craig Harms

UAV (DRONE) WORKSHOP: PROBLEM-SOLVING, TURNKEY SYSTEMS, AND WHAT'S NEXT
Organizers: ALan Rees, Raymond Carthy, and Thane Wibbels

DOES WHAT WE DO MATTER? THE CRITICAL NEED TO EVALUATE AND HOW TO DO IT
Organizers: Shelli Hendricks and Jack Frazier

CAPTIVE REARING FOR RESEARCH AND CONSERVATION
Organizers: David Owens and Jeanette Wyneken

THE TORTOISESHELL TRADE: CURRENT STATUS AND OUTREACH EFFORTS
Organizer: Brad Nahill

MIGRATORY CONNECTIVITY IN THE OCEAN: GLOBAL SEA TURTLE MIGRATORY ROUTES AND CONNECTED AREAS
Organizers: Connie Kot, Sarah Poulin, and Sarah DeLand

GIS WORKSHOP
Organizers: Andrew DiMatteo and Laura Sparks

RECREATIONAL FISHING INTERACTIONS WITH SEA TURTLES
Organizer: Sue Barco

MARINE DEBRIS AND SEA TURTLES
Organizers: Daniel González-Paredes, Alejandro Fallabrino, Andrés Estrades, Mark Hamann, Brendan Godley, and Emily Duncan

STUDENT COMMITTEE WORKSHOP: TRENDING RESEARCH TOPICS AND TECHNIQUES
Organizers: Katherine Shaw, Christopher Gatto, and Itzel Sifuentes

FINDING THE SOLUTION FOR LIGHT POLLUTION THROUGH COLLABORATIVE MANAGEMENT
Organizers: Rick Herren, Rachel Tighe, David Godfrey, and Stacey Marquis

BEYOND THE BROCHURE: CREATING A MEANINGFUL EDUCATION COMPONENT TO HELP SECURE YOUR RESEARCH GRANT
Organizers: Rebecca Mott and Kendra Cope

ASSESSING TRENDS IN THE BIODIVERSITY OF MARINE TURTLES FROM 2010-2020 TO CONTRIBUTE TO THE 2ND UNITED NATIONS WORLD OCEANS ASSESSMENT
Organizer: Qamar Schuyler

THE GLOBAL MALE SEA TURTLE INITIATIVE: ADDING MALES TO THE CONSERVATION EQUATION
Organizers: Marco Garcia Cruz, Margarita Lampo, Cathi Campbell, Karen Bjorndal, Alan Bolten, Cynthia Lagueux, and Hannah Vander Zanden

GETTING THE MOST OUT OF SATELLITE TELEMETRY FOR MARINE TURTLES
Organizers: Padraic O'Flaherty, Colin Hunter of Lotek Wireless, Inc., and Sirtrack Ltd.

TEMPERATURE-DEPENDENT SEX DETERMINATION: FROM MOLECULAR BIOLOGY TO EVOLUTIONARY ECOLOGY
Organizers: Marc Girondot, Matthew Godfrey, Itzel Sifuentes-Romero, and Jean- Michel Guillon

HOW ENGINEERED BEACHES CHANGE SEA TURTLE NESTING & INCUBATION
Organizers: Mario Mota, Raymond Carthy, and Nicole Desjardin

EASTERN PACIFIC LEATHERBACK WORKSHOP (TALLER LAÚD OPO)
Organizers: Bryan Wallace and Velkiss Gadea

GLOBAL PERSPECTIVES ON PHOTO ID (PID) AS A 21ST CENTURY TOOL FOR SEA TURTLE RESEARCH AND CONSERVATION
Organizers: Steven G. Dunbar, Jillian Hudgins, Claire Jean, and Dustin Baumbach

ADVANCED VETERINARY TECHNIQUES WORKSHOP FOR EXPERTS

Organizers: Shane Boylan, Craig Harms, and Greg Lewbart

ENVIRONMENTAL CONTAMINANTS & SEA TURTLES

Organizers: Jennifer Lynch and Brian Stacy

MEASURING & MITIGATING RISING NEST TEMPERATURES

Organizers: Blair Bentley and Jeanette Wyneken

UPDATES ON THE STATUS OF SEA TURTLES WORLDWIDE & HOW PROPOSED CHANGES TO THE U.S. ENDANGERED SPECIES ACT MIGHT AFFECT THEM

Organizers: Catherine Kilduff, Jacki Lopez, and Miyoko Sakashita

HOW TO FUND SEA TURTLE CONSERVATION PROJECTS

Organizers: Alexis Guilleux, Rodrigue Ngafack, and Thushan Kapurusinghe

REPRODUCTIVE PHYSIOLOGY: WHAT TURTLE GONADS REVEAL AND HOW TO READ THEIR SECRETS

Organizer: Colin Limpus

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The Leatherback Trust
The Marine Conservation Action Fund of the New England Aquarium
Turtle Nesting Safe
CLS-Argos
Equilibrio Azul
Loggerhead Marinelife Center
Lotek/Biotrack/Sirtrack
ProDelphinus
SWOT
The Pacuare Nature Reserve
Turtle-Trax
WWF

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ANATOMY, PHYSIOLOGY, & HEALTH

BACTERIAL AND FUNGAL COMPOSITION OF NESTING LOGGERHEAD FEMALE CLOACAL MUCUS USING A MOLECULAR-BASED APPROACH

Jennifer Brofft Bailey, Sierra Bartlett, Andrien Wilson, Mukti Patel, and Kathryn Stephenson Craven

Georgia Southern University, Armstrong Campus, Savannah, GA, USA

Microbial infection of incubating sea turtle eggs is a threat to hatch success. Sea turtle eggs are exposed to a wide variety of microbes associated with the mother and the nest. Over the past several years, our research group has surveyed the bacterial and fungal composition within unhatched ('failed') loggerhead eggs on Jekyll Island and Wassaw Island, Georgia (USA); many potential pathogens have been detected by this effort. The current study is focused on charactering the cloacal microbiome of nesting female loggerheads. Despite the potential impact of these microbes on the health of the mother and her clutch, this component of the sea turtle normal flora has been understudied. During 2013-2018, cloacal mucus was collected from loggerhead females nesting on Wassaw Island, GA. Cloacal mucus was collected aseptically during egg deposition using sterile swabs. Swabs were then stored in a sterile Falcon tube, frozen and maintained at -80C until analysis. A molecular-based method not reliant on cultivation, was used to characterize the associated microbial communities. DNA was extracted using the PowerSoil DNA Isolation kit and used as a template to PCR amplify bacterial 16S rRNA genes and fungal internal transcribed spacer (ITS) regions present in the samples. Amplified genes were then cloned and sequenced. Sequences having at least 97% (bacterial 16S) and 99% (fungal ITS) nucleotide identity were grouped into the same operational taxonomic unit (OTU). Representative sequences from each OTU were compared to GenBank sequences and subject to phylogenetic analysis in order to tentatively identify the microbes corresponding to the amplified genes. Thus far, diverse microbial types have been identified. Fungal types include members of the genera *Malassezia*, *Aspergillus*, *Penicillium* and *Tilletiopsis*, all of which have been detected in the surveyed unhatched eggs. Interestingly, *Fusarium keratoplasticum* and *Fusarium falciforme* have yet to be detected in the cloacal samples despite consistently representing the most commonly recovered fungal types in the unhatched eggs. Bacterial diversity is high among samples of cloacal mucus, with most of the 16S sequences recovered from the phyla Bacteroidetes, Proteobacteria, Firmicutes and Actinomycetes. Most cloacal bacteria detected have sequences with high nucleotide identity to the 16S genes of either environmental clones or bacterial isolates recovered from animal intestinal tracts. Continued screening of cloacal samples is ongoing. Collectively, this data should continue to elucidate the loggerhead microbiome and determine whether the mother represents a significant source of pathogenic microbes to clutches. We express our profound gratitude to our collaborators at the Caretta Research Project for samples from Wassaw Island and our collaborators at the Georgia Sea Turtle Center for samples from Jekyll Island. This work was completed with scientific collecting permits from the USFWS and GA.

DIVERSITY OF GENE EXPRESSION IN SEA TURTLE BLOOD*

Shreya M. Banerjee[1], Jimmy Benge[2], Camryn Allen[3,4], Jennifer Lynch[5], Eleanor Sterling[6,7], Eugenia Naro-Maciel[8], Kate McFadden[9], Margaret Lamont, and Lisa M. Komoroske[4,10]

[1] Department of Environmental Conservation, University of Massachusetts, Amherst, MA, USA
[2] BioGenex, Fremont, CA, USA
[3] The Joint Institute for Marine and Atmospheric Research, Marine Turtle Biology and Assessment Program, Protected Species Division, Pacific Islands Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Honolulu, HI, USA
[4] Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, La Jolla, CA, United States
[5] Chemical Sciences Division, National Institute of Standards and Technology, Hawaii Pacific University, Waimanalo, HI, USA
[6] Center for Biodiversity and Conservation, American Museum of Natural History, New York, NY, USA
[7] New York University, New York, NY, USA
[8] School of Agricultural, Forest, and Environmental Sciences, Clemson University, Clemson, SC, USA
[9] Wetland and Aquatic Research Center, United States Geological Survey, Gainesville, FL, USA
[10] Department of Environmental Conservation, University of Massachusetts, Amherst, MA, USA

Organisms can modulate physiological responses to environmental conditions in many ways, including altering gene expression. Transcriptomic studies can identify key biological functions that may be altered under different environmental conditions or throughout development. However, there have been limited studies in sea turtles to date due to ethical and logistical challenges of obtaining high quality tissue samples. However, non-lethal blood samples can be used to understand the diversity of genes that are expressed within and among populations of sea turtles, as well as the biological functions that may be affected by different natural and anthropogenic conditions. We used RNA-Sequencing to explore the diversity of genes expressed and the allelic variation present among individuals and four species (green, hawksbill, leatherback and loggerhead turtles). We extracted RNA from blood samples and assembled and annotated a reference transcriptome. In total, we identified a total of 560,500 unique genes expressed by these individuals (range per individual: 330,512 - 432,555). Overlap in genes expressed across individuals ranged from 64% to 87%, and with loggerheads displaying the lowest mean proportion of shared expressed genes. Turtles within populations generally had higher mean proportions of shared expressed genes relative to representatives of other populations (e.g., green turtles in Southern California, USA vs. Hawaii, USA). One individual captured off Kailua, Hawaii, USA had a higher diversity of expressed genes than any of the other individuals sampled. These data show variation in gene expression by species as well as populations within species, and identifies candidate biomarker genes informative for additional studies, such as using transcriptomics to assess how differential gene expression is correlated with sex, disease status, and/or exposure to contaminants.

QUANTIFYING BREVETOXINS IN GUT CONTENTS AND TISSUES OF SEA TURTLES STRANDING DURING A RED TIDE EVENT*

Rick Bartleson

Sanibel Captiva Conservation Foundation, FL, USA

A bloom of *Karenia brevis* starting in October 2017 resulted in the largest number of sea turtle deaths ever attributed to a single red tide event. Between October, 2017 and October, 2018, 247 sea turtles stranded on Sanibel, Captiva and the surrounding waters (128 loggerheads, 83 Kemp's ridleys, 34 green turtles, and one turtle not identified to species). An overwhelming majority of these strandings were observed with no external wounds or abnormalities and the source of mortality was uncertain using external evaluation alone. This unfortunate mass mortality event provided a unique opportunity to quantify brevetoxin levels in the tissues of strandings and confirm toxin-related mortality associated with lethal concentrations. Learning more about uptake of the toxin and physiological response by juvenile and adult sea turtles was a secondary goal. Liver, fat, muscle, and blood samples were collected from loggerhead, green, and Kemp's ridley sea turtles (n=50) that stranded between May and September, 2018 in an effort to better understand how these algal blooms affect sea turtles. Gut contents of dead turtles were examined for identifiable prey to conduct a dietary analysis. Representative samples from the gut were analyzed to quantify brevetoxin and microcystin levels using immunoassay and GC/MS. In conjunction with other monitoring efforts, we collected data on location of bloom patches and intensities over the course of the event. Given that *Karenia* concentrations above 105 cells l-1 were consistently documented for 11 consecutive months, we anticipate lethal levels of brevetoxins in the samples collected. Preliminary results indicate that loggerheads and Kemp's ridleys consumed four main prey categories: crustaceans, mollusks, chelicerates, and fish. Crabs and mollusks (whelks, conchs, moon snails and clams) were the dominant prey consumed by both loggerheads and Kemp's ridleys, occurring in 95% of gut samples. Often, crabs and mollusks were the only prey items noted. Less frequently observed prey items were fish and spider crabs in Kemp's ridleys. Understanding dietary habits and brevetoxin uptake will be useful for predicting the impacts of future catastrophic Harmful Algal Bloom events.

SURGICAL AND MEDICAL TREATMENT OF INJURIES CAUSED BY INTERACTION WITH HUMAN ACTIVITIES IN 537 SEA TURTLES OBSERVED IN THE LAST FOUR YEARS

Antonio Di Bello, Delia Franchini, Stefano Ciccarelli, Francesco Caprio, and Carmela Valastro

Department of Veterinary Medicine, University of Bari, Italy

The impact of human activities represents a serious problem for the conservation of turtles. In this study 537 cases of injured sea turtles observed at the Sea Turtle Clinic of the Department of Veterinary Medicine, University of Bari, from 2015 to 2018 are reported. The cases analysis was evaluated based on the capture systems, the severity of lesions, the treatment performed, and the results obtained. We are enrolled 895 turtles, 891 Loggerheads (*Caretta caretta*) and 4 Green turtles (*Chelonia mydas*), referred by different Sea Turtles Rescue Centers in southern Italy. For each subject a data collection, including way of finding and morphometric parameters, clinical and radiographic examinations were performed; if it was suspicion or evidence of fishing lines through the gastrointestinal tract, ultrasound investigations were also performed. The 895 turtles examined ranged between 17.5 cm and 90 cm of CCL (mean 58.9 cm) and 15.5 cm and 77 cm of CCW (mean 53.7 cm), weight ranged between 0.6 kg and 76.1 kg (mean 26.4 kg). Based on the capture modes, 727 (81.2%) sea turtles had been accidentally caught with trawl, 108 (12.0%) found adrift, 49 (5.5%) stranded, 6 (0,7%) were captured on the hook by boaters and 5 (0.6%) with gill nets. In 109 turtles were detected signs related to recent or previous interaction with longline or similar non-professional fishing tools: 31 showed only the presence of hooks, 74 showed hooks and fishing line from mouth and/or cloaca and 4 only the fishing line that crossed the gastrointestinal tract. Among these 109 subjects, 85 underwent surgery for removing foreign bodies from the gastrointestinal tract, 9 to remove the hook from the oral cavity with mild sedation, 2 naturally expelled the hook with digestion, while 13 cases were not undergoing surgical removal. 340 subjects showed clinical and radiographic signs of gas embolism and/or drowning (305 gas embolism, 15 drowning and 20 both diseases). 336 of the 340 (98.8%) were accidentally caught with trawl nets, while 4 (1.2%) were found stranded or drifting. The other 88 turtles had mainly fractures of the head and/or carapace and plastron or entanglement injuries. 358 turtles did not show any clinical or radiographic evidence of pathology, 344 (96.1%) were trawled, 14 (3.9%) found adrift. Of the 895 turtles studied, 52 (5.8%) died, 13 before the observation, 39 due to reported disease. The data from this study confirm the high impact of fishing systems on turtles, as well as other human activities. Most of the turtles observed were caught in the south of the Adriatic Sea where trawling is a widespread fishing method, that causes death in the highest percentage. In fact, 5.0% of the turtles caught with this fishing system have already died or died immediately hours after observation. Moreover, 340 out of 727 (46.8%) turtles accidentally trawling showed signs of gas embolism and/or drowning. The severity of the damage and the timeliness of hospitalization were fundamental elements for the prognosis and resolution of the disease. Therefore, it's reasonable to think that a large part of these animals would die, if released immediately after capture. Data collect on turtle captured with hooks and fishing lines confirmed previous studies. Many subjects with hooks and very short line showed no clinical alteration, conversely, all turtles with line in gastrointestinal tract showed signs of illness caused by intestinal damages. All of these subjects have been found adrift or stranded and the ultrasonography detection proved to be decisive to identified fishing lines, to show intestinal damage and to choose the best surgical approach.

ENDOCRINE CORRELATES OF REPRODUCTION ASSOCIATED WITH OVARIAN STATUS AND BODY CONDITIONS IN THE NORTH ATLANTIC GREEN TURTLE (*CHELONIA MYDAS*)*

Renato Saragoça Bruno[1], Jaime Alberto Restrepo Machado[2], Gilberto Rafael Borges Guzman[3], and Roldán A. Valverde.[1,2]

[1]*Biological Sciences Department of Southeastern Louisiana University, LA, USA*
[2] *Sea Turtle Conservancy, Tortuguero, Costa Rica*
[3] *Asociacion de Proteccion a las Tortugas Marinas del Caribe*

Sea turtle reproduction is energetically costly, entailing long-distance migrations, courtship and mating, selection of nest sites, and the production of multiple clutches of eggs. Thus, female sea turtles must reach an energetic threshold before undergoing reproduction, and environmental events that disturb food availability affect the number of individuals reproducing each season. In a changing world, where more common and extreme climatic phenomena alter nutritional pathways, understanding the regulation of sea turtle reproduction is crucial for conservation. In most vertebrates, including humans, the central nervous system and the pituitary gland use hormones to orchestrate long-term functions such as growth, response to stress, and reproduction. In female sea turtles, upon receiving signals from the hypothalamus, the pituitary stimulates the ovaries to produce the sex hormones estradiol 17ß (E_2) and testosterone (T) that are linked to the initiation of the reproductive cycle and to egg formation. In response to E_2, the liver produces vitellogenin (VTG), a protein deposited in ovarian follicles during a process called vitellogenesis and that largely constitutes egg yolk. Thus, reproductive success relies heavily on yolk deposition, and understanding the sequence of events leading to vitellogenesis is essential for identifying threats to sea turtle reproductive success. Despite the evidence that reproduction is controlled by sex hormones and proteins, the paucity of endocrine studies aimed at wild sea turtle populations leaves a gap in our knowledge regarding the concentrations of these molecules throughout the reproductive cycle. By analyzing concentrations of steroid hormones and VTG and body conditions in female green turtles (*Chelonia mydas*) of the North Atlantic population throughout one nesting season, we aimed to further our understanding of hormonal control of sea turtle reproduction. Between June and October 2018, we sampled blood from the cervical sinus (N=91) and weighed and measured (N=30) female green turtles nesting at Tortuguero National Park, Costa Rica. We quantified steroid hormones using Enzyme-linked Immunosorbent Assays (ELISA) and used an in-house indirect ELISA exclusive to our research team to quantify VTG in the samples. Results of this study will provide the complete story of the fluctuation of endocrine correlates of reproduction E_2, T, and VTG throughout the nesting season of female green turtles from the North Atlantic. Additionally, this information can be used as a basis for the creation of an index of reproductive status of female green turtles, pinpointing events affecting sea turtle reproductive output, and estimating the size of this population.

TIMING OF FIBROPAPILLOMATOSIS TUMOR REGRESSION IN JUVENILE GREEN TURTLES

Kayla L. Burandt, Jake Kelley, and Kate L. Mansfield

University of Central Florida, Marine Turtle Research Group, Orlando, FL, USA

Fibropapillomatosis (FP) is a benign tumor-forming disease that mainly affects juvenile green turtles (*Chelonia mydas*). It is commonly found in coastal habitats where environmental factors likely affect FP development. While FP can cause mortality and sublethal effects in juveniles, tumors can regress naturally over time, with many individuals documented as making full recoveries. However, this tumor regression process is not well understood. We assessed the timing of tumor regression in juvenile green turtles by evaluating the time it takes to go from initial tumor development to complete regression, as well as factors affecting tumor regression. We used data collected from a long-term mark-and-recapture study of juvenile green turtles in the Indian River Lagoon (IRL), Florida, USA. Fibropapillomatosis rates documented in the IRL averaged 50% during the study (1982-2018), with many individuals documented as having partial and full regression of tumors over time. Previous work shows that most turtles quickly develop FP upon recruitment to the IRL at around 30 cm straight carapace length, with most individuals showing no signs of FP by the time they reach 50 cm straight carapace length. We assessed the time it took for tumors to regress using records from visual examinations of 225 flipper-tagged turtles with a history of FP. We evaluated if FP tumor regression time is affected by the season, the size of the turtle, and the severity of tumors. Our data suggest that the time from initial FP development to complete tumor regression varies between 2 to 6 years. This study provides a regional baseline for tumor regression duration in wild juvenile green turtles affected by FP within western Atlantic waters. This is important for understanding the disease system and monitoring its effects in a high-FP prevalence population.

NON-LETHAL INVESTIGATION OF CONTAMINANT TOXICITY IN LOGGERHEAD (CARETTA CARETTA) SEA TURTLES USING SKIN BIOPSY CULTURES*

Caleshia S. Calvin

Texas Tech University, Lubbock, TX, USA

The six sea turtle species that inhabit the coastal waters of the United States are labeled as either vulnerable, endangered, or critically endangered by the International Union Conservation of Nature Red List. Loggerheads (*Caretta caretta*) are specifically classified as vulnerable and this species of sea turtle inhabits and migrates throughout the Atlantic, Pacific, and Indian oceans. According to the Marine Turtle Specialist Group of the IUCN Species Survival Commission, the anthropogenic hazards of most concern for all sea turtles are the impacts from fisheries, poaching, coastal development, pollution and pathogens, and climate change. Other studies have illustrated that trawl net entanglements, recreational activities, and habitat degradation are also great threats to the loggerhead population. The exposure and uptake of marine contaminants, coupled with these threats, can have deleterious effects on sea turtles. Polycyclic aromatic hydrocarbons (PAHs) and halogenated aromatic hydrocarbons (HAHs) are common marine contaminants. These contaminants have been detected at various stages of the sea turtle life cycle. Both PAHs and HAHs have been detected in sea turtle eggs, including in yolks and chorioallantoic membranes. PAHs and PCB congeners have also been found in plasma, liver, muscle, fat, and kidney tissues. Little is known about the potential adverse effects of these chemicals in sea turtles. Organotypic or organ slice culture is widely used for toxicity testing in pharmacology and medicine but is still novel in wildlife. Organ slice cultures were established from skin biopsies collected from healthy animals at the NOAA Sea Turtle Facility in Galveston, Texas. Several studies have indicated that this ex vivo methodology more closely represents in vivo systems than the traditional in vitro cultures that lack a three-dimensional structure and are composed of only one cell type. We previously validated the viability of these skin slice cultures in the loggerhead sea turtle, both in media with and without fetal bovine serum, for up to 96h. Viability was assessed by the following endpoints: (1) the measurement of lactate dehydrogenase (LDH) in the culture media, (2) quantitation of the internal potassium in skin biopsies by flame atomic absorption spectrometer, and (3) cell culture establishment from skin. Skin biopsies were cultured in media dosed for 4-72h with either benzo[a]pyrene (B[a]P) at 0.01µM, 1µM, and 100µM concentrations or polychlorinated biphenyl 126 (PCB 126) at 0.01µM, 0.1µM, and 1µM concentrations. In both chemical exposure scenarios, skin biopsies exposed to the carrier solution alone, dimethyl sulfoxide (DMSO, <0.1%), served as control. The enzymatic activity of CYP1A, a well-established biomarker of exposure for PAHs and planar HAHs, was measured using ethoxyresorufin O-deethylase (EROD), methoxyresorufin O-demethylase (MROD), benzyloxyresorufin O-debenzylase (BROD), and pentoxyresorufin O-depentylase (PROD) by spectrophotometry. Preliminary results indicated that CYP1A activity could be detected in the skin biopsy cultures after exposure to B[a]P and PCB 126.

STABLE ISOTOPE ANALYSIS REVEALS FORAGING NICHE SEGREGATION AND RESOURCE USE OF GREEN AND HAWKSBILL TURTLES IN PACIFIC COSTA RICA

Chelsea Clyde-Brockway[1], Maike Heidemeyer[2,3,4], Elizabeth A. Flaherty[5], and Frank V. Paladino[6]

[1] *Department of Forestry and Natural Resource, Purdue University, West Lafayette, IN, USA*
[2] *Centro de Investigación en Biología Celular y Molecular (CIBCM)*
[3] *Centro de Investigación en Ciencias del Mar y Limnología (CIMAR)*
[4] *Universidad de Costa Rica, San José, Costa Rica*
[5] *Department of Forestry and Natural Resource, Purdue University, West Lafayette, IN, USA*
[6] *Department of Biology, Purdue University, Fort Wayne, IN, USA*

Sea turtles provide a wide range of ecosystem services with the spongivorous hawksbill turtle promoting reef biodiversity and green turtles managing algae growth and increasing nutrient cycling in sea grass pastures; therefore, understanding resource use, diet, and niche overlap across species is critical for conservation and habitat management. In 2017, we collected whole blood and skin samples from spatially co-occurring Indo-Pacific green turtles, East-Pacific green turtles, and Pacific Hawksbill turtles that forage in newly discovered foraging locations in North Pacific Costa Rica. We used stable isotope analysis to determine proportional contributions of regionally available diet sources to animal tissue and used kernel estimation methods to quantify niche space and niche overlap. Specifically, we compared diet and niche between juvenile turtles from three spatially co-occurring populations of East Pacific turtles (hawksbill turtles, East-Pacific green turtles and Indo-Pacific green turtles), between juvenile and adult East-Pacific green turtles, and between sexes of turtles in Costa Rica. Our results indicate that although all green turtles are classified as one species, East-Pacific and Indo-Pacific green turtles have distinct stable isotope signatures and significant niche differentiation in core niche space estimates, suggesting separation in resource use. Indo-Pacific green turtles and hawksbill turtles, however, had overlapping niche space at core contour levels (50%). This suggests comparable trophic position, although specific dietary composition was unique. In addition, age class (adult vs juvenile) and sex (male, female, immature) resulted in distinct stable carbon and nitrogen signatures. Diet and niche space analyses suggest that turtle foraging plasticity results in divided resource use. This, as well as the ecological roles of turtles in Matapalito and Salinas bays, requires a more holistic approach to the protection of sea turtles, in which we increase protection of their environments in Pacific Costa Rica as well as increasing protection of sea turtles themselves.
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HIGH CIRCULATING CORTICOSTERONE IN COLD-STUNNED JUVENILE GREEN TURTLES SUGGESTS TRANSIENT STRESS IN OTHERWISE HEALTHY TURTLES

Chelsea Clyde-Brockway[1], Elizabeth A. Flaherty[1], and Frank V. Paladino[2]

[1] Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN, USA
[2] Department of Biology, Purdue University, Fort Wayne, IN, USA

Every year, thousands of green turtles become immobilized by rapid decreases in water temperature along the East Coast of the United States and wash ashore. To quantify stress in cold-stunned juvenile green turtles, we measured corticosterone and cortisol, along with testosterone and dihydroxy testosterone, in epidermis and plasma of green turtles upon arrival at the North Carolina Aquarium before rehabilitation, during the 2017 (n = 12) and 2018 (n = 9) cold-stunning events (January – March). We included epidermis as an indication of chronic hormone levels without the inflation associated with capture. In addition, we collected plasma and epidermal samples from captive green turtles (2018) that were bred and maintained by the Cayman Islands Turtle Farm, Grand Cayman. We included captive turtles to investigate the use of non-dynamic tissues in stress physiology, and to measure handling stress without cold-stunning. We classified all turtles in this study (captive and wild) as juvenile due to very low androgen levels and small size (curved carapace length < 50 cm). In North Carolina, epidermal hormone concentrations were not significantly different between years as hormonal concentrations in non-dynamic tissue represents a measure of hormones at the time the tissue was created. Epidermal tissue was created long before the turtles encountered cool water, suggesting that turtles are not exposed to chronically stressful environments. Plasma hormonal concentrations for each turtle was significantly higher than epidermal tissue for all hormones measured. Corticosterone, the biologically active stress hormone in reptiles, was the only plasma hormone that changed between years and was higher in 2018 than 2017. Since water temperatures did not vary significantly between years, this difference in corticosterone concentration could be related to turtle size (and therefore age) because turtles were larger in 2018 (curved carapace length 38.8±4 cm; weight 5.3±1.5) compared to 2017 (curved carapace length 32.5±3 cm; weight 3±0.8 kg). We suggest that the turtles in North Carolina are undergoing acute stress that is not indicative of chronically stressful environments since their stress response is exaggerated compared to previous studies that measured handling stress in green turtles in Australia, and all other health parameters indicate good health. North Carolina is an important foraging location for juvenile green turtles, rehabilitation and subsequent release of cold-stunned juvenile turtles is very important to the continued success and conservation of this population. Results from the Cayman Islands Turtle Farm are ongoing. Acknowledgements: We would like to thank Dr. Emily Christiansen and Dr. Matthey Godfrey for their assistance with North Carolina permits and sample collection. We would like to thank Dr. Walter Mustin, Dr. Vandanaa Baboolal and Dr. Ana Malabia for collecting samples at the Cayman Islands Turtles farm and securing necessary export permits. This project was approved by the North Carolina Aquarium Institute for Animal Care and Use Committee (protocol #NCA16-005) and Purdue Animal Care and Use Committee (protocol #1510001309). Samples from the Cayman Islands Turtle Farm were imported under USFWS CITES Permit 18US06369C/9.

FUSARIUM DOMINANCE OF FUNGAL DIVERSITY IN LOGGERHEAD SEA TURTLE NESTS IN THE SOUTHEASTERN U.S.*

Kathryn Stephenson Craven, Morgan Lamb, Madalynn Walker, Charriz Weed, Madison Sox, Shawna Defreitas, and Jennifer Brofft Bailey

Georgia Southern University, Armstrong Campus, Savannah, GA, USA

Failed sea turtle eggs were surveyed for potential fungal pathogens using a molecular approach that does not rely on cultivation. The DNA was extracted from aseptically collected samples. The fungal internal transcribed spacer (ITS) region was amplified from DNA templates using PCR. Amplified ITS products were then cloned and sequenced. Fungal ITS sequences sharing at least 99% nucleotide identity were grouped into operational taxonomic units (OTUs). To identify the corresponding fungi, representative members of each OUT were compared to the GenBank database and subjected to phylogenetic analysis. The fungal community within fully incubated loggerhead sea turtle eggs collected on Jekyll Island, GA (2010, 2012) and Wassaw Island, GA (2013, 2016) was dominated by members of the *Fusarium solanispecies* complex (FSSC), specifically *Fusarium keratoplasticumand* and *Fusarium falciforme*. Recovered *F. keratoplasticumand* and *F. falciforme* ITS sequences had high nucleotide identity (99-100%) to and clustered with those of *F. keratoplasticumand* and *F. falciformeisolates* cultivated in studies that implicated these fungi in sea turtle egg failure. FSSC ITS sequences have been detected in nest sand samples, but have not yet been detected in cloacal swab or fresh egg samples. Other fungal genera were identified from cloacal and fresh egg samples as a continuation of the study of probable fungal sources. Some of the fungal types detected in these samples correspond to those representing minor fungal components within failed eggs. Data thus far suggests that *F. keratoplasticum* and *F. falciforme* are common inhabitants of unhatched loggerhead eggs in coastal GA and that these organisms are likely derived from nest sand. This data has implications that could prove important for management decisions. Now that the Southeastern US has been documented as positive for FSSC, when counting or moving nests, perhaps egg handling practices that could increase FSSC exposure should be reconsidered. We express our profound gratitude to our collaborators at the Caretta Research Project for samples from Wassaw Island and our collaborators at the Georgia Sea Turtle Center for samples from Jekyll Island. This work was completed with scientific collecting permits from the USFWS and the GA Department of Natural Resources. Funding for this project was provided by Armstrong State University and Georgia Southern University.

VENOUS BLOOD GAS AND ACID-BASE EVALUATION OF WILD, HOOKED, AND COLD-STUNNED LOGGERHEAD SEA TURTLES (CARETTA CARETTA)

Nicholas Dannemiller[1,2], Sarah Rose[3], Allyson McNaughton[3], and Susan Barco[3]

[1] *Stranding Response Program, Virginia Aquarium & Marine Science Center, Virginia Beach, VA, USA*
[2] *Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO, USA*
[3] *Stranding Response Program, Virginia Aquarium & Marine Science Center, Virginia Beach, VA, USA*

Two common causes of live loggerhead sea turtle strandings resulting in admission into rehabilitation in Virginia are cold stunning (i.e. hypothermia) and interactions with recreational hook and line fisheries. Upon admission for rehabilitation, blood analyte data are an invaluable tool in guiding the veterinary care of stranded loggerheads. Although previous studies have documented hematologic and plasma biochemical values, there are currently limited reports on the blood gas and acid-base status of stranded loggerheads in northwestern, mid-Atlantic waters. The objectives of this study were to describe and compare the venous blood gas and acid-base status of three groups of loggerheads: 1) presumed healthy, wild turtles, 2) turtles hooked by recreational fisherman, and 3) cold-stunned turtles. Venous blood gas, acid-base, and select plasma biochemical values at the time of admission to the Virginia Aquarium Marine Animal Care Center and capture by Virginia Aquarium research teams from 2010-2018 were compared retrospectively for 29 wild, 27 hooked, and 26 cold-stunned loggerheads. Hooked turtle values were not controlled for potential comorbidities. pH and pCO_2 were temperature corrected to reflect the turtles' respective body temperatures, and bicarbonate and ionized calcium concentrations were subsequently calculated using these temperature corrected values. Analyses highlighted that cold-stunned loggerheads presented with multiple metabolic, respiratory, and electrolyte derangements. Cold-stunned turtles exhibited significantly increased total solids (Kruskal-Wallis X^2=13.757, p-value < 0.05; median=5.85 g/dL) and bicarbonate (Kruskal-Wallis X^2=10.36, p-value < 0.05; median=44.4 mmol/L) as well as significant hypokalemia (Kruskal-Wallis X^2=21.87, p-value < 0.05; median < 2.0 mmol/L) and significantly decreased BUN (Kruskal-Wallis X^2 = 16.146; p-value < 0.05; median=23 mg/dL). Cold-stunned turtles also had significant hypocalcemia (Kruskal-Wallis X^2=21.87= 21.113, p-value < 0.05; median=0.64 mmol/L) compared to wild (but not hooked) loggerheads. Hooked loggerheads presented with minimal clinical pathologic derangements including significantly decreased packed cell volume (Kruskal-Wallis X^2=22.471, p-value < 0.05; median= 25%). Cold-stunned and hooked loggerheads had significant hyperglycemia (Kruskal-Wallis X^2=31.052, p-value < 0.05; median=184 and 120 mg/dL, respectively) compared to wild conspecifics (median=72 mg/dL), and wild and hooked loggerheads had significantly increased lactate (Kruskal-Wallis X^2=20.987, p-value < 0.05; median=7.4 and 10.5 mmol/L, respectively) compared to cold-stuns (median=1.2 mmol/L). This study highlights the importance of ongoing efforts to understand the pathophysiology of the blood analyte derangements seen in stranded loggerheads at the time of triage and represents the first evaluation of the venous blood gas and acid-base status of hooked and cold-stunned loggerheads in northwestern, mid-Atlantic waters.

HEAVY METALS IN THE BLOOD OF BLACK TURTLE BREEDING MALES (CHELONIA MYDAS AGASSIZII) OF THE POPULATION OF MICHOACÁN, MÉXICO

Carlos Delgado-Trejo[1,2], Jorge Adrian Mora Guzmán[2], and Cutzi Bedolla Ochoa[1,2]

[1] Departamento de Ecologia Marina y Costera-INIRENA
[2] Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Michoacán México

The population of black sea turtle in Michoacan, México is possibly the largest population of Chelonia in the tropical eastern Pacific with approximately 15000 nesting females per year, this population has been monitored since 1978 and continues to 2018. This population has recovered significantly from 2000 mainly on the beach of Colola, the main site of nesting of this population in Mexico and possibly throughout the eastern Pacific region. Although this population has recovered demographically in the last decade, some threats such as the pollution of marine ecosystems in which it interacts in its life cycle continue to operate. The presence of heavy metals has been reported in several species and populations of sea turtles, which by their concentrations can pose a threat to their health and to those who consume them legally and illegally. Pollution is the introduction of harmful elements that are not common in a given ecosystem. Some of the most common contaminants derived from human activity are pesticides, herbicides, chemical fertilizers, detergents, hydrocarbons, wastewater, plastics and other solids. Many of these contaminants accumulate in the depths of the ocean, where they are ingested by small marine organisms through which they are introduced into the global food chain. Sea turtles represent an excellent field of study to measure concentrations of such contaminants, feed at different trophic levels, and in different areas of the Earth. Due to its state of conservation, there is a growing interest in these endangered species around the world. Before this study was not known the presence and concentration of heavy metals in males breeding black turtle of the population of Michoacán, this paper evaluates the concentrations of heavy metals in this segment reproductive. This paper reports the presence and concentration of 12 heavy metals (Al, As, Cd, Co, Cr, Cu, Fe, Mn, NOR, Pb, SE, Zn) in blood obtained from 20 male breeding males of black tortoise (*Chelonia mydas agassizii*) of the population of Michoacán, México. Heavy metals were obtained through a MP-AES microwave-induced plasma emission spectrometer. Elevated Se concentrations (13.9 µg/G-1), Ni (12.38 µg/G-1) and Pb (12.17 µg/G-1) were detected and low concentrations of Mn (0.06 µg/G-1), and Cr (0.02 µg/G-1). The concentrations of Ni and Pb exceeded the permissible maximum limits for life in estuaries and coasts of the EPA (2003). No correlations were observed between the size (LCC) and the weight of the males with the concentration of heavy metals in the blood. Thanks to Earl Possard from U.S Fish and Wildlife Service, Universidad Michoacana de San Nicolás de Hidalgo, Jeff George from Sea Turtle Inc. Brad Nahill from One Billion Baby Turtles, Pat Burchfield and Jaime Peña from Gladys Porter Zoo. Perfentino Valencia From Colola community and Colola: Capital Mundial de la Tortuga Negra A.C.

WHEN IT IS REALLY NECESSARY TO AMPUTATE AN ENTANGLED FLIPPER: EVALUATION OF VASCULARIZATION WITH COLOUR DOPPLER ULTRASOUND AND MDCT ANGIOGRAPHY IN LOGGERHEADS

Delia Franchini[1], Carmela Valastro [1], Stefano Ciccarelli[1], Mario Ricciardi[2], Diana Lenoci[3], Francesco Caprio[1], and Antonio Di Bello[1]

[1] *University of Bari, Department of Veterinary Medicine*
[2] *Pingry Veterinary Hospital, Bari, Italy*
[3] *Private Practitioner, Cerignola (FG), Italy*

Marine turtle entanglement is defined as 'the process under which a marine turtle becomes entwined or trapped within anthropogenic material'. Entanglement has the potential to cause a range of fatal and non-fatal impacts because debris or fishery gear cause strangulation of anatomical parts such as flippers or the neck that leads to deep lacerations, maiming, amputation, increased drag, restricted movement or choking. Partially or completely amputated forelimbs are common and turtles unable to dive cannot eat or rest. The aim of the present study was to evaluate with Colour Doppler ultrasound and MDCT any residual vascularisation or neovascularization in entangled flippers of 9 loggerheads, monitoring over time the possible revascularization of ischaemic flipper areas even when the sensitivity is absent. When residual vascularization was present, we analysed which vessels are involved in neoangiogenesis. Ultrasound examinations were performed on 4 turtles using a portable US device (Esaote MyLab Alpha). A linear multifrequency probe 10-14 MHz (Esaote 1543) was used with longitudinal and transversal scans optimized for anatomical and vascularization study of the entangled flipper and when it was present, the controlateral flipper served as healthy control. To study the flow of the flipper vessels the bidirectional color doppler was used. The flow of the brachial artery and part of the radial was clearly visible. The flow in the ulnar artery was not identified. The biceps muscle and extensor carpus were completely dissected. Small subcutaneous vessels presented flow. The follow-up after 2 months showed the presence of neoangiogenesis of superficial collateral vessels in the residual muscle and subcutaneous tissue. Five turtles underwent a total-body MDCT examination with a 16-slice MDCT scanner (Somatom Emotion: Siemens, Forchheim, Germany). In all patients CT images were acquired before and after the manual injection of iodinate contrast medium. In all patients the CT showed variable degrees of bone damage of the middle part of the humeral diaphysis. In all patients with severe narrowing of the brachial segment of the flipper and humeral fracture, the main trunk of the brachial artery was interrupted and the two halves appeared connected by small tortuous collaterals vessels. Following surgical curettage of all the entangled flippers, the treatment protocol included exclusive use of the plant-derived dressing (1 Primary Wound Dressing®) applied daily on the wound surface. Only 1/9 flipper was amputated. All the soft tissue defects were completely healed by secondary intention. Understanding by means of imaging diagnostics if the distal stump of an entangled flipper is still vascularized is a critical point before carrying out a treatment, to try to perform a conservative treatment, avoiding amputation as much as possible.

BIOCHEMISTRY VALUES AND PHYSICAL EXAMINATION OF GREEN SEA TURTLES (CHELONIA MYDAS) IN SISTEMA ARRECIFAL VERACRUZANO NATIONAL PARK, VERACRUZ, MEXICO

Emilio Suárez Domínguez[1], Ibiza Martínez Serrano[1], Albertina Cortés Sol[1] Claudia Belen Ortega Planell[1], and Vanessa Labrada Martagón[2]

[1] *Universidad Veracruzana*
[2] *Universidad Autónoma de San Luis Potosí*

Blood biochemistry and physical examination have been suggested as important techniques to measure the impact of human activities on the turtles and their habitat. Moreover, the need of establish blood biochemistry reference values for each population has been identified as a priority for turtle conservation. Especially in regional or local scales, like the Sistema Arrecifal Veracruzano National Park (PNSAV, by its Spanish acronym). PNSAV is a Protected Natural Area (PNA) located in the coastal area of the Mexican state of Veracruz. This place has historically served as a port, being one of the most important in the country. For this reason, this site is subject to significant pressure as a result of maritime traffic, fishing, tourism, among other activities. Therefore, human activities may pose a risk to the species that inhabit the PNSAV, especially the green turtle (*Chelonia mydas*), which is highly susceptible to suffering from changes in its environment and also is the most abundant species in this PNA. Given the above, the aim of this work was to establish the reference values of the blood biochemistry of a group of green turtle juveniles of the PNSAV and evaluate the physical status. For this purpose, twelve juvenile green turtles were captured and later released, during March-November 2017, through the manual capture from an Argos boat with an outboard motor. The curved carapace measurements vary from 41 to 71 centimeters. Blood samples were extracted from the cervical sinuses and were analyzed through spectrophotometry. The values obtained were 104.7 ± 10.8 (mg/dL) for glucose, 197 ± 40.4 (mg/dL) for cholesterol, 264,8 ± 103.8 (mg/dL) for triglycerides, 14.9 ± 2.7 (mg/dL) for urea, 1,9 ± 0.4 (mg/dL) for uric acid and 0.3 ± 0.09 (mg/dL) for creatinine. On the other hand, all the specimens examined were found free of injuries and only three of them had few shell and fin barnacles. These values are within those referred for other populations of clinically healthy green turtles from the Bahamas, Hawaii, Venezuela and Baja California Mexico. These results are a hallmark that the juvenile specimens of the PNSAV analyzed correspond to healthy individuals. However, it is necessary to continue with this study to establish and determine other aspects of the health of the green turtle that contribute to its management and conservation in this protected area of Mexico. We want to thank the collaboration project between the Universidad Veracruzana and the administration of the port of Veracruz for the financing (API-GI-CS-62601-054–16).

DYNAMICS OF STRESS AND IMMUNE COMPETENCE DURING REHABILITATION OF DEBILITATED SEA TURTLES

Grace Dodillet[1], Annie Page-Karjian[1], Justin R. Perrault[2], Charles A. Manire[2], Terry M. Norton[3], and Roldán A. Valverde Error! Bookmark not defined.[4]

[1] *Harbor Branch Oceanographic Institute, Florida Atlantic University, Boca Raton, FL, USA*
[2] *Loggerhead Marinelife Center, Juno Beach, FL, USA*
[3] *Georgia Sea Turtle Center, Jekyll Island, GA, USA*
[4] *Southeastern Louisiana University, Hammond, LA, USA*

Chronic debilitation, characterized by near-terminal starvation of any cause, is a grave problem for stranded and rehabilitating loggerhead sea turtles (*Caretta caretta*). Little is known about the etiology of this disease, despite the fact that approximately 50% of stranded loggerheads admitted to rehabilitation facilities along the coasts of Georgia and Florida exhibit clinical signs of chronic debilitation. Although chronically debilitated loggerheads are common patients in rehabilitation facilities and are presumably stressed and immunosuppressed, to date little is known about fluctuations in their stress and immune responses during the rehabilitation and recovery processes. This study aims to provide a better understanding of the role of stress and immune function in chronically debilitated loggerhead turtles by investigating the dynamics of various biomarkers throughout the duration of rehabilitation. To do this, we analyzed blood/plasma samples from chronically debilitated, rehabilitating loggerhead turtles for various biomarkers of immune system health (e.g., packed cell volume [PCV], complete blood count [CBC], H/L ratio, haptoglobin); and chronic and oxidative stress (e.g., plasma glucose, corticosterone, and reactive oxygen species [ROS] concentrations; superoxide dismutase [SOD] and lysozyme activities). Blood health data for 48 cases of chronically debilitated loggerhead turtle patients in rehabilitation facilities during 2013 – 2017 were retrospectively analyzed. Preliminary data indicates a decrease in ROS and SOD activity during rehabilitative care, and an increase in PCV, white blood cell (WBC) counts, lysozyme activity, and plasma glucose levels from admission to release. Additionally, pre-release values were significantly higher than entry values for PCV, total protein, total WBC counts, and glucose. These results highlight the critical role of nutritional and supportive care in re-establishing normal immune capacity, and emphasize the need to expand upon these data to include more specific biomarkers of chronic and oxidative stress and multiple time points. Prognostic indicators identified in this study will be valuable to rehabilitators by helping to direct triage and clinical decision-making, thereby helping to streamline the rehabilitation process and utilize resources as efficiently as possible.

SCALES AND SCUTES VARIABILITY IN CHELONIA MYDAS FROM SOUTHERN BRAZIL: PHENOTYPIC DIVERSITY OR HYBRIDIZATION?

Gabriel Fraga da Fonseca[1], Liana Rosa[2,3], and Camila Domit[2,3]

[1] *Laboratório de Zoologia, Universidade Estadual de Ponta Grossa (UEPG). Ponta Grossa, PR, Brazil*
[2] *Laboratório de Ecologia e Conservação, Centro de Estudos do Mar (CEM/UFPR)*
[3] *Universidade Federal do Paraná. Pontal do Paraná, PR, Brazil*

Sea turtles often display great phenotype variability, including the number and shape of the scutes of carapace and the head scales. This variability is apparent in both individuals from different origins and also hybrids, being the assessing of those parameters the first step to identify potential individuals to be

investigated by molecular and morphological methods. Sea turtle hybridization is reported at a high incidence in some nesting areas in Brazil. The hybridization process is recorded for almost all species of the Cheloniidae family, including the green turtle (*Chelonia mydas*) being more frequent between two species, loggerhead (*Caretta caretta*) and hawksbill (*Eretmochelys imbricata*). Recent studies highlight the hybrids should be better-analyzed focusing on their morphological and physiological characteristics, while also demanding a better understanding of their ecological and genetic roles in the natural environment. Assess these data will bring up pieces of evidence of evolutionary process, supporting the development and implementation of adequate policies and guidelines for sea turtle conservation. The present study measured the number of prefrontals and postocular scales, and also the nuchal, marginal, vertebral, costal and supracaudal scutes of 605 individuals of *C. mydas* recorded stranded in the Paraná coast, southern Brazil. The animals were collected between August 2015 and March 2018 by a systematic beach monitoring program (PMP-BS*). Only slightly decomposed individuals (considered code 2 and 3) were analysed, avoiding interference from scales and scutes detachment caused by the decomposition process. About one third of all individuals analysed presented a variation in at least one scale or scute, resulting in 219 (~35%) green turtles with sub- or supra-numerary scalation. The most common alteration was found in the postocular scales, on both sides of the head, ranging from three to six (expected number = 4). Vertebral scutes variations, even in only 23 cases, were always recorded in supra-numerary number, between six and eight scutes. From 605 *C. mydas*, 26 had morphological characters comparable to other sea turtle species: 22 of those have differences in the number of scutes and scales, might be caused by hybridization. Molecular analysis of these 26 specimens will be conducted to test the hypothesis of occurrence of hybrid or at least provide information about phenotype variation on the mixed stocks using the Paraná foraging ground. Thus, this study evaluated morphological variation on juveniles *C. mydas* in Paraná, yielding primary information about biological and evolutionary issues.

EVALUATING HARMFUL ALGAL BLOOM EFFECTS ON GROWTH RATES OF JUVENILE GREEN TURTLES

Mia El-Khazen, Jake Kelley, Chris Long, and Kate L. Mansfield

University of Central Florida, Marine Turtle Research Group, Orlando, FL, USA

Rising mean temperatures and anthropogenic factors have led to an increase in harmful algal blooms (HABs). These blooms are responsible for detrimental impacts on ecosystems such as fish die-off and hypoxic events. On the east coast of Florida, USA, the frequency of HABs is increasing in estuarine systems. In a diverse ecosystem such as is in east-central Florida, it is important to evaluate the impact of HABs on threatened species, particularly juvenile green turtles (*Chelonia mydas*) that use coastal waterways as foraging habitats. The Indian River Lagoon (IRL) is a foraging area for juvenile green turtles, and although HABs have not directly caused large die-offs of green turtles in the IRL, much of the macroalgae that green turtles feed on died off as a result of prior HABs, reducing food availability both during and after HAB events. Previous work conducted by the University of Central Florida Marine Turtle Research Group indicated that body condition of green turtles in the IRL decreased during recent HABs and stayed low in the years after the blooms. Growth rates may have also been affected by HABs due to limited food availability. We hypothesize that the impacts of recent HABs have caused decreased growth rates among juvenile green turtles in the IRL. To assess our hypothesis, we analyzed data from a long-term mark recapture project in the IRL. We compared growth rates of juvenile green turtles before (January 2005-March 2011), during (April 2011-August 2013), and after (September 2013-present) the occurrence of two consecutive HAB events in the IRL. We used generalized additive models (GAMs) to model growth rates from over 150 recapture records and then compared growth rates among our time-frames of before,

during, and after the event. Our analyses suggest that growth rates decreased in the IRL during the blooms. A decrease in growth rates related to HABs could lead to smaller adults or an increased age at maturity, either of which could affect long-term reproductive output. Mitigating the effects of HABs should be a conservation goal to protect the long-term viability of green turtle populations.

SPECIES-SPECIFIC EFFECTS-BASED IN VITRO ASSAYS AND TRACE ELEMENT ANALYSES DETECT DIFFERENCES IN EXPOSURE AND EFFECT IN GREEN TURTLE FORAGING GROUNDS*

Kimberly Finlayson

Australian Rivers Institute, Griffith University, Nathan, QLD, Australia

Exposure to chemical contamination can be assessed using a number of methods. For trace elements, chemical analysis remains the most prevalent method for assessing exposure. Effects-based analyses using in vitro bioassays have benefits when assessing exposure to organic contaminants, as compounds not targeted during chemical analysis, compounds below the detection limit, and mixture effects are better accounted for. Using a combination of effects-based analysis for organics and chemical analysis for trace elements, differences in chemical exposure between three green turtle foraging grounds in southern Queensland, Australia, were examined. Effects-based analyses were carried out by extracting organics from turtle blood using the QuEChERs method and applying the extracts primary turtle skin fibroblast cells. Two endpoints, cytotoxicity and oxidative stress, were measured in separate bioassays. Whole blood was analysed for 26 trace elements (Ag, Al, As, Ba, Cd, Co, Cr, Cs, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, Sn, Sr, Th, Ti, Tl, U, V, W, Zn, Zr). The bioassay and trace element analyses indicate site specific differences between each of the three turtle foraging grounds, in particular for Moreton Bay where cytotoxicity and oxidative stress were more pronounced and elevated blood concentrations of Cs, Ag, As and Se were positively correlated. This study demonstrates that incorporating effect data into typical chemical exposure analysis can provide a better indication of risk than chemical analysis alone.

ISOLATION AND CHARACTERIZATION OF VIBRIO SPP. IN NESTING OLIVE RIDLEY (LEPIDOCHELYS OLIVACEA) SEA TURTLES FROM NORTHWESTERN MEXICO

Jorge Eduardo Valdés Flores[1], Vicente Olimón Andalon[1], Igmar Sosa Cornejo[1], Hector Manuel Flores Villaseñor[2], Jorge Adalberto Velazquez Román[2], Alma Guadrón Llanos[2], Marco Antonio Valdez Flores[2], Alan Zavala Norzagaray[3], Nidia León Sicairos[2], and Vicente Adrian Canizalez Román[2]

[1]*Facultad de Biología. Universidad Autónoma de Sinaloa. C.P. 80030, Culiacán Sinaloa, Mexico*
[2] *Centro de Investigación Aplicada para la Salud Pública (CIASaP), Facultad de Medicina, Universidad Autónoma de Sinaloa, Culiacán, Mexico*
[3] *Departamento de medio ambiente y 15seudomona comunitario, Instituto Politécnico Nacional, Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional – Sinaloa, Guasave, Mexico*

Oral and Cloacal aerobic microbial isolation was characterized by 40 nesting sea turtles on the nesting beach of Ceuta (Municipality of Elota) Sinaloa, México (Pacific Ocean). Samples were taken in Olive ridley turtles (*Lepidochelys olivacea*) from July to October 2018. Aim: Isolate and characterize *vibrio spp*, to

determine the presence or virulence-associated genes in nesting olive ridley turtles. Results: We isolated 5 different gram-negative species (*E. coli, Proteus sp, seudomonas p, Shigella sp, Klebsiella sp*.) and 22 different *Vibrio spp*. Among the strains of *Vibrio*, we will search for the presumptive different *Vibrio spp.* (*V. Cholerae, V. fluvialis, V. Alginolyticus and V. parahaemolyticus*) they belong in order to determine the pathogenic strains and presence of genes associated with virulence. In conclusion, we isolated gram negative bacteria and *Vibrio spp.* that are potential human (toxigenic) pathogens in sea turtles and could represent the transmission of environmental microbes to human (illegal and unhealthy to eat sea turtles), we discourage the consumption of meat and eggs in northwestern Mexico.

ASSESSING HAEMATOLOGICAL AND BIOCHEMICAL PARAMETERS AND THEIR EFFECTIVENESS AS A HEALTH ASSESSMENT IN RESCUED LOGGERHEAD SEA TURTLES (CARETTA CARETTA) IN LAMPEDUSA, SOUTH MEDITERRANEAN

Daniela Freggi and Danielle Stringer

Lampedusa Turtle Group, Lampedusa, AG, Italy

The South Mediterranean is a common foraging and nesting site for loggerhead sea turtles, but they often come into conflict with anthropogenic factors like fishing gears and pollution. Lampedusa Sea Turtle Rescue Centre admits around 100 annually in variable health conditions, which are provided with any necessary veterinary treatment and then released when physical fitness is deemed normal. Haematological assessments have been performed on many admissions over the last six years and the data for some parameters recorded: glucose (mg/dL), microhaematocrit (%), total protein (g/dL) and erythrocyte count (/µL of blood). As part of a preliminary study, 2017, the data collected to date was statistically analysed against the health condition; method of capture; age; sex and morphometric data (curved carapace length (CCL); curved carapace width (CCW); straight carapace length (SCL) and straight carapace width (SCW). Compared to physiological parameters, around 30% of animals had high glucose levels, 20% low microhaematocrit readings and 38% low erythrocyte counts. Turtles that were caught by manual methods were also found to have significantly lower erythrocyte counts ($P \leq 0.05$). Our new study aims to build on this research by an intensive period of data collection, August – October, 2018, with weekly repeats for each animal whilst they are housed in the rescue centre. Additional information for each turtle will include a body condition score (BCS), quantified by a body condition index (BCI), as well as an assessment of the epibiota. Haematological testing will also include additional total and differential white cell counts and biochemical analysis, and this new collection of data will undergo statistical analysis.

INFLUENCE OF UV LIGHT ON VITAMIN D AND IMMUNE FUNCTION IN GREEN (CHELONIA MYDAS) SEA TURTLES WITH FIBROPAPILLOMATOSIS*

Victoria Garefino and Sarah Milton

Florida Atlantic University, Boca Raton, FL, USA

Sea turtles play a vital role in the marine environment and can be indicators of ecosystem health. Green sea turtles (*Chelonia mydas*) are an endangered species prone to a debilitating disease called fibropapillomatosis (FP). This disease is typically seen in juveniles and has been associated with a weakened immune system and polluted environments. Turtles infected with FP show significantly lower immune function compared to turtles without FP. The current treatment for this disease is tumor removal surgery; however, regrowth often occurs. The aim of this study is to determine the influence of UV light on vitamin D levels and immune function in juvenile green sea turtles with FP. Juvenile green sea turtles with FP brought into the Gumbo Limbo Nature Center in Boca Raton, FL for rehabilitation were split into control and treatment groups. Turtles without FP and only minor other injuries were also included in the study as a control group for immune function in turtles without the disease. Ultra violet (UV) light irradiance was measured in each tank using a HOBO Pendant Temperature/Light Data Logger. UV light irradiance showed maximum exposure averages of 144,146 Lux and 166,057 Lux in control tanks and 543,369 Lux and 449,123 in treatment tanks. Blood samples were collected on intake, every two months and at release when a turtle was kept for more than 8-12 weeks. White blood cells were isolated on a discontinuous Percoll gradient and incubated with Fluorescein Isothiocyanate (FITC) beads for 1 hour at 37°C and 4°C to allow phagocytosis to occur. Rates of phagocytosis were measured using Flow Cytometry on a FACSCalibur high-speed digital bench-top cell sorter as a measure of immune function. Samples are also being tested for plasma vitamin D concentrations, as increased vitamin D levels in the blood has been shown to increase immune system function in other vertebrates. Preliminary data show low rates of phagocytosis in turtles with FP on intake, with a mean value of 5.1%. Turtles without FP, however, had a mean intake rate of phagocytosis of 1.95%. One FP treatment turtle showed an increase in the rate of phagocytosis from 2.31% at intake to 6.28% when sampled 2 months later. The results of this project may provide rehabilitation facilities with a mechanism to improve the outcome of animals with this disease found in south Florida and other locations with widespread FP occurrence. Acknowledgements: This study is funded by an award to SLM and a graduate scholarship to VG from the Friends of Gumbo Limbo. All work is performed under FWC permit #053.

USING CELL CULTURES TO INVESTIGATE THE TOXICITY OF MARINE CONTAMINANTS IN LOGGERHEADS*

Céline Godard-Codding[1], Jocylin D. Pierro[1], Christiana Wittmaack[1], James Surles[1], and Benjamin M. Higgins[2]

[1] *Texas Tech University, Lubbock, TX, USA*
[2] *Southeast Fisheries Science Center, Galveston Laboratory – Protected Species Branch, National Oceanic and Atmospheric Administration, Galveston, TX, USA*

Perfluorooctanoic Acid (PFOA), Benzo[a]pyrene (B[a]P), and Polychlorinated Biphenyl 77 (PCB 77) are contaminants commonly found in marine environments. These chemicals have been detected in the tissues, eggs, plasma, and prey items of sea turtles, including loggerheads (*Caretta caretta*). These chemicals are known for cytotoxicity, mutagenicity, carcinogenicity, immunotoxicity, adverse reproductive and developmental effects, and negative impacts on pulmonary, renal and hepatic systems in a wide range of species. Interestingly, some reports have also found higher polycyclic aromatic hydrocarbons (PAHs) and PCBs burdens in sea turtles affected with fibropapillomatosis (FP). Overall, the effects of these organic contaminants in the threatened loggerhead and in other sea turtle species are poorly known since in vivo toxicological testing is prohibited in these animals. Here we report on in vitro cytotoxicity of PFOA, B[a]P, and PCB 77 in primary loggerhead skin cells. We established the primary cultures from skin biopsies collected from healthy animals at the NOAA Sea Turtle Facility in Galveston, Texas. The effects of chemical exposure were measured by two common viability assays – MTT and Lactate Dehydrogenase (LDH). Toxicity was assessed according to commonly used in vitro testing guidelines with cell cultures (n=7) exposed to each chemical for 1-4 days. Exposure concentrations were based upon environmentally relevant levels found in sea turtle eggs, plasma, tissue, prey items, and habitats. Toxicant concentrations were 0.01, 0.1, 1, and 10 μM for PCB 77 and B[a]P, and 0.05, 0.5, 5, 50, and 500 μM for PFOA. Data was analyzed using Analysis of Variance (ANOVA), Tukey's Kruskal-Wallis, Wilcoxon, Welch's ANOVA and Games-Howell tests where applicable. Analyses have detected toxicity of PFOA, B[a]P, and PCB 77 at several time points and concentrations, in both the MTT and LDH assays. Cytotoxicity was detected by MTT assays at the highest doses following exposure at all time points for PCB 77 and PFOA. To our knowledge, this is the most comprehensive in vitro study on organic contaminant toxicity in loggerhead sea turtle primary cultures obtained from healthy animals. This study provides important groundwork on establishing the harmful effects of common marine contaminants on sea turtles. We are currently developing mathematical models to extrapolate these in vitro data across biological organization levels in order to provide novel information applicable to risk assessment of sea turtles.

A MULTI-FACETED HEALTH ASSESSMENT FOR A SAMPLE OF NESTING LOGGERHEAD TURTLES

Vivian Hernandez[1], Rachel Smith[1], and Blair Witherington[2]

[1] Disney's Animals, Science and Environment, Lake Buena Vista, FL, USA
[2] Inwater Research Group, Jupiter, FL, USA

We compiled health-status reference information for nesting loggerhead sea turtles to create a reference for sea turtles that can be applied to those in human care, whether they are permanent residents or in temporary rehabilitation. While other studies have sampled the health of wild loggerhead sea turtles, we chose to use nesting females as a proxy for a healthy population; these animals have to be in general good health to mate, migrate and lay eggs on nesting beaches. We do not suggest that the sample of nesting loggerheads used represents an ideal baseline for the species as a whole, but the sample is unique as a reference. Nesting loggerheads were sampled in the Archie Carr National Wildlife Refuge in Brevard County, Florida during the months of May through August in 2017 and 2018. Sampled loggerheads were approached only after oviposition had begun. Blood samples, morphometric measurements, visual assessments of body condition, and fat thickness via a portable ultrasound were collected from the sampled loggerheads between the egg laying stage and her descent back into the ocean. Partial or complete data were collected from 60 loggerheads over two seasons. Fulton's body condition factor was calculated for 50 loggerheads over both seasons. The blood and serum samples for 10 loggerheads from 2017 have currently been analyzed for various blood chemistry concentrations including calcium, cholesterol, glucose, potassium, magnesium, total protein and triglycerides. Preliminary results of the blood and serum samples show a negative correlation with triglyceride levels as the season progressed. Samples collected earlier in the nesting season had a higher concentration (mg/dL) of triglycerides than the samples collected later in the season. These trends may be attributed to loggerheads fasting over the duration of their nesting season. These data will be combined with the blood and serum analysis for 25 additional loggerheads sampled in 2018.

HIERARCHICAL OCCUPANCY MODELING TO ACCOUNT FOR IMPERFECT HERPESVIRUS DETECTION IN THE FIBROPAPILLOMATOSIS DISEASE SYSTEM

Jake Kelley, Anna E. Savage, and Kate L. Mansfield

University of Central Florida, Marine Turtle Research Group, Orlando, FL, USA

In disease ecology, hierarchical models are used to address imperfect pathogen detection, which is a common problem, but often not accounted for. Occupancy modeling is a hierarchical model framework developed to assess site-occupancy of a species when detection is imperfect, and it can be adapted for use in disease ecology. Using the pathogen as the ‘species’, and its host as the ‘site’, occupancy modeling can be used to account for imperfect pathogen detection in assessing pathogen prevalence. We used hierarchical occupancy models to investigate the sea turtle disease fibropapillomatosis (FP), which is characterized by development of benign tumors on the skin, eyes, and/or internal organs. While all species of sea turtles can be afflicted, juvenile green turtles (*Chelonia mydas*) in coastal habitats are most strongly affected by FP. The putative pathogen of FP is chelonid herpesvirus 5 (ChHV5). However, individuals can be infected with ChHV5 but present no visible signs of disease. Testing for ChHV5 infection in a turtle without FP is imperfect due to the nature of herpesviruses, which can exist as latent infections at very low quantities and exhibit localized infections concentrated in particular areas of the body and absent in other areas. This makes it difficult to assess the prevalence of ChHV5 in populations affected by FP and the role of ChHV5 in FP development. We developed hierarchical occupancy models accounting for imperfect pathogen detection to accurately assess ChHV5 prevalence and infection dynamics. We assessed ChHV5 prevalence at a coastal juvenile green turtle foraging site, the Indian River Lagoon (IRL) in east central Florida, USA. The IRL is the site of an ongoing long-term juvenile sea turtle monitoring project that started in 1982. Fibropapillomatosis prevalence in green turtles of the IRL has averaged 50% throughout the study period. The longevity and high FP rates of the IRL study make it ideal for assessing the ChHV5-FP system. We used quantitative polymerase chain reaction (qPCR) techniques to test for the presence of ChHV5 in blood samples from over 800 juvenile green turtles captured between 1995 and 2018. We then used modified hierarchical occupancy models to evaluate ChHV5 infection dynamics in the IRL, including overall pathogen prevalence, factors that affect presence of ChHV5 infections in individuals, and the detectability of ChHV5 via our sampling and qPCR methods. Initial model results indicated that over 85% of juvenile green turtles in the IRL were infected with ChHV5, far exceeding naïve ChHV5 prevalence estimates that do not account for imperfect detection. Assessing the true ChHV5 prevalence at this site and others is important for understanding the relative role of the virus in the development of FP. Here we found that a majority of turtles in the IRL were infected with ChHV5, while only 50% of turtles on average had external FP tumors, suggesting that environmental and/or immune factors likely play a strong role in FP tumor development. Funding and support for this work was provided in part by the National Marine Fisheries Service, the Florida Fish and Wildlife Conservation Commission, the U.S. Fish and Wildlife Service, the Richard King Mellon Foundation, the Disney Wildlife Conservation Fund, the Bernice Barbour Foundation and the Brevard Zoo. In addition, this study was funded in part by a grant awarded from the Sea Turtle Grants Program. The Sea Turtle Grants Program is funded from proceeds from the sale of the Florida Sea Turtle License Plate. Learn more at www.helpingseaturtles.org.

DEVELOPING A METHOD FOR ASSESSING BODY COMPOSITION OF SEA TURTLES IN THE FIELD

Sara Kophamel

James Cook University, Douglas, QLD, Australia

Examining sea turtle populations also helps understanding the impact of environmental and anthropogenic factors on other marine species and on the ecosystems they inhabit. Sea turtles are thus considered sentinels of ecosystem health. In other words, having healthy turtles means having a healthy ecosystem. A way of examining sea turtle health is by looking at their body composition. Body composition, referring to the amount of fat, lean mass and water, is an important marker of the physiological performance of every living organism. In sea turtles, fat provides an energy reserve which is essential for survival especially in adverse conditions. Together, the amount of fat and muscle indicate the health status and reproductive success of the animal and its population. Poor body compositions are directly linked to poor reproductive success, as animals with depleted fat stores won't be successful producing offspring. Body composition assessments therefore provide valuable information about a population's fitness. However, currently there are no methods to assess body composition of sea turtles in the field. This study examines the in vivo methods available for body composition assessment and concludes that bioelectrical impedance analysis, being validated by computed tomography scans, could be used as a method for body composition assessment of sea turtles in the field. Preliminary results will be presented.

RESEARCH ON THE FEEDING ECOLOGY OF GREEN SEA TURTLE (CHELONIA MYDAS) IN THE OGASAWARA ISLANDS

Sayaka Hosoi, Shun Ito, Koto Shimotori, Remiha Akira, Ayako Shinba, and Kendai Kuroki

Tokyo University of Marine Science and Technology, Tokyo, Japan

The Ogasawara islands are the largest rookery in Japan for green sea turtles (Chelonia mydas). Long-term researches on nesting and post-hatching behavior have been conducted in this region. Understanding the in-water ecology is equally important to uncover the breeding and migration of green sea turtle. Sea Turtle Research Collegium (Tokyo University of Marine Science and Technology) investigated the digestive tract contents of both male and female green sea turtles during the mating season. Traditional turtle harvesting is conducted in Ogasawara under the regulation Tokyo metropolitan government. The research was conducted from 2016 to 2018 from March through May. Digestive tract contents were collected from esophagus, stomach, and intestine from 48 harvested individuals (male:26, female:22). Tract contents were cleaned with seawater directly after collection. Samples were classified and measurement of wet weight and size were recorded. Several species of seaweed were found in the digestive tract contents and composition had individual variations. Overall, the percentage of *Dictyotales* and *Fucales* were high in 2016, and *Halymeniales* in 2017 and 2018. The percentage of sea squirt (*Pyrosoma atlanticum*) was high in 2018. In addition, esophagus contents were found from 83.3% of the sea turtles. This number strongly suggests that green sea turtles were feeding during the mating season. Meanwhile, the possibility of esophageal contents ingested before migrating to the Ogasawara islands cannot be ignored. In order to monitor the speed of digestion, digestion rate of captive-housed green sea turtle was assessed during the same nesting season. The result should ascertain whether these digestive tract contents were foraged in the

sea peripheral of Ogasawara islands. Foraging ecology and migration route of mature green sea turtles in Ogasawara islands will be discussed from those researches of digestive tract contents and digestion speed.

INVENTORY AND POTENTIAL USES OF THE NIST BIOLOGICAL AND ENVIRONMENTAL MONITORING AND ARCHIVAL OF SEA TURTLE TISSUES (BEMAST) PROJECT

Jennifer Lynch[1,2], Melissa R Jung[2], Brenda Jensen[2], Amanda Moors[3], and Rebecca Pugh[3]

[1] *National Institute of Standards and Technology, Chemical Sciences Division, Waimanalo, HI, USA*
[2] *Hawaii Pacific University, College of Natural and Computational Sciences, Kaneohe, HI, USA*
[3]*National Institute of Standards and Technology, Chemical Sciences Division, Hollings Marine Laboratory, Charleston, SC, USA*

In 2011, the National Institute of Standards and Technology (NIST) began BEMAST, a project that archives sea turtle tissues primarily for health and contaminant assessments. The rationale and stringent protocols for BEMAST sample collection and processing were outlined previously[1]. This presentation will provide an updated inventory and description of uses of the archive to promote future collaborative studies. The seven-year collection now includes >2771 tissues from 886 individual sea turtles and 289 sea turtle nests, and is expected to grow. Samples are collected by permitted non-NIST collaborators from live captures, stranded and bycatch necropsies, and egg excavations. Samples represent six species from coastlines of the United States Southeast, California, Hawaii, Palmyra Atoll, the Mariana Islands, Guam, and pelagic waters of the tropical Pacific Ocean. Tissues, including blood, scute, fat, muscle, liver, bile, follicles, fibropapilloma lesions, blubber, skin, ingested plastics, prey, digestive fluids, and egg contents are homogenized into multiple subsamples and stored at liquid nitrogen vapor temperatures (< -150 °C) at the NIST Biorepository in the Hollings Marine Laboratory in Charleston, South Carolina. The samples have been proven useful for numerous and diverse studies with >16 collaborating institutions. Six published studies have measured metabolomics, chemical contaminants, natural products, and plastic debris ingestion[2-7]. Nine additional studies are underway analyzing samples for hormones, organohalogen non-targeted screening, transcriptomics, RNA stability, plasma protein fractions, perfluorinated contaminants, and metals. These are only a few examples of uses of the samples. In addition, > 800 blood samples are frozen at -40 °C from loggerhead and Kemp's ridley sea turtles with rich metadata, including satellite tracks, from the U.S. Southeast. These offer excellent samples for contaminant studies addressing temporal, spatial, and species differences, as well as endocrine disruption and E.P.A. Superfund site investigations. Researchers requesting samples within the U.S. can obtain tissue access forms by emailing jennifer.lynch@nist.gov.

ON SWIMMING ISLANDS, ISLANDERS, AND HITCHHIKERS – WHAT SEA TURTLE DIATOMS TELL US ABOUT THEIR HOSTS*

Roksana Majewska[1,2], Danay A. Stoppel[3], Carla Swanepoel[3], Christopher Nolte[4], Diane Z. M. Le Gouvello du Timat[4], and Ronel Nel[4]

[1] *Unit for Environmental Sciences and Management, North-West University, Potchefstroom, South Africa*
[2] *South African Institute for Aquatic Biodiversity (SAIAB), Grahamstown, South Africa*
[3] *Unit for Environmental Sciences and Management, North-West University, Potchefstroom, South Africa*
[4] *Department of Zoology, Nelson Mandela University, Port Elizabeth, South Africa*

The first study describing particularly abundant communities of sea turtle-associated diatoms was published only three years ago. Since then, there has been a steadily growing interest in the subject. Diatoms are well-known and widely used bioindicators of various environmental changes occurring at both micro- and macroscale, and it was suggested that diatoms found on sea turtles could be used as efficient indicators of the sea turtle behaviour and health. Recent reports indicate that an important portion of the sea turtle diatom community is composed of taxa not observed on other substrates, suggesting a unique, and possibly evolutionary important, relationship between sea turtles and their microalgal associates. The presumably truly epizoic forms appear to colonize the sea turtle carapace and skin at the initial stages of the biofilm development and, producing significant amounts of mucilaginous extracellular substances, facilitate attachment of other, not strictly epizoic taxa. Currently, however, virtually nothing is known about the origins of the sea turtle diatoms, their ecological functions, and significance for the host, whereas information on their biodiversity, ecophysiology, and biogeography remains extremely scarce. The current study is a part of the ongoing large-scale project that attempts to collect multidimensional data on diatoms growing on all seven sea turtle species from different geographical regions. This research is the first to investigate communities inhabiting not only the sea turtle skin and carapace but also the sea turtle-associated barnacles that provide an entirely different living substrate for microbial growth. Since barnacles possess pelagic and motile larval stages, they may constitute an important vector for spreading sea turtle and other surface-associated diatoms in the marine ecosystem. Samples used in this study were collected from loggerheads and leatherbacks from Kosi Bay (eastern coast of South Africa) during three nesting seasons. Diatom analysis revealed remarkable differences and high dissimilarity levels among samples collected from both the three different substrates (i.e., sea turtle skin, carapace, and barnacles) and the two different sea turtle species sampled. Interestingly, a significant difference was also detected between samples collected from apparently healthy and injured animals. The sampling season, on the other hand, seemed to not affect the animal-associated diatoms. These results clearly indicate a certain level of host-specificity in epizoic diatoms inhabiting the same geographic area and their preference for a particular animal substrate type. This also implies that both the diversity of epizoic diatoms and the complexity of the mechanisms involved in epizoic community structuring may be much larger than previously thought. We believe that this and future research exploring diatom flora on sea turtles will shed more light on various aspects of the intricate relationship among a vertebrate, an invertebrate, and a microalga and will help us better understand ecological functions of the various elements of the sea turtle holobiome.

INCIDENCE OF CONGENITAL MALFORMATIONS IN EMBRYOS OF GREEN SEA TURTLE (CHELONIA MYDAS) AT TORTUGUERO, COSTA RICA

Alexandra Martínez-Fuentes[1], Jaime Restrepo[1], and Roldán A. Valverde[1,2]

[1] *Sea Turtle Conservancy, Costa Rica*
[2] *Southeastern Louisiana University, LA, USA*

The occurrence of anomalies, malformations and asymmetries is indicative of instability during embryonic development, which is negative for the fitness of the animal. These events are rare and may be related to intrinsic and or extrinsic factors, which have an impact on embryonic processes. Currently, there are few studies on the subject in sea turtles. For this reason, the objective of the present study is to characterize the presence and frequency of malformations in embryos of green sea turtle (*Chelonia mydas*) in Tortuguero National Park, Costa Rica. Every nesting season the Sea Turtle Conservancy (STC) marks and monitors nearly 200 nests on the northernmost 8 km in the National Park. Once the incubation period concludes, these nests are exhumed and analyzed carefully to estimate hatching and emerging success, as well as to identify different factors affecting the proper development of these nests. This sample represents 15 to 20 % of the nests laid every season in the study area. We conducted a thorough review of the past 19 years from the extensive database maintained by the STC and estimated the incidence of malformations with prevalence and intensity index. It should be noted that poached, predated or destroyed by another turtle nests were not included. The analysis of the data comprises a total of 2.066 nests and 225.657 eggs, registering a mean hatching success of 78.1 % (± 21.6) for these years. A total of 1.054 embryo records were analyzed, identifying 14 types of malformations: general deformity (52.3 %) was the most frequently registered during these years, followed by the lack of pigmentation (26.5 %) and twins (12.2 %). Prevalence (5.8 % on nests and 17 % on the embryos) and intensity (1.6 malformed embryos per nest and 1 malformation per embryo) were low compared with other studies. This report provides the basis for a more detailed study with respect to malformations, especially to specify the occurrence deformities (e.g., type and region of the body where they are located). In the same way, aspects such as the characterization of the laying female and a correlation with environmental factors could help to understand better these factors affecting embryo development and influencing the occurrence of malformations during the incubation period.

SOMATIC GROWTH RATES OF NESTING LOGGERHEAD SEA TURTLES (CARETTA CARETTA) IN THE EAST ATLANTIC OCEAN

Samir Lopes Tavares Martins[1], Elena Abella[2], Nádia Ferreira Veiga[2], Luis Cardona[3], Adolfo Marco[4], and Nuno de Santos Loureiro[1]

[1]*Faculty of science and technology, University of Algarve, Portugal*
[2]*BIOS.CV - Conservation of the Environment and Sustainable Development, Sal Rei – Boa Vista Island, Cabo Verde*
[3]*RBio and Department of Evolutionary Biology, Ecology and Environmental Sciences, Faculty of Biology, University of Barcelona, Spain*
[4]*Estación Biológica de Doñana, CSIC, Spain*

Sea turtles are highly migratory species traveling between nesting and foraging areas. In some sea turtle populations, different individuals use different foraging areas thus having different diets and exploring

different resources. These contrasting foraging strategies may result into differences in growth and reproductive output. The coastal waters off Western Africa support the foraging grounds of one the largest loggerhead sea turtle (*Caretta caretta*) populations in the world. This population, which breeds in the Archipelago of Cabo Verde, presents a foraging dichotomy among sexually mature females, as demonstrated by satellite tracking and stable isotope analysis. The overall evidence reveals that small adult females forage in oceanic habitats and large adult females forage in neritic habitats off mainland Africa. Further studies with stable isotopes suggested that oceanic foraging is prevalent among the adult females, and is likely that adult loggerhead remain faithful to their foraging area for many years. Currently there is a paucity of demographic data about this population. The present study offers the first estimate for the somatic growth rate of adult loggerhead sea turtles in Western Africa. We use the capture-mark-recapture records of 754 different nesting females in the Cabo Verde Archipelago collected over 13 yr (2005 - 2018). Most females were recaptured only once (n = 691), with several turtles captured twice (n = 12), 3 times (n = 41), 4 times (n = 1) or 6 times (n = 1). The mean curved carapace length (CCL) in the first capture ranged from 72 cm to 106 cm (mean = 82.84, SD = 4.58 cm), and the average mean growth rate in this sample was 0.34 cm/year (SD = 0.60, ranged from – 2.80 to 4.56 cm/year). No statistically differences existed in the somatic growth rate of the females of different size classes <75 cm, 75.5–79.5 cm, 80–85 cm, 85.5–90 cm, 90.5–95 cm, and >95 cm). The animals showed a non-monotonic growth pattern, with peak growth within the <75 cm CCL and 90.5–95 cm CCL size class. Growth slowed thereafter to negligible values, at a non-linear rate, upon reaching an 85.5-90 cm CCL and >95 cm CCL size. The results showed that in both trophic groups, the younger females tend to growth faster than the older females. Understanding the growth rates is an important step towards resolving life history differences within sea turtle populations, and to understand population dynamics for both conservation and management such as this endangered population. We would like to thank the following organizations for supporting the study through funding: U.S. Fish and Wildlife Service and MAVA Foundation.

PREDICTING SURVIVAL RATE OF NEW YORK COLD STUNS USING BLOOD PARAMETERS

Maxine Montello[1] and Wendy McFarlane[2]

[1] The Riverhead Foundation for Marine Research and Preservation, Riverhead, NY, USA
[2] Department of Biology, Manhattanville College, Purchase, NY, USA

This study seeks to examine the correlation between measured blood parameters and success rate for release of rehabilitated cold stunned sea turtles found along New York (NY) beaches. The term cold stun is well known in the sea turtle community and is of significance in the northeastern US during winter months as sea turtles are rendered inactive due to extreme temperature shock. Typical species that cold stun are Kemp's ridleys (*Lepidochelys kempii*; most common), greens (*Chelonia mydas*), and loggerheads (*Caretta caretta*). Leatherbacks (Dermochelys coriacea), though known to strand in the winter, typically do not show evidence of cold stunning. The Riverhead Foundation for Marine Research and Preservation (RFMRP), located on Long Island, is the sole rehabilitation facility for NY State, and is the primary response team for live sea turtle stranding. Previous research related to the support of cold stuns has been conducted by other sea turtle rehabilitation facilities. The unified goal is rapid rehabilitation and release to natural environments. The RFMRP is working to refine and test an efficient and effective warming regime that will result in higher success rates for releases, while also monitoring physiological indicators that may be used to predict survival. Previous studies have suggested that indicators of high survival potential may be derived from blood results during the first few days of hospitalization. Along with a standard CBC blood screen, this study will measure blood parameters such as blood pH, pCO_2, pO_2 and potassium; indicators suggested as predictive for survival. This study will take place during the upcoming 2018/2019 cold stun season.

Between the months of October and January, the RFRMP will receive all cold stuns that strand on NY beaches. Upon arrival to the RFMRP's facility, internal temperature will be monitored using a cloacal temperature probe, and all turtles will be assigned a class level denoting the severity of their condition (Class I - Class IV). Class I and II are more responsive animals while Class III and IV patients require more critical care by attending veterinarians. Physiological status of all turtles will be documented through evaluation of external injuries and cardio-respiratory response. Blood samples will be obtained on day 1 and day 5 and all samples will either be processed in-house or sent to an offsite processing facility (Antech). During the 5-day period, all patients will be allocated to rooms based on internal temperature, and the temperature regime (5°C/day) will continue until a maximum temperature between 25°C and 30°C has been achieved. Mortalities that occur during the first 5 days of arrival will have a post mortem sample obtained. All cold stuns that arrive unresponsive and show no signs of life will be declared dead on beach (DOB) and will not be included in overall success rate. RFMRP is striving for high release rates for allcold stunned sea turtles of Classes I through IV. It is hoped that slow elevation in temperature and close monitoring of key blood parameters for all cold stuns will allow for better, more predictive, success rates and early spring release. Acknowledgements: The authors would like to thank veterinarians (Dr. Rob Pisciotta, Dr. Richard Hanusch and Dr. Jen Muscarello) as well as the rescue team staff (Kristina Hansen, Daphne Shen and Ellen Davignon) and many volunteers.

CASE STUDY: IDENTIFICATION OF INTRAOSSEOUS FIBROPAPILLOMA LESIONS IN A GREEN SEA TURTLE (CHELONIA MYDAS) USING COMPUTED TOMOGRAPHY

Nina Nahvi[1], Sophie Dennison-Gibby[2], Brian Stacy[3], and Thomas deMaar[4]

[1] Sea Turtle, Inc., South Padre Island, TX, USA
[2] Animal Imaging, Irving, TX, USA
[3] National Marine Fisheries Service, Office of Protected Resources, University of Florida, Gainesville, FL, USA
[4] Gladys Porter Zoo, Brownsville, TX, USA

Fibropapillomatosis (FP) is a neoplastic disease of sea turtles that can be debilitating and is characterized by masses that may occur anywhere on or in the body. FP was not documented in green sea turtles in Texas prior to 2010. A green sea turtle with FP was caught on hook and line in the Laguna Madre Bay in Texas in April 2017. The patient underwent six CO_2 laser tumor removal surgeries during seven months of rehabilitative care. Based on aggressive external tumor regrowth, computed tomography (CT) was performed in July 2017 to look for internal FP lesions. The CT showed polyostotic lesions of the humerus and clavicle that were benign in character. A follow-up CT scan was performed in October 2017 that revealed rapid progression of the previously identified lesions as well as new osseous and pulmonary lesions. The rapid progression indicated aggressive disease despite the previous benign appearance, and intraosseous and pulmonary FP were suspected. The patient was euthanized and histology confirmed multicentric FP involving humeri, scapulae, lungs, stomach and multifocal external tissues. Although intraosseous FP tumors have been reported, they are unusual, and in this case, had an unexpectedly benign appearance on CT. This case study demonstrates the importance of CT for evaluation of FP patients. We are awaiting histopathological results on two additional green sea turtles that potentially have FP bone lesions identified on repeat CT scans. Intraosseous FP is an aggressive disease that may have an unusually benign appearance on CT that could easily be overlooked. I am currently awaiting histopath results on 2 additional green sea turtles that may potentially have FP bone lesions as well. In which case, I would broaden the scope of the poster to include all 3 turtles.

CAUSES OF STRANDING AND MORTALITY IN SEA TURTLES AT THE NATIONAL PARK OF MORELOS REEFS DURING THE PERIOD OF 2017-2018

Erika Yazmin Hernandez Ortiz[1], Maribel Escobedo Mondragón[2], Vanessa Francisco Ramos, and Luis Alberto Ramos

[1] *CONANP*
[2] *UNAM*

This study analyzes the causes of stranding and mortality of 26 sea turtles (*Chelonia mydas, Eretmochelys imbricata* and *Caretta caretta*) reported to the National Park of Morelos Reefs at the State of Quintana Roo Mexico, from 2017 to 2018 to analyze the anthropogenic impact. For the determination of the mortality causes necropsies were performed and classified into five categories: bycatch and entanglement, trauma, infectious diseases, alteration on the habitual diet and metabolic disorders (not conclusive). Of the 26 cases 9% were attribute to bycatch and entanglement, 6% to trauma,1% to infectious diseases, 14% alteration on the habitual diet and 64% to metabolic disorders (not conclusive). Only 15% of the mortality causes were attributable to anthropogenic treats, no evident plastic debris were found or ingested by the turtle and because of the advance autolysis we couldn't take samples for histopathological studies.

COMPREHENSIVE HEALTH ASSESSMENT OF NESTING FEMALE AND HATCHLING GREEN TURTLES (CHELONIA MYDAS) IN SOUTHEASTERN FLORIDA*

Annie Page-Karjian[1], Jeffrey Cartzendafner[1], Ashley Schenk[1], Christina M. Coppenrath[2], Ryan Chabot[3], Roldán A. Valverde[4], Charles A. Manire[2], Lawrence H. Herbst[5], and Justin R. Perrault[2]

[1]*Florida Atlantic University, Harbor Branch Oceanographic Institute, FL, USA*
[2]*Loggerhead Marinelife Center, FL, USA*
[3]*Inwater Research Group, FL, USA*
[4]*Southeastern Louisiana University, LA, USA*
[5]*Albert Einstein College of Medicine, NY, USA*

Examining sea turtle health is an important component of any coastal ecosystem survey that includes sea turtle developmental, foraging, and/or nesting habitat(s). Important indicators of population health that we can monitor include population demographics, mortality trends, and baseline blood values. The objectives of this study were, for nesting adult female and hatchling green turtles (*Chelonia mydas*) in Juno Beach, Florida, USA, to: (1) establish baseline health indices; (2) evaluate blood samples to identify subclinical carriers of chelonid herpesvirus 5 (ChHV5); and (3) compare measured health indices between turtles that did and did not test positive for ChHV5. To address these objectives, we collected and analyzed the following health data for 60 adult female turtles: reproductive success; body morphometrics; hematology; plasma biochemistry, protein electrophoresis, haptoglobin, and corticosterone concentrations; plasma activity of lysozyme, superoxide dismutase, catalase, and glutathione peroxidase; plasma content of reactive oxygen and nitrogen species; quantitative PCR (qPCR) analysis of whole blood targeting chelonid herpesvirus 5 (ChHV5) DNA; and enzyme-linked immunosorbent assays (ELISAs) for plasma antibodies to ChHV5 and lung-eye-trachea virus (LETV). For 388 of the turtles that hatched from eggs deposited by 43 of the adult females, we collected and analyzed the following health data: body morphometrics; hematology; plasma glucose and total solids concentrations; and qPCR analysis of whole blood targeting ChHV5 DNA. All of the turtles included in the study were determined to be in good body condition with

minimal shell epibiota, and no grossly observable signs of developmental abnormalities or traumatic injuries. Additionally, no fibropapilloma tumors were observed on any of the turtles. Hematologic and biochemical reference intervals are presented as a baseline for healthy nesting and hatchling green turtles in Florida. Spearman correlations were observed between haptoglobin concentrations and several plasma analytes, including albumin (r_s >=0.28, P=0.03), beta gobulins (r_s =0.8, P<;0.001), total globulins (r_s =0.62, P<0.001), total protein (r_s =0.54, P<0.001), and albumin:globulin (r_s =0.36, P=0.01). Of the 60 adult female turtles evaluated, 26 (43.3%) had whole blood samples that tested positive for ChHV5 DNA via qPCR, with a mean viral copy number of 4,276 (± 6,821; range = 244–33,512) viral copies per µg DNA. Of 41 adult females tested for plasma antibodies to ChHV5 and LETV, 12 (29.3%) and 6 (14.6%) tested positive, respectively. The level of agreement between the qPCR and ELISA assays for ChHV5 was poor (K= –0.028), with qPCR being more sensitive than ELISA for detection of ChHV5. Between the two assays for ChHV5 (qPCR and ELISA), 33/60 (55%) of the adult female turtles tested positive. Of the 388 hatchling turtles evaluated, 132 (34.0%) had blood samples that tested positive for ChHV5 DNA via qPCR, with a mean viral copy number of 5,327 (± 14,678; range = 50–109,869) viral copies per µg DNA. A fair level of agreement (K=0.027) was observed in the qPCR data for mothers and their hatchlings. Notably, no statistically significant differences were observed between health data for nesting turtles that did and did not test positive for ChHV5 DNA. Juno Beach hosts one of the largest aggregations of nesting green turtles in Florida. Consequently, monitoring sea turtle health on Juno Beach is critical for helping develop an up-to-date baseline reference index for sea turtle health in Florida, and in the Northwestern Atlantic in general. This study represents the most comprehensive collection of health data for this turtle aggregation to date, and as such, provides a timely and useful profile of nesting female green sea turtle health in southeastern Florida. Acknowledgements: This work was financially supported by: Sea Turtle Conservancy Florida Sea Turtle License Plate Grants Program; American Association of Zoo Veterinarians' Wild Animal Health Fund; Florida Save Our Seas License Plate Fund.

SAMPLE QUALITY MATTERS: EFFECTS OF HEMOLYSIS ON PLASMA ELECTROLYTES, MINERALS, AND PROTEINS IN LEATHERBACK SEA TURTLES*

Justin R. Perrault[1], Katelyn M. Fraser[1], Kimberly S. Rigano[1], and Nicole I. Stacy[2]

[1] Loggerhead Marinelife Center, FL, USA
[2] Department of Comparative, Diagnostic, and Population Medicine, College of Veterinary Medicine, University of Florida, FL, USA

Plasma chemistry analytes provide important diagnostic information regarding health and disease status in many species. Oftentimes, plasma quality, specifically plasma color, is not taken into consideration in sea turtle health studies, despite the fact that moderate to severe hemolysis (i.e., lysis of red blood cells) can significantly alter plasma biochemical results. Ignoring sample quality may lead to misinterpretation of chemistry data. Sample hemolysis often occurs during or after blood sample collection and can result from increased negative syringe pressure (e.g., difficult blood withdrawal), direct contact of blood with ice, exposure to warm temperatures, or delays in sample processing. Little is known about intracellular erythrocyte chemistry in reptiles and when cell lysis occurs, erythrocyte constituents are released into plasma. The objective of this study was to evaluate the effects of moderate hemolysis on plasma electrolytes, minerals, and proteins in nesting leatherback sea turtles (Dermochelys coriacea). Plasma hemolysis is visually scored on a scale from 0–3+ in diagnostic laboratories, with 0 indicating a completely non-hemolytic sample and 1+ to 3+ indicating mild, moderate, and severe hemolysis, respectively. Twenty-seven plasma samples with absence of hemolysis were selected for use in this study and were sub-divided into two aliquots: one non-hemolytic sample (i.e., score = 0) and a second sample that was intentionally hemolyzed by mixing 40 µL of thawed and thus completely hemolyzed whole blood from the same turtle with 400 μL of the non-hemolytic plasma to create a visual hemolysis score of 2+, equaling a "cherry-red" color. Samples were analyzed for electrolytes (sodium, potassium, chloride), minerals (magnesium, calcium, phosphorus), total protein, and protein electrophoretic fractions (pre-albumin, albumin, alpha$_1$-globulins, alpha$_2$-globulins, beta-globulins, gamma-globulins). Differences between means of non-hemolytic plasma and hemolytic plasma analytes were determined using a paired-samples t-test with a Bonferroni correction. Sodium, potassium, chloride, magnesium, phosphorus, total protein, albumin, alpha$_1$-globulins, alpha$_2$-globulins, beta-globulins, and gamma-globulins were significantly higher in hemolytic plasma compared to non-hemolytic plasma. The albumin:globulin ratio was significantly lower in hemolytic plasma compared to non-hemolytic plasma. Alpha$_2$-globulins and potassium were the analytes most impacted by hemolysis, with an average of 3.3- and 2-fold increases in hemolyzed samples compared to non-hemolytic samples, respectively. Our results indicate that sample quality (i.e., hemolysis score) must be considered when interpreting plasma analyte data, as values from hemolyzed samples can be spurious and even fall outside reference ranges for the species. This may influence clinical decisions for individual turtles in rehabilitation or research settings or result in misinterpretations of population level data. Therefore, hemolysis scores should be reported alongside the clinical chemistry data in all sea turtle health studies. Samples with moderate to severe hemolysis should be excluded from datasets when interpreting electrolyte, mineral, and protein results.

HEALTH STATUS OF LOGGERHEAD TURTLES (CARETTA CARETTA) IN THE GULF OF ULLOA, BAJA CALIFORNIA SUR: HEMATOLOGY, BLOOD BIOCHEMISTRY AND BODY CONDITION*

Leslie Agali Resendiz Pichardo, Sergio Francisco Flores Ramírez, Jorge Antonio Guzman Segura, and Helena Varela Talango

[1] *Laboratory of Molecular Ecology and Genetics applied to Conservation. Autonomous University of Baja California Sur, La Paz, Baja California Sur, México*

Loggerhead sea turtles (*Caretta caretta*) from The North Pacific population, perform a trans-oceanic migration of ca. 12.000 km., from the Japanese archipelago to the Northeastern Pacific. Large numbers of juvenile loggerhead turtles from such population, congregate on the western coast of the Baja California Peninsula, particularly within the Gulf of Ulloa. The site stands out for its high productivity and biomass, an attribute that explains the intense and profitable fishing activities that take place in the area, and a significant concentration of loggerheads preys. Since 2003, high mortality rates of loggerhead turtles due to incidental fishing have been recorded in the area. Such mortality rates reached alarming rates in 2012, surpassing the historical average by 600%. Although a study demonstrated high entanglement rates of sea turtles in the area, the Mexican government did not take action to mitigate bycatch, arguing that an inter-institutional report questioned the number of turtles killed in fishing nets, noting that other causes of death (e.g., famine, diseases) should be assessed. Therefore, the U.S. issued an embargo threat, forcing the Mexican Government to decree a Fishing Refuge in the Gulf of Ulloa. However, fishermen strongly deny that their fishing gear kills turtles, while environmental and fisheries authorities, and politicos, demand additional evidence to confirm that the mortality of loggerheads in the Gulf of Ulloa is not due to other causes (e.g., disease, famine, pollution and harmful algal blooms). The latter prompted us to assess the health status of loggerhead turtles distributed in the Gulf of Ulloa. In this study, the haematological and biochemical reference intervals were determined from 40 sampled loggerheads captured in the Gulf of Ulloa (November 2016 to September 2017). We were able to discern two size classes (23 small immature and 17 large immature/mature). The body condition of all loggerhead was assessed based on the categories of the Body Condition index all were found to have a very good body condition >1.20). In addition, no significant differences were found between both size classes regarding the haematological variables: Heterophil, Eosinophil, Basophil, Lymphocyte, Monocyte. The P value for all variables described was P>0.05. A higher percentage of hematocrit was observed in large loggerheads compared to small loggerheads with a P value <0.01. No significant differences were found between both classes regarding blood biochemistry parameters: AST; Bile acids; Creatine kinase; UA; Glucose; Ca; Phosphorus; Total protein; Albumin; Globulin; K; and Na. The P value for all parameters described was P> 0.05). We reviewed and compared the values of the variables analyzed with former studies performed on other loggerhead populations. Based on our results, it is concluded that hematological reference values, blood biochemistry and body condition may vary with respect to age, size, geographic distribution, migratory status, nutritional and environmental conditions. However, the reference intervals obtained are similar to those of other healthy loggerhead populations, which supports loggerheads in the area are in good health condition and is unlikely that their high seasonal mortality rates are due to disease, and more likely due to bycatch. Acknowledgements: This work was supported by Alliance WWF-Carlos Slim Foundation, GRUPO TORTUGUERO DE LAS CALIFORNIAS, A. C. and the Laboratory of Molecular Ecology and Genetics applied to the Conservation of the Autonomous University of Baja California Sur, obtained permits of the General Directorate of Wildlife-SEMARNAT (SGPA/DGVS/06375/15, SGPA/DGVS/03335, SGPA/DGVS/03336). I appreciate the invaluable support to carry out this work: Jorge Guzman, Helena Varela, Sergio Flores, Victor de La Toba, Vladimir de La Toba, Karen Oceguera, Hugo Sanchez, Sebastian Alvarez and Miriam Castro.

MODELING THE IMPACT OF A COMMON MARINE POLLUTANT ON SEA TURTLE SURVIVAL*

Jocylin D. Pierro[1], Angela L. Peace[2], and Sarah J. Webb[1]

[1] *The Institute of Environmental and Human Health, Department of Environmental Toxicology, Texas Tech University, 1207 Gilbert Drive, Lubbock, TX, USA*
[2] *Department of Mathematics and Statistics, Texas Tech University, Lubbock, TX, USA*

Loggerhead (*Caretta caretta*) sea turtles are a threatened species, and yet little toxicological research has been conducted on them. This study entails toxicity testing of Perfluorooctanoic Acid (PFOA) on loggerhead sea turtle cells, followed by the production of a mathematical model that predicts survival based upon the empirical data. PFOA is a commonly found contaminant in marine environments. This toxicant is known for its cytotoxicity, mutagenicity, immunotoxicity, adverse developmental effects, and negative impacts on renal and hepatic systems in multiple animal models, including reptiles. Toxicity of PFOA on loggerhead skin was examined using the MTT viability assay to assess primary skin cell cultures exposed to environmentally relevant concentrations for one to four days. Toxicant concentrations were 0.05, 0.5, 5, 50, and 500 μM for PFOA. This toxicological data was then used in the General Unified Threshold Model of Survival (GUTS) to provide a framework for the prediction of loggerhead sea turtle cell survivability overtime. GUTS delivered a guideline for parameterizing sound models that effectively looked at the sensitivity of loggerhead cells to PFOA. There are two survivability models that resulted from the use of GUTS. One model looks at the individual sensitivity of cells to chemical exposure, while the other bases calculations on the idea that all cells will begin to die after a threshold concentration is reached. Both approaches provided valuable and novel insight into the survivability risks PFOA poses to loggerhead sea turtles. Each model was analyzed for effectiveness through confidence intervals. These models serve as tools for conducting standard ecological risk assessments through the establishment of a fifty percent lethal concentration (LC_{50}) prediction at various exposure time points. Both models indicate an increase in death and decrease in survivability overtime after exposure to the highest dose of PFOA. These models provided the first GUTS models for this marine reptile and the first application of GUTS to cell populations rather than individual animals, pioneering the advent of mathematical models for endangered species that cannot undergo normal toxicity testing. Modeling sea turtle cell survival rates provides a first step for safely and effectively evaluating the impact of toxicants on individual animals. Here, we populated these models with experimental data obtained from short-term in vitro exposure scenarios and are currently investigating how the information obtained can assist in predicting long-term effects on animal fitness and survival. This information can inform regulatory bodies about pollutants requiring the greatest amount of supervision in use and disposal, so as to reduce their negative impact on sea turtles and other endangered marine wildlife.

DIFFERENCES BETWEEN GENETIC LINEAGES OF TWO MARINE LEECH SPECIES IN HOST PREFERENCE AND CORRELATION WITH FIBROPAPILLOMATOSIS

Leah Rittenburg, Anna E. Savage, and Kate L. Mansfield

University of Central Florida, Orlando, FL, USA

Fibropapillomatosis (FP) is a neoplastic disease characterized by the development of external and internal tumors. FP is documented in all seven species of marine turtles, and primarily affects juveniles in neritic areas. FP prevalence has been increasing globally, and although tumors may not directly be fatal, they can lead to the death of the turtle if feeding is significantly impeded. Possible factors determining FP development include environmental conditions, presence of a vector organism, and the turtle's immunological health and life stage. Studies have named Chelonid herpesvirus 5 (ChHV5) as the most likely etiological agent of FP, but much about ChHV5 disease dynamics is unknown. Possible vectors of ChHV5 include two species of leeches from the family Ozobranchidae: *Ozobranchus margoi* and *Ozobranchus branchiatus*. Both species are ectoparasites that feed on the blood of marine turtles. *Ozobranchus margoi* primarily parasitizes loggerhead sea turtles (*Caretta caretta*), but has been reported on three other marine turtle species, including green sea turtles (*Chelonia mydas*). *Ozobranchus branchiatus* mainly parasitizes *C. mydas*, rarely feeding on other species, but has been reported on four other marine turtle species, including *C. caretta*. Quantitative data are lacking on host preferences among *Ozobranchus* species and genetic lineages, as well as association with FP presence or absence in host turtles. Here, we extracted genomic DNA from 100 unidentified leeches collected from *C. mydas* and *C. caretta* juvenile turtles with and without FP in the Indian River Lagoon, Florida, USA. FP prevalence in this area averages 50% in *C. mydas* juveniles but is considerably lower in *C. caretta*. Using PCR, we amplified and then Sanger sequenced a 685 base pair fragment of the mitochondrial Cytochrome c oxidase I (CO1) gene from leech genomic DNA. We used sequence polymorphisms to identify the species of each leech and also assessed the presence of distinct genetic lineages within each species using Bayesian phylogenetic analysis of COI data. We determined the frequency at which each leech species was found on each turtle host species, and tested for significant correlation between different leech species and lineages and the presence or absence of FP in the turtle hosts. Understanding these preferences and relationships will help illuminate host-parasite interactions and provide insight into the role of marine leeches in transmission of FP between turtles. Acknowledgements: I would like to thank my fellow researchers in the Savage Lab, as well as Dr. Anna Savage and Dr. Kate Mansfield, for their guidance and training throughout this project. I would also like to thank the University of Central Florida Marine Turtle Research Group for allowing me to use their samples and for their support.

ULTRASOUND STUDY OF REPRODUCTIVE STRUCTURES IN NESTING AUSTRALIAN FLATBACK SEA TURTLE, NATATOR DEPRESSUS

David C. Rostal[1], Janice S. Grumbles[1], Sabrina Fossette-Halot[2], Tony Tucker[2], and Scott Whiting[2]

[1] *Georgia Southern University, GA, USA*
[2] *Department of Biodiversity, Conservation and Attractions, Kensington, Australia*

The Flatback sea turtle, *Natator depressus*, is the least studied of all the sea turtles. It is found only in the waters of Australia and is considered phylogenetically one of the older extant sea turtles. We studied the reproductive structures using non-invasive ultrasound to determine ovarian follicle size and oviductal egg size and overall reproductive condition. Fifteen turtles were examined between Nov. 18th and 22nd, 2017 on Thevenard Island, Western Australia. In turtles that false crawled, we were able to identify oviductal eggs and collect egg size prior to nesting. During this period, 12 nesters displayed mature ovaries while 3 displayed partially depleted ovaries. Atretic follicles of various sizes were observed in several females. This was a pilot study to determine efficacy of the procedure as well as to collect data to compare with other sea turtle species. The Flatback sea turtle produces the largest ovulatory follicles of any Chelonidae.

INJURY ASSESSMENT OF LEATHERBACK SEA TURLTES (DERMOCHELYS CORIACEA) AT SANDY POINT NATIONAL WILDLIFE REFUGE, ST. CROIX

Alyssa Scarfo[1], Kelly Stewart[1], and Claudia Lombard[2]

[1] *The Ocean Foundation, Washington DC, USA*
[2] *US Fish and Wildlife, Fredkristed, USVI*

There are many threats to leatherback sea turtles including egg harvest, bycatch, entanglement, and plastic pollution. Sandy Point National Wildlife Refuge (SPNWR), on the southwestern point of St. Croix, USVI, was dedicated to protect the dense aggregation of leatherback, hawksbill, and green turtles at various times of the year. Several efforts have been made at SPNWR to protect the turtles including overnight patrols and educational programs. The US Fish and Wildlife protects these sea turtles at the refuge and conducts several research projects during the nesting season. The purpose of our study was to assess the rates and types of injuries on female leatherbacks during the nesting season at SPNWR. We wanted to compare how frequently injuries occur, the type of injuries, how quickly injuries heal, and which females have more injuries: remigrants or neophytes. During the 2016 and 2018 nesting season photographs of injuries were taken as the female was laying her eggs. A 3x5 index card was placed next to each injury to gauge the size and a photo was taken. The wound was then categorized based on the stage or degree of healing and the type (location on the body) of injury. Stage one was a fresh wound still bleeding and a stage five wound was one that had pink or white scarring. The type of injury were as follows: 1) missing limb, 2) superficial scrapes on the carapace, 3) large gashes or chunks missing from hips or shoulders and 4) evenly-spaced rake marks on the top of the head and neck. For each injury, we tried to determine the cause: entanglement, bites, shark or other predator, bycatch or boat strike. The data were compared in several ways. In 2016 there were 49 individuals (24 neophytes and 25 remigrants) and of those, 37 were injured (16 neophytes and 21 remigrants). This 2018 nesting season, SPNWR had 38 individuals (15 neophytes and 23 remigrants), and 34 individuals had injuries (12 neophytes and 22 remigrants). In 2016 and 2018 there are more injuries in the 10-day block of 5/12-5/22 than any other 10-day block. Over time, there was no significant change in females injured before their first nest versus those injured throughout the season. In 2018 there was an

average of 2.18 injuries per turtle for the individuals injured (34 of 38). Documenting and assessing the rate of healing and the type of injuries in leatherbacks helps us better understand the risks they face. The photographs allow us to estimate the healing rates over the season. By assessing these data, we can also identify the most common type of injury, as well as the riskiest time of the season. Leatherbacks from different populations may have different threats near their nesting beach and it's important to determine these threats to be able to develop conservation priorities and mitigation measures.

THE MICROBIOTA OF SEA TURTLES*

Franciscus Scheelings[1], Rob Moore[2], Marcel Klaassen[3], and Richard Reina[1]

[1] *Monash University, VIC, Australia*
[2] *RMIT University, VIC, Australia*
[3] *Deakin University, VIC, Australia*

The gastrointestinal tract of animals is populated by a vast array of microorganisms (bacteria, fungi, protozoa and viruses) that are important for a range of physiological functions. This microbial community is known as the microbiota. Without the symbiotic relationship between hosts and their microbes, metazoan life would not be possible. Disturbances in microbial communities are implicated in a range of disease states and decreased fitness. Understanding these relationships in species other than humans is fundamental to modern conservation as a healthy, functioning microbiome is essential to animals being able to utilize environmental resources as well as combat disease. We examined the microbiota of green turtles (*Chelonia mydas*), hawksbill turtles (*Eretmochelys imbricata*), leatherback turtles (*Dermochelys coriacea*), flatback turtles (*Natator depressus*), olive ridley turtles (*Lepidochelys olivacea*), and loggerhead turtles (*Caretta caretta*) by collecting colonic swabs from various populations of these species. Analysis of microbial composition was achieved using 16S rRNA gene sequencing. We then identified factors that influence sea turtle microbiota such as species, foraging and fasting (nesting), and population and genetics. This investigation forms the most comprehensive microbiome investigation in sea turtles to date, and has important ramifications for understanding vertebrate evolution as well as sea turtle ecology in the face of a changing world. In order to improve sea turtle conservation, we need to expand on our knowledge of the relationships between sea turtles, their microbes, and the environment and this study provides the first insight into these interactions.

INVESTIGATION OF METAL CONTAMINATION FROM LEAD SHOT IN HAWAIIAN GREEN SEA TURTLES (CHELONIA MYDAS)

Katherine R. Shaw[1], George H. Balazs[2], T. Todd Jones[3], Harry W. Lynch[4], David M. Klein[1], Jing Liu[5], George P. Cobb[5], and Jennifer M. Lynch[6]

[1] *Department of Environmental Toxicology, Texas Tech University, Lubbock, TX USA*
[2] *Golden Honu Services of Oceania, Honolulu, HI USA*
[3]*Pacific Islands Fisheries Science Center, National Oceanic and Atmospheric Administration, Kaneohe, HI USA*
[4] *The Nature Conservancy of Hawaii, Honolulu, HI USA*
[5] *Department of Environmental Sciences, Baylor University, Waco, TX USA*
[6] *Chemical Sciences Division, National Institute of Standards and Technology, Kaneohe, HI USA*

The Kaimalino neighborhood in Kailua Bay, Hawaii, is located on windward Oahu. This was once the home of the Honolulu Skeet Club. During the 23 years the skeet club was active (1933 – 1956), lead (Pb) shot was used resulting in significant accumulation of these pellets on and near the coastline. Layers of lead shot can be seen in the sand, tidepools along the coastline and on the seafloor. Hawaii Department of Health warning signs at public access points currently advise that Pb and arsenic (As) found in pellets may be harmful to children if swallowed. The pellets slowly degrade and release Pb, As, antimony (Sb) and tin (Sn). This puts organisms living, breeding, and foraging in this area at risk of heavy metal accumulation and toxicity. An important herbivorous species living and foraging in the area is the Hawaiian green sea turtle (*Chelonia mydas).* Green turtles studied since 2000 along the shoreline of the Kaimalino neighborhood at the mouth of the Kawainui Marsh are highly resident, with 75% of turtles re-captured during sampling events spanning three years, 2011-2013. This high site fidelity suggests that turtles may serve good as bioindicators of contaminants in Kailua Bay. Sand and algae samples from the beach and tidepools were collected in 2017 and analyzed via inductively coupled plasma- mass spectrometer (ICP-MS) in order to trace Pb movement through the ecosystem. Pb concentrations in sand within the historic skeet shooting area with visible lead shot contamination ranged from 388,000 mg/kg – 653,000 mg/kg with as concentrations of 2,720 mg/kg - 3,120 mg/kg, while Pb in sand with no obvious Pb shot ranged from 140 mg/kg - 12,300 mg/kg with As concentrations from less than the detection limit (<DL) - 22.6 mg/kg. In comparison, Pb and As concentrations in sand further down the beach with no visible Pb shot were <DL. *Acanthophora spicifera*, a red algae commonly consumed by green turtles, was collected from tidepools within and outside the historic shooting range to quantify dietary contributions of Pb. A Pb concentration of 6.29 ng/g was found in the algae within the shooting range while samples taken from further down the beach had a Pb concentrations ranging from <DL to 12.8 ng/g. Blood and scute samples were taken for 33 sea turtles sampled between 2011 and 2013. All samples were analyzed for Pb via ICP-MS and statistical analyses performed using the statistical program R. The Nondetects and Data Analysis for Environmental Data (NADA) package was used for left censored data. Blood Pb concentrations ranged from <DL- 936 ng/g, with an average of 342 ± 179 ng/g and As concentrations ranged from 36.7 - 1960 ng/g with an average of 314 ± 407 ng/g. Scute Pb concentrations ranged from <DL-724 ng/g with an average of 187 ± 108 ng/g, while scute As concentrations ranged from 113 ng/g – 1820 ng/g with an average of 487 ng/g ± 404 ng/g. The concentrations in this study are much lower than those in green turtles in San Diego Bay, a highly contaminated estuary, where the concentrations were 1260 ± 222 ng/g in the blood and 7230 ± 992 ng/g in the scute. While the toxic threshold for Pb in sea turtles is not known, Pb does not have a biological function in animals. Additional research needs to be done to determine the toxic effects of lead on sea turtles.

USING CIRCULAR FLOW TO GROW SEA TURTLE BARNACLES EX SITU

Kevin C. Swain[1], Zachary Lane[2], and John D. Zardus[1]

[1] *The Citadel, Charleston, SC, USA*
[2] *University of Southern Mississippi, MS, USA*

Sea turtle barnacles (*Chelonibia testudinaria*) start life, like many marine crustaceans, hatching from an egg and then developing through multiple larval stages in the plankton. At the final cyprid stage, the larvae search for a suitable substratum on which to settle, metamorphose, and grow into adulthood. While the larvae of many barnacle species have been successfully reared and settled in the laboratory, there has been little attention or success in maintaining adult stages ex situ. To address this gap and make possible studies on live adults of largely inaccessible barnacle species, we devised two apparatuses utilizing rotating PVC pipes to facilitate barnacle attachment and growth, the settlement-promoting 'larvulator'and a grow-out tank, the 'maturation spinner'. The larvulator operates by a motor driven, double gear system that rotates a rack of six concurrently revolving pipes within a circular chamber; whereas, the maturation spinner employs a belt and pulley system to spin pipes about their central axis, upright in a standard table-top aquarium. Each device operates on the principle of generating the effects of flow in a static chamber without needing to pump water. In the case of the epibiotic barnacle *C. testudinaria*, the PVC pipes serve as a synthetic mobile host, moving through the water. We demonstrate that these devices can be used to achieve larval settlement and growth with *C. testudinaria*. Settlement rates of this species on PVC pipes was consistently low relative to the quantity of larvae supplied, but typical settlement rates for this species remains unknown. Growth rates were similar or reduced relative to wild populations, but we were able to maintain adults on pipes in excess of two years. Increased understanding of larval and adult barnacle diets may improve outcomes but our methodology presents a viable way to grow adult barnacles in the laboratory.

TESTING THE QUALITY AND STABILITY OF PLASMA PROTEIN AND WHOLE BLOOD RNA IN ARCHIVED LOGGERHEAD SEA TURTLE BLOOD, CARETTA CARETTA

Kelly Townsend

Elmhurst College, IL, USA

Sample storage conditions can affect the accuracy and reproducibility of biological measurements. Storing samples at lowest available temperatures as fast as possible is considered ideal, but not always feasible during remote or logistically challenging field sampling events. Sampling sea turtles during in-water studies poses logistical challenges at sea in frequently rough and limiting conditions. Here, we examined the quality and stability of plasma proteins and of whole blood RNA from loggerhead sea turtle blood collected as part of an eighteen-year-long curated specimen collection at NIST in Charleston, South Carolina. These variables are often used to assess sea turtle health; therefore, it is necessary to maintain the integrity of these components during storage. Protein electrophoresis was conducted on plasma from individual turtles collected in 2018 (n =3), 2008 (n =3), and 2001 (n =3). Plasma was also pooled from four turtles and subjected to various temperatures. Whole blood was collected in blood collection tubes containing sodium heparin or PAXgene tubes with an RNA preservative. These were subjected to different storage treatments that can likely occur during logistically difficult field sampling. Following the various treatments, plasma proteins showed minor differences among collection years, and no differences among storage treatments even when exposed to 38° for three hours. RNA quality was also assessed from whole blood using an RNA

Integrity Number (RIN). Whole blood collected in sodium heparin tubes and frozen and from PAXgene tubes after extended thaw resulted in poor quality samples with low RINs. High quality RNA was obtained from a sodium heparin tube that was never frozen (RNA isolated within 48 h) and from PAXgene tubes even when freezing was delayed by up to 264 h. Overall, these results indicate that plasma proteins remain stable over time and when exposed to undesirable storage conditions, and RNA degrades rapidly in sea turtle samples after freezing. These aspects are important to consider when planning logistics and optimal sample preservation ahead of sampling and long-term storage.

CARAPACE COLORATION PATTERNS OF BLACK TURTLE NESTING FEMALES (CHELONIA MYDAS AGASSIZII) OF THE POPULATION OF MICHOACÁN, MEXICO

Nestor Dávalos Alonso[1], Carlos Delgado-Trejo[2], and Cutzi Bedolla Ochoa[2]

[1] *Facultad de Biología, Universidad Michoacana de San Nicolas de Hidalgo, Morelia Michoacna, México*
[2] *Departamento de Ecología Marina y Costera-INIRENA, Universidad Michoacana de San Nicolás de HIdalgo, Morelia, Michoacán, México*

The population of black turtles of the eastern Pacific is morphologically characterized, among other things, because it is the smallest of the populations of *Chelonia mydas* in the world, they also have a marked dark coloration of the carapace in relation to other populations of *Chelonia* from Indo-Pacific and Atlantic, also black turtle show a carapace in the shape of a dome. The most important black turtle nesting sites in the eastern Pacific are found in Mexico, Colola on the coast of Michoacan possibly houses more than 70% of the population of nesting females in the region. During the 2016/2017 nesting season, the coloration patterns present in breeding female black turtles (*Chelonia mydas agassizii*) were evaluated in Colola beach. From a sample of 160 black turtle females, morphometric data were obtained (Curve Carapace Length), and photographs of the carapace were taken at a distance of 1 m in a standardized method, and a variance analysis (ANOVA) was performed to determine if significant differences between mophometric aspects such as the size of the females and the coloration of the carapace. Four patterns were identified in the coloration of the carapace, the dominant pattern was the (b) Matrix-Mottled brown and Black with 50% of the sample, followed by the pattern (c) Matrix-Mottled Black with 35%, the pattern (a) Matrix-Dominant brown with 9% and with 6% of the sample the pattern (d) Matrix-Dominant Black. Based on the morphometric measurements of the carapace (Curved Carapace Length) they were grouped into 10 cm size class ranges. The first range 71-80 cm were located the largest number of turtles with 75, the following range 81-90 cm with 66 turtles, following the range 91-100 with 17 turtles and two turtles in the range of 101-110 cm. The analysis of variance (ANOVA) showed significant differences, in the variations of coloration by size ranges of black turtle nesting females, among the four coloration patterns in relation to the carapace size. The matrix color is present in all the size ranges, combining brown tones for the smaller females (71-80 cm LCC); a combination of brown and black tones for medium sizes (81-90 cm LCC); With the disappearance of the brown tonality presenting only patterns of black blotches in sizes above the average (91-100 cm LCC), a black dominant carapace pattern was also found in two turtles with sizes between 101-110 cm LCC. According to our results, the largest females present the darkest colorations possibly as an effect of ontogenetic development, which suggests that the larger the turtles are made, the darker they are.

EFFECTS OF INCUBATION TEMPERATURE ON HATCHLING PERFORMANCE AND PHENOTYPE IN LOGGERHEAD SEA TURTLE (CARETTA CARETTA, LINNAEUS, 1758)

Alejandro Usategui-Martín[1], Ana Liria-Loza[1], Jeffrey D. Miller[2], María Medina-Suárez[3], Saray Jiménez-Bordón[4], Valentín Pérez-Mellado[5], and Daniel Montero[1]

[1] *University of Las Palmas de Gran Canaria, EcoAqua University Institute, Gran Canaria, Spain*
[2] *Biological Research and Education Consultants, MT, USA*
[3] *NGO Cabo Verde Natura 2000, Cape Verde*
[4] *NGO Asociación para el Desarrollo Sostenible y Conservación de la Biodiversidad, Canary Islands, Spain*
[5] *University of Salamanca, Department of Animal Biology, Spain*

On natural conditions sea turtle eggs are subjected to a changing thermal environment but little is known about the effect of these temperature fluctuations during incubation on the performance and phenotype of hatchlings. In this study we try to determine how incubation temperature pattern (increasing or stable) and incubation temperature regime (low or high) affect incubation and hatching duration, hatching and emergence success, hatchling phenotype (carapace length and weight) and self-righting interval at hatching. Loggerhead sea turtle (*Caretta caretta*) clutches were collected at different beaches of Cape Verde archipelago and divided among incubators with different temperature regimens and patterns. Minimum straight carapace length (SCLmin) and weight (g) of all individuals were measured at hatching. In addition, the hatching duration and the time interval required for each hatchling to self-right were recorded. Results showed that incubation temperature regimes influenced all parameters studied more than the increasing temperature patterns. Low incubation temperatures, both increasing and stable, increased incubation time, produced bigger hatchlings with slower righting response compared to the higher temperatures. An optimal range of incubation temperatures was determined by assessing the most favorable values for hatchlings, although some differences in this optimal range between rookeries were found in the upper temperature range.

REPORT OF LEUCISTIC ADULT FEMALE GREEN SEA TURTLES (CHELONIA MYDAS) SUCCESSFULLY NESTING AT TORTUGUERO, COSTA RICA

Roldán Arturo Valverde[1,2] and Jaime Restrepo[1]

[1] *Sea Turtle Conservancy, Costa Rica*
[2] *Southeastern Louisiana University, LA, USA*

Leucism is a congenital condition affecting the normal pigmentation of skin or eyes and most frequently presents itself as partial or complete lack of melanin in the body. Its occurrence is an anomaly in wildlife. In sea turtles in particular, this feature represents a major disadvantage due to higher detectability, increasing depredation risk of affected individuals. Pale coloration also implies some intrinsic complications for thermoregulation. Although a lack of coloration has been previously documented in sea turtles, the existing reports only address the presence of affected newborn hatchlings in a few beaches around the world. We are unaware of reproductive actively sea turtles with evidence of Leucism ever been reported in the wild. Tortuguero National Park in Costa Rica constitutes the most important rookery in the Atlantic Basin for Green sea turtles (*Chelonia mydas*). Every year more than 20,000 adult females select this beach as a nesting site. The Sea Turtle Conservancy (STC) runs the longest ongoing conservation

program in the world, monitoring sea turtle nesting populations at Tortuguero since 1959. Over the past 6 decades almost 65,000 Green turtle individuals have been tagged, measured and examined for injuries or physical alterations that might compromise their reproductive success. The presence of highly developed leucistic embryos is not uncommon in Tortuguero's population; however, no hatchlings or adult females have been previously reported. This presentation provides the first confirmed report of two leucistic female Green sea turtles successfully nesting at Tortuguero Beach. During the 2018 Green turtle nesting season, two separate individuals that presented alterations in their coloration patterns were detected while nesting. Both females were tagged for future identification and biometric data were collected. They presented curved carapace lengths of 108.4 and 109.7 cm. Both were carefully examined for possible malformations. Their nests were marked, protected with cages to prevent predation. They will be monitored throughout the incubation period to determine their hatching success and make a detailed evaluation of the progeny. The detection of these females at a nesting site presents a unique opportunity to study the viability of individuals exhibiting this type of abnormalities. It will let us evaluate the effect and implications this condition can present on the reproductive fitness of sea turtles, and it may allow us to identify the contribution of these specimens to their population.

THE IDENTIFICATION OF DNA-BASED BIOMARKERS FOR INTERNAL FIBROPAPILLOMATOSIS TUMOR DETECTION AND REHABILITATION OUTCOME PREDICTION BY WHOLE GENOME SHOTGUN DNA SEQUENCING OF BLOOD PLASMA*

Kelsey Yetsko[1], Rachel Thomas[1], Christine Schnitzler[1], Liam Whitmore[1], Jessica Farrell[2], Whitney Crowder[1], Catherine Eastman[1], Devon Rollinson[1], Brooke Burkhalter[1], Mark Q. Martindale[1], and David J. Duffy[1,2]

[1]The Whitney Laboratory for Marine Bioscience, Sea Turtle Hospital, University of Florida, St. Augustine, FL, USA
[2]Gumbo Limbo Nature Center, Sea Turtle Rehabilitation Center, Boca Raton, FL, USA
[3]Department of Biological Sciences, University of Limerick, Limerick, Ireland

Fibropapillomatosis (FP) is a disease that most commonly afflicts green sea turtles (Chelonia mydas) and has dramatically increased in prevalence and distribution since the early 1900s. The disease results in tumorous growths that can occur externally on a turtle's soft tissues and/or internally in the visceral organs. While external tumors can often be removed through surgery, there are currently no effective treatments for turtles presenting with internal tumors. Internal FP tumors must first be detected by x-ray, MRI, CT scanning or endoscopy. For many facilities, this requires transport of turtles off-site, limiting the availability of testing and delaying the diagnosis of internal tumors. Often internal FP are only diagnosed after a turtle has received months of clinical care, at great effort and expense to rehabilitation facilities. This also causes unproductive stress to the patients as, due to the lack of treatments, once detected, turtles harboring internal tumors are humanely euthanized. Furthermore, given the hard shell and carapace, x-ray and CT scans are not ideally suited for diagnosing internal tumors, making diagnosis of early or small tumors especially problematic. To overcome these limitations, we conducted blood plasma profiling using DNA sequencing (DNA-seq) with the specific aim of developing a diagnostic test for internal FP tumors as well as determining prognostic rehabilitation outcome biomarkers. DNA-seq is ideally suited to identifying circulating internal tumor DNA in blood plasma samples, a well-established source material for blood-based biomarkers for cancer detection, increasingly utilized in human oncology. In order to develop a simple qPCR-based blood test for the presence of internal FP tumors as well as a predictive test for the likely rehabilitation outcome of individual patients, DNA was extracted from blood plasma samples from green sea turtle patients whose outcomes and presence of internal FP tumors were known, and sequenced

using Illumina whole genome shotgun sequencing. This sequence data was then aligned to the reference C. mydas genome and analyzed to compare differential gene abundance patterns between turtles with good outcomes versus poor outcomes, and between turtles with internal FP tumors versus those with only external tumors. Using this approach, four putative genetic markers were identified: one for internal FP (Gimap4), two for overall rehabilitation outcome (Trim39 and Flo11), and one associated with both internal tumor presence and overall outcome (Nacht). The DNA sequences for these markers were then used to develop assays for blood plasma-based qPCR validation in a larger green sea turtle patient cohort, and the results of these tests will be discussed. In conclusion, applying genomic techniques adopted form human precision medicine enabled us to rapidly identify putative biomarkers for the detection of internal FP tumors and for predicting the likely rehabilitation outcome of patients early in the FP rehabilitation process. Such simple blood tests will ultimately enable researchers to perform more frequent, less expensive and less invasive diagnostics to determine the presence of internal FP tumors as well as predict the likely rehabilitation outcome of individual patients. This will greatly aid in patient care and rehabilitation, ultimately leading to more effective detection, management and individual treatment strategies.

CONSERVATION, MANAGEMENT, & POLICY

EFFECTS OF THE ILLEGAL CONSUMPTION OF SEA TURTLES ON HUMAN HEALTH IN NORTHWESTERN MEXICO*

A. Alonso Aguirre[1], Kathryn Jacobsen[1,2], Lila C. Fleming[1,2], Alexander J. Robillard[1,3], Cesar P. Ley-Quiñónez[4], and Alan A. Zavala-Norzagaray[4]

[1]*George Mason University, Fairfax, VA, USA*
[2]*CHHS*
[3]*ESP*
[4]*Instituto Politecnico Nacional*

Human consumption of endangered sea turtles remains prevalent throughout Mexico even though laws restricting trade in threatened and endangered species have been in place for several decades. Our prior research has found that the majority of sea turtle mortality in Baja California is due to human consumption. While demand for sea turtle meat has reportedly decreased in some regions, turtle trafficking and illegal harvesting continue to threaten environmental security in the region. Besides being a threat to animal and ecological health, poaching may be a threat to human health. People who consume turtle meat may be exposed to bacteria, parasites, and other pathogens as well as organochlorine compounds and heavy metals such as cadmium and mercury. In 2017, we conducted a knowledge, attitudes, and practices (KAP) survey with a convenience sample of more than 200 residents of 14 fishing communities in northwestern Mexico. We asked participants about their nutritional and health status, dietary and risk behaviors, and perceptions of local ecological issues, and we collected hair samples that could be tested for heavy metals. About one-quarter of the participants reported consuming sea turtle in the past month. Laboratory tests showed a high prevalence of elevated levels of arsenic, lead, and mercury. Preliminary analyses show that people who eat sea turtle meat are more likely than their neighbors to have high levels of mercury in their hair. Conservation efforts may be more successful when they appeal to people's self-interest rather than merely focusing on ecological benefits. Concerns about toxins in sharks, tuna, and other types of deep-sea fish have reduced human consumption of some species. Sea turtle conservation efforts may benefit from awareness campaigns that emphasize the adverse health outcomes associated with eating turtle meat while continuing to affirm the economic benefits of healthy ecosystems. Transdisciplinary research that draws on diverse fields such as ecology, epidemiology, toxicology, environmental law, and public policy provides a valuable foundation for solving planetary health issues. Creative reframing of biodiversity concerns in countries around the globe will be necessary for promoting environmental health and public health in a time of accelerating environmental change.

PRELIMINARY IMPACTS OF PLASTIC POLLUTION IN GALÁPAGOS SEA TURTLES*

Juan Pablo Muñoz-Pérez[1], Jason G. Castañeda[1,2], Brendan J. Godley[3], Mark Hamann[4], Ceri Lewis[3], Alice Skehel[1], Kathy Townsend[5], and Daniela Alarcón-Ruales[1]

[1]*Galápagos Science Center GSC (Universidad San Francisco de Quito-University of North Carolina at Chapel Hill), Av. Alsacio Northia, Isla San Cristobal, Galápagos, Ecuador*
[2]*Galápagos National Park Service, Galápagos, Ecuador*
[3]*University of Exeter, UK*
[4]*James Cook University, Australia*
[5]*University of Sunshine Coast, Australia*

Nine sea turtles (5 green turtles (*Chelonia mydas*), 2 olive ridley (*Lepidochelys olivacea*), and 1 hawksbill (*Eretmochelys imbricata*) were recorded as affected by plastic marine debris in the Galápagos Marine Reserve (GMR). The following information is presented. Case 1: The photographic record of the stomach contents of a dead *C. mydas* founded at Bartolomé Island in the late 1980´s by the USFQ professor Gunter Reck. Case 2: Macro-plastics were found in the stomach of a dead juvenile *C. mydas* at San Cristóbal Island Galápagos in 2016. The stomach content was washed through a 5mm sieve and the plastic pieces remaining were visually identified and isolated. Further analysis to identify microplastics will be completed. The samples have been stored for future analysis using spectroscopy. Case 3: The entanglement and near decapitation/amputation of the front limbs of one juvenile *C. mydas*. The turtle was found and released from a type of plastic bag (saquillo) by a local fisherman in 2016 at Española Island. Cases 4 and 5: Macro-plastics and microplastics have been found in two dry *C. mydas* fecal samples, one found in late 2017 and the other one in early 2018 at San Cristóbal Island. Samples will be analyzed using a digestion technique, removing organic material the macro and microplastics to be counted. To confirm the presence of microplastics spectroscopy will be completed on all suspected items. Cases 6, 7 and 8: The entanglement in ghost long-line fishing gear and large set of nets and buoys of 3 L. *olivacea*. One found and released by a tourist boat at Fernandina Island in 2018, another found and released by fishermen near Santa Fe Island in 2018 and the last one found and released by naturalistic guide near San Cristóbal Island in 2018. Case 9: The entanglement of a juvenile *E. imbricata* in a plastic bag (saquillo). The turtle was found and released by a tourist ship in 2018 at San Cristóbal Island. The Galápagos Marine Reserve (GMR) hosts four of the worlds seven sea turtle species, three of these species were recorded as affected by plastic marine debris in the GMR. All the entangled individuals were released, and documentation was taken during each event, further recovery data cannot be collected from the animals since they were not tagged. The cases presented are the first evidence of plastic impact (ingestion and entanglement) on Galápagos sea turtles. This information was collected thanks to our citizen science efforts where we encourage naturalistic guides, local students and fishermen to collect and share this critical information in a vast area like the Galápagos archipelago. More research efforts are needed into the impacts of plastic on wildlife across this globally important archipelago.

BUILDING CAPACITY FOR COMMUNITY-BASED CONSERVATION OF THE EASTERN PACIFIC LEATHERBACK IN THE DARIEN GAP OF COLOMBIA AND PANAMA*

Diego Amorocho[1] and Juan Sebastian Ayala[2]

[1]*WWF*
[2]*CIMAD*

Beaches along the Colombian and Panamanian Pacific Coast were explored seeking for nesting leatherback and hawksbill between September 2017 and October 2018. Local community leaders - with special attention to youth - were trained to effectively conduct nesting surveys and assess protected hatcheries while gained field experience in monitoring of sea turtles. Attendants were also trained on communication skills and technology use for better ecotourism practices on the nesting sites. Issues about current threats and potential solutions were discussed with local communities and national parks officers to define the best techniques for monitoring sea turtle nesting grounds at Utria National Park (Colombia) and Cerros Hoya (Panamá). Binational cooperation was promoted between environmental authorities and NGO of Panama and Colombia. The collaborative process has resulted in an important information exchange and lessons share concerning conservation management of critical nesting habitats in Panama and Colombia while has increased community engagement for alternative and responsible of sea turtles use in both countries. A total of 21 beaches were monitored along the Pacific; 15 in Panama and six in Colombia. Leatherback nests were identified in five in assessed beaches along the Pacific coast of the Veraguas province in Panama. The more important nesting site is Gato Beach, a 120 m beach protected by a small bay, where intense nesting activity was observed during 4-day surveys conducted three times in one year. In Colombia, north of Cabo Corrientes, no more than three females were observed by locals in the last year. Presence of other species nesting in same breeding grounds was confirmed: Olive ridley (*Lepidochelys olivacea*), hawksbill (*Eretmochelys imbricata*) and Pacific green (*Chelonia mydas agassizii*). In the Colombian Chocó, community-based conservation group Asociación Caguama, was trained in the use of d-hookers to release those incidentally ingested by sea turtles when feeding. A practical session was carried out by successfully removing a hook deeply inserted in the throat of an encountered animal. The procedure does not cause any harm to the animal and was a real hands-on research-management action carried out with community members. Study outcomes includes the establishment of a scientific baseline supported on data gathered about sea turtle nesting populations in the Colombian and Panamanian Pacific coasts. Gained research knowledge useful for decision making by park´s administrators can contribute to improve livelihoods of coastal indigenous groups and Afro-Colombian communities from Panama and Colombia by using sea turtles as a flagship species for developing sustainable alternatives and improve local income (i.e., ecological lodges, handicrafts sale, guided tours, etc). The results from this study demonstrates the need to continue binational efforts strengthening community-based conservation initiatives in Veraguas province of Panama and Choco north Pacific of Colombia. Results indicates that these small, remote and isolated beaches nesting areas and important for at least two species visually confirmed (green and olive ridley). During the field trips hawksbill and leatherback acknowledged by locals and supported by direct observation of tracks and nest chambers in the monitored beaches.

INICIATIVA CAREY COLOMBIA

Karla Barrientos-Muñoz[1], Cristian Ramirez-Gallego[1], Rogelio Perea[2], and Elver Espinel[3]

[1]Fundación Tortugas del Mar, Envigado, Antioquia, Colombia
[2]Establecimiento Público Ambiental
[3]POLICIA DE COLOMBIA

For 10 years we have been working to reduce the trade of hawksbill crafts in Colombia. It has been a strong work, where we generated the surveys to identify the places of sale, age and sex of people who sell it, sensitization to national and foreign touristssensitization to artisans, creation of the initiative with public, private entities and NGOs,training for environmental and police authorities, sensitization to the general public with the media: newspapers, TV, radio, social networks, confiscation of hawksbill crafts,judicialization of traffickers (First time in Colombia), confiscation of tourists and environmental seal for stores and craftsmen who do not sell hawksbills. During these ten years, we have managed to reduce the traffic of hawksbill crafts in Colombia by 10% in 2008.

WHAT WOULD FISHERMEN DO? PROTECTED SPECIES WORKSHOP TRAINING: ONLINE, INFO-GRAPHIC, AND VIDEO DEVELOPMENTS

Colby Brady

NOAA, Pacific Islands Regional Office, Honolulu, HI, US

Owners and operators of Western Pacific pelagic longline vessels must attend and be certified for completion of a NMFS Protected Species Workshop (PSW) each year. The PSW includes training on protected species identification (e.g., sea turtles, seabirds, marine mammals, sharks/rays), biology, migration, handling and release techniques. Mandatory annual PSW certifications are required for renewing a longline fishing permit and ensures that longline fishing vessel owners and operators are well versed on the most up-to-date mitigation techniques for protected species. Training presentations include hands-on demonstrations, videos, and printed reference materials. An online course is also available for owners and operators who have already completed a classroom workshop. PIRO is also developing a new, modernized learning management system (LMS) training website that will substantially increase the accessibility of the training for vessel owners and operators using a wide variety of commonly available computers, operating systems, and web browsers. An info-graphic – in storyboard style – is being developed that will provide enhanced guidance to vessel owners, operators, and crew for improving the handling and release of protected species that are too large to bring aboard, such as leatherback sea turtles, marine mammals and other species. Each year, over 300 vessel owners and operators from Hawai`i and almost 100 from American Samoa attend the PSW. Lessons learned in developing these improved protected species handling and release training products will be shared.

PREDATOR-PREY RELATIONSHIPS IN COCOS ISLAND NATIONAL PARK: WHERE HAVE ALL THE TURTLES GONE?*

Elpis J. Chávez Calderón[1], Randall Arauz[2], and Todd Steiner[3]

[1]CREMA, Rescue Center for Endangered Marine Species, Costa Rica
[2]Fins Attached Marine Research and Conservation, Colorado Springs, CO, USA
[3]Turtle Island Restoration Network, Olema, CA, USA

Tiger sharks (*Galeocerdo cuvier*) and cheloniid sea turtles share the same insular and coastal habitats in tropical and warm-temperate waters, such as coastal reefs, bays, lagoons and oceanic islands. Cocos Island National Park is known as an important developmental, foraging and resting site for many highly migratory species including a variety of sharks and sea turtles. Tiger sharks are commonly reported at isolated Pacific oceanic islands such as Hawaii, Galápagos, and Revillagigedo, yet have only recently made their appearance at Cocos Island after almost 50 years of absence. Tiger sharks are among the largest apex predators, capable of consuming a wide variety of prey, including other sharks, bony fishes, large sea turtles, seabirds, and even human garbage. The increased abundance of an apex predator like the tiger shark may lead to changes in ecological assemblages either by direct or indirect effects (e.g. predation, competition or behavioral changes) that may have an impact in the long term on the function and health of the entire ecosystem. We used a combination of data from acoustic telemetry techniques, dive sightings, and video footage evidence to examine the effect of the presence of tiger sharks on the population of sea turtles in Cocos Island. We analyzed over 25 years of observations data collected by divemasters to explore the trends in abundance of tiger sharks and cheloniid sea turtles over time, as well as acoustic tracking data from 40 turtles and 8 tiger sharks to determine spatial and temporal overlap. Our results suggest that the presence of tiger sharks has led to the recent decline of the resident turtle population in Cocos Island. The observed decline in the resident sea turtle population may be a direct effect of predation or may be due to a behavioral change on behalf of the sea turtles to avoid tiger shark predation (i.e., landscape of fear). The presence of tiger sharks could be triggering changes not only to directly prey items such as sea turtles but on the entire ecological assemblage of Cocos Island itself, including long-term potential impacts on ecosystem function and health.

COLLECTIVE ACTIONS FOR IMPROVING THE CONSERVATION STATUS OF THE EU SEA TURTLE POPULATIONS (LIFE EUROTURTLES): FIRST RESULTS

Paolo Casale[1], Luigi Agresti[2], Vincent Attard[3], Georgios Fyttis[4], Tilen Genov[5], Drasko Holcer[6], Matic Jancic[5], Bojan Lazar[5], Peter Mackelworth[6], Melina Marcou[7], Marco Oliverio[1], Isabella Pratesi[2], ALan F. Rees[8], and Panagiota Theodorou[8]

[1]*Dept. Biology and Biotechnologies "C. Darwin", University of Rome "La Sapienza", Roma, Italy*
[2]*WWF Italy, Roma, Italy*
[3]*Nature Trust Malta, La Valleta, Malta*
[4]*Oceanography Centre University of Cyprus, Nicosia, Cyprus*
[5]*Department of Biodiversity, University of Primorska, Koper, Slovenia*
[6]*Croatian Natural History Museum, Zagreb, Croatia*
[6]*Blue World Institute of Marine Research and Conservation, Veli Losinj, Croatia*
[7]*Department of Fisheries and Marine Research, Nicosia, Cyprus*
[8]*ARCHELON - the Sea Turtle Protection Society of Greece, Athens, Greece*

The nesting sites and foraging grounds located in the EU are extremely important for the Mediterranean populations of the loggerhead turtle (*Caretta caretta*) and the green turtle (*Chelonia mydas*). However, anthropogenic threats are also particularly intense in the EU, with high coastal development and fishing activities, that combined affect sea turtles at all stages of life (the critical reproductive phase at land and all age classes at sea). The aim of the LIFE EUROTURTLES project is to improve the conservation status of the EU populations of two priority sea turtle species, the loggerhead turtle and the green turtle. The project focuses on those areas where conservation measures are considered important and urgent, and could make a difference for the sea turtle status at EU, national and local scales. The project includes six EU countries: Croatia, Cyprus, Greece, Italy, Malta and Slovenia. The specific project objectives are to: (i) reduce the impact of anthropogenic threats at nesting sites; (ii) reduce the impact of anthropogenic threats, in particular fishery-related threats in foraging grounds; (iii) improve the effectiveness of marine Natura 2000 sites for sea turtle conservation by extending current sites over turtle hot spot areas and improving management; (iv) set up a consistent approach to the conservation of the EU sea turtle populations in order to optimise current and future efforts and resources in the EU; (v) contribute to the EU Marine Strategy Framework Directive with consistent methods and with baseline data for improving the capacity of monitoring the conservation status of the EU sea turtle populations in the future; (vi) promote among EU citizens the concept of shared responsibility for EU sea turtle populations and the value of natural marine resources, of which sea turtles are viewed as an excellent and charismatic flagship species; (vii) set up an EU network for sea turtle conservation based on common objectives and methods. Here we present the first results of the project at its mid-term stage, highlighting successful approaches and problems encountered.

THE MCT ENVIRONMENTAL MANAGEMENT PLAN: A TOOL THAT CAN HELP PROTECT THE NESTING OF SEA TURTLES IN PLAYA MOíN, COSTA RICA

Didiher Chacón-Chaverri[1,2], Luis Fonseca-Lopez[1], and Didiher Chacon-Vargas[1]

[1]*LAST*
[2]*WIDECAST*

The Moín Container Terminal (MCT) is the largest coastal engineering structure in Costa Rica and for which a detailed and inclusive environmental management plan (EMP) was requested and generated. This plan included measures not only to stop or reduce direct impacts such as light emission, coastal erosion or vessel interaction; but also to reduce other threats not linked to the construction or direct operation of the port. After four seasons, more than 50,000 baby turtles have been released from three species of sea turtles, a social network has been created in the surrounding communities, alternative livelihoods have been created and a source of work for people who have local knowledge of nesting. An extensive call to the social groups of the city of Limón has allowed the program not only to involve more than 1000 children, but also their families. The project has an interesting range of activities and protocols that have allowed it not only to reduce the mortality of nests, females and neonates; but also to attract the attention of the local society, increasing the possible sources of income, reducing the impacts and generating social awareness in the communities of the area. Moín Beach is part of several beaches in Costa Rica with an important nesting of *D. coriacea* and given its current trend in the Western Caribbean, these efforts are necessary. The work model of the environmental plan can be an important tool to be applied in other beaches of the region.

WHAT DO TOURISTS LIKE? KEY ELEMENTS FOR A SATISFACTORY TURTLE TOUR IN TORTUGUERO, COSTA RICA*

Marlenne Vázquez Cuevas[1], Ma. Jimena Gutiérrez-Lince[1], Andrés González Castro[2], Jaime A. Restrepo M.[1], and Roldán A. Valverde[1,3]

[1]*Sea Turtle Conservancy, Gainesville, FL, USA*
[2]*Area de Conservación Tortuguero (ACTo), Sistema Nacional de Areas de Conservación (SINAC), Costa Rica*
[3]*Southeastern Louisiana University, Hammond, LA, USA*

In the community of Tortuguero, Costa Rica, tourism is the main source of income for its inhabitants since the 80's and represents a very important role in sea turtle conservation, it raises awareness about the protection of these species, provides funding for conservation projects and creates alternative livelihoods and revenues for people who otherwise would (used to) engage in direct consumption or sale of products derived from sea turtle. In 2017 a total of 46,480 tourists from different parts of the world visited Tortuguero to participate in the Green turtle observation tours (*Chelonia mydas*). For this reason, understanding the tourist needs is essential for the success and long-term viability of the local economy and the conservation of these endangered species. Our goal was to identify the key factors that determine an optimal experience for the tourists who take the turtle tour. Between August and October 2018 more than 400 tourists were surveyed after taking art of the experience, these surveys focused on crucial elements that influence tourist satisfaction, such as the educational content of the tour, as well as the aesthetic, cultural and experiential elements related to nature. Preliminary results indicate that more than 90% of the surveyed people rated the experience as "good or excellent", among the factors that negatively influence the experience we found the high concentrations of tourists during the tour and the perception of disturbing the turtles. On the other hand, the factors that have a positive influence are the observation of at least one of the stages of the nesting process, a good preparation of the guide and the perception of influencing positively the conservation efforts. The information obtained by this study will serve to improve the service offered during turtle tours, in addition to promote a quality tourism experience based on the visitor's opinions. This work contributes to improve conservation tools and management strategies for an adequate sea turtle-based tourism in the community of Tortuguero, adding information to existing assessment and monitoring mechanisms that allow decision makers to continue with the conservation success that this community represents.

IDENTIFICATION OF MONITORING PRIORITY AREAS FOR SPECIES OF CONCERN USING GIS-BASED FUZZY MODELS: THE CASE OF SOURE MARINE EXTRACTIVE RESERVE ON THE AMAZON COAST*

Beatriz Dias[1,2], Bruna Maria Lima Martins[3], Maura Elisabeth Moraes de Sousa[3,4], Andrei Tiego Cunha Cardoso[5], and Adrian Jordaan[1]

[1]*University of Massachusetts, Amherst, MA, USA*
[2]*CAPES Foundation, Rio de Janeiro, Brazil*
[3]*Bicho D'agua Institute, PA, Brazil*
[4]*LAPMAR Laboratory of Marine Environmental Monitoring Research*
[5]*ICMBIO- Chico Mendes Biodiversity Conservation Institute, Nucleo de Gestao Integrada Costa dos Corais, Brazil*

The costs of monitoring species of concern in data-limited regions can provide a discouraging management paradigm. However, adequate and careful biological survey design can point us towards effective monitoring of critical areas, and help move towards ecosystem approaches, including designating spatial management frameworks. The current study envisions the cost reduction of environmental monitoring of sea turtles, river dolphins and manatees within the Soure Marine Extractive Reserve (MER) in Marajo Island, Brazil. ICMBio/MMA (Chico Mendes Institute for Biodiversity Conservation/Brazilian Environment Ministry) recently published the first management plan for the area, 17 years after the marine multiuse conservation unity creation. The identification of conservation priorities by the management plan, also pointed out to the information gap when it comes to prioritizing actions and efforts, considering species of concern. Here we present a novel and adaptable method to prioritize monitoring and in the future additional enforcement. We use ArcGIS (10.4.1) to map all the activities occurring in the area, and fuzzy logic framework to link datasets and identify locations with a higher degree of monitoring priority for species of concern. The representation of fuzzy logic goes beyond the binary categorization; it allows the elements to belong to one or more categories, called fuzzy sets, with a gradient of membership defined by the fuzzy membership function. This framework allows us to incorporate the uncertainty of reporting data in a spatial gradient. Our data collection encompassed geographic data on fisheries and reported species of concern sightings, from Chico Mendes Biodiversity Conservation Institute (ICMBio). We mapped the occurrence of sea turtles, dolphins and suitable habitat for manatees, based on grazing spots, during a scientific expedition in 2014. We encountered four estuarine dolphin carcasses (*Sotalia guianensis*, n= 5) and two *Lepidochelys olivacea* nests. In addition, we collected and analyzed vegetation samples from the main tidal channels to identify manatee (*Trichechus manatus*) habitat suitability. Our results show that 30% of the Soure MER core area have high monitoring priority, with some spillover into the buffer zone. The model defined the southeast portion of the core area as the largest single patch for monitoring of species of concern, due to the higher concentration of fixed fishing gears. For future, this model could be adapted to inform habitat suitability and test the effectivity of the different use zones delimitated in the Soure MER management plan.

HABITAT USE OF EASTERN PACIFIC HAWKSBILL SEA TURTLES: A HIGH-RESOLUTION STUDY IN A FORAGING HOTSPOT IN THE GULF OF CALIFORNIA, MEXICO*

Lourdes Martinez Estevez

University of California, Santa Cruz, CA, USA

Hawksbill sea turtles are listed as Critically Endangered due to: 1) degradation of nesting habitats, and 2) directed and bycatch mortality of juveniles and adults. Eastern Pacific hawksbill turtles constitute the most endangered population with perhaps as few as 600 nesting females. In contrast to other hawksbill turtle populations, the Eastern Pacific population uses mangrove estuaries, particularly in the Gulf of California, Mexico, as foraging habitats. Mangrove habitats also support many small-scale fisheries and, in the Gulf of California, are the source for over 30% of small-scale fisheries landings. Near shore marine protected areas (MPAs) are a successful and widely implemented fisheries management strategy. Strategies for the establishment of nearshore MPAs have recently expanded to explicitly include local users (particularly fishers) in their design and enforcement (Locally Managed Marine Areas – LMMAs). Hawksbill turtles may benefit from well-designed LMMAs because they concentrate in mangrove estuaries during the extended (20-30 year) subadult stage. Here we present the results of a hawksbill sea turtle's habitat utilization analysis on a mangrove estuary at San Jose island, Mexico. This habitat was established as a LMMA in 2012 and is a known area of high hawksbill densities. We deployed 44 VEMCO acoustic coded tags on 41 hawksbill sea turtles, linked to acoustic monitoring receivers. We also deployed harness mounted video cameras for short term recording on foraging turtles captured within the estuary. Our results indicate high site fidelity over months and years in the majority of individuals; 40% of tagged hawksbill turtles were detected along a year, 37% in two consecutive years, and 23% in three consecutive years. Video recordings documented feeding behavior of 12 hawksbill turtles, being mangrove roots, sponges and algae the identified diet items. Restricted movements of foraging hawksbills highlight the relevance of mangrove estuaries for the recovery of the Eastern Pacific population. This knowledge brings an opportunity to identify additional mangrove sites for LMMA establishment for fisheries management and hawksbill protection in the Gulf of California.

A TURTLE HERE, A TURTLE THERE, ARE THERE TURTLES EVERYWHERE? PART II - AN EXAMINATION OF ADULT LIGHTING DISORIENTATIONS IN PINELLAS COUNTY, FL DURING THE 2016-2018 MARINE TURTLE NESTING SEASONS

Andie Fisher[1,2] and Laura Wright[2]

[1]*University of South Florida, Saint Petersburg, FL, USA*
[2]*Sand to Sea Inc.*

It is well known that one of the leading contributions to the disorientation of marine turtles, both adult and hatchling, is artificial lighting. This companion study analyzed the effect artificial lighting may have on adult female marine turtles utilizing nesting habitat in Pinellas County, Florida. All observed adult

disorientation events were documented by sea turtle nesting patrols during the 2016-2018 nesting seasons. These events were reported using forms provided by Florida Fish and Wildlife Conservation Commission. Reports were compiled and analyzed to identify what, if any, municipalities had a greater number of disoriented female turtles compared to neighboring locations. This study found that there was a significant difference in the number of disorientation events that occurred over time amongst the 10 municipalities studied ($p= 0.001$), with the most significant difference between Clearwater Beach and Belleair Shore ($p=0.0003$). Furthermore, nesting success for disoriented adult females differed from the average success rate for all crawls, with 52.2% nesting success reported in disoriented adults compared to the statewide average of ~50% during the 2016-2018 seasons. These findings illustrate that there is a remarkable difference in the number of adult disorientation events occurring throughout the nesting season in Pinellas County and future studies may help coastal stewards focus their conservation efforts. This second study continues to demonstrate the need for lighting compliance and education to decrease the negative impacts on both adult and hatchling sea turtles.

A CHANCE TO EVALUATE THE EFFECT OF REHABILITATION ON MARINE TURTLE LONG TERM SURVIVAL

Daniela Freggi[1] and Julien Pfiffer[2]

[1]*Lampedusa Turtle Group, Lampedusa, AG, Italy*
[2]*Octopus Foundation, Lausanne, Switzerland*

Sea turtles are considered an endangered species in the world. In the last 30 years, conservation programs were developed in all continents and many rescue centers were set up, especially in remote areas, but often poor communication is made among them. In the last 10 years medical workshops give the opportunity to exchange medical procedures, in order to analyse the influence of rehabilitation in conservation plans. Still, sea turtle medicine remains a very complex and poorly investigated field. Most of operators have not a complete experience in the medical specific domain, and for professionals too is complex to evaluate the effect of their therapies and surgeries. In the Lampedusa Sea Turtle Rescue Center, settled in the middle of the Mediterranean Sea, since 2000 we experienced more than 2000 treatments and surgeries on differently injured patients. the complexity to evaluate the final results of therapies and medical procedures and their effect on marine turtle wildlife, we planned the follow by radiotacking 2 “special” patients, thanks to the precious support of Octopus Foundation. Homerous is a female loggerhead with a massive injury limiting the use of 3 flippers and Hope s a young loggerhead rescued in very poor conditions with a line crossing the digestive tube and hematocrit value of 4! Along 4 years, Homerous undertook weekly sessions of physiotherapy in the open sea using a jacket connected to a line of 70 m, in order to improve her swimming ability; Hope underwent on a complex surgery, including esophagus and inguinal access and the implantation of a tube feeding. The aim of the present work is to better understand what the impact of medical procedures on the long-term survival of sea turtles is and to evaluate if the efforts of rehabilitation really improve chances for the animal to perform the natural behaviour in the wild again. To further comprehend the movement of Homerous and Hope, factors such as Mediterranean’s currents, water temperature, diving depth and wind patterns were considered. Lastly, the 2 heroines were projected as ambassadors of turtles of the Mediterranean Sea, and the impact of the consciousness was estimated in view of social media platforms.

THE SPATIAL AND TEMPORAL DISTRIBUTION OF POACHING EVENTS AT TORTUGUERO, COSTA RICA

George Glen[1,2], Emma Harrison[3], and Andrew Jackson[2]

[1]*Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, FL, USA*
[2]*Department of Zoology, School of Natural Sciences, Trinity College Dublin, Ireland*
[3]*Sea Turtle Conservancy, Gainesville, FL, USA*

Sea turtles have been, and in many cases still are, viewed as a staple food source by coastal communities. Because of the demand for turtle products, i.e., meat and eggs, sea turtles endured centuries of unabated exploitation on land and in the sea. While the global perception of sea turtles has shifted away from consumption and toward conservation, many rookeries incur large-scale losses from illegal harvesting every year. Tortuguero in Costa Rica is one such place that has withstood historically high levels of exploitation. Tortuguero hosts the largest green turtle rookery in the Atlantic basin, as well as small numbers of nesting leatherback and hawksbill turtles. The plight of the green turtle, in particular, was first reported by Archie Carr, who in 1954 described the magnitude of the harvest. Most female green turtles emerging to nest were intercepted by veladores ("stayers awake") and shipped to market for consumption. During these early years, the future of the green turtle at Tortuguero was bleak. Since then, however, a significant paradigm shift has occurred, forestalling the collapse of the nesting population. After the creation of Tortuguero National Park (TNP) in 1975 and the implementation of laws by the Costa Rican government in 1992 prohibiting the harvest of turtles and their eggs, many from the local community who once poached turtles are now guiding tourists along the beach to observe them nest. Despite the protected status of Tortuguero's beaches, however, poaching still occurs. While poaching effects a small percentage of the total nests and females annually, quantifying the rate of change in poaching is an essential factor in evaluating the efficacy of the National Park in protecting sea turtles. Using data obtained from the Sea Turtle Conservancy (STC), we modeled the spatial and temporal distribution of poaching events. In doing so, we identified hotspots and temporal trends. Poaching events are concentrated around Tortuguero river mouth and on the northern limit of the National Park. Data from the entire 18-miles suggest that within the National Park poaching is negligible. Spikes in poaching, however, take place but these are infrequent. The spatial distribution of poaching events seems to have persisted since monitoring was standardized in 1998, but the number of events per year displays a negative trend. A large amount of variation in the within-year temporal data implies that poaching is a highly random process, dictated by human behavior. The most prevalent reason for poaching seems to be a lack of effective law enforcement and ease of escape, motivated by direct economic benefits. Its fluctuating nature and localized concentration on the beach suggest that a potential poaching deterrent would be staggered patrols by the National Park rangers, mainly when the STC and tour guides are absent from the beach. Staggered patrols are recommended over routine monitoring to prevent poachers learning the behavior of the rangers. Like many National Parks, however, TNP is understaffed and underfunded. Therefore, to protect all turtles nesting at Tortuguero, additional resources should be allocated to support TNP in its mission.

SEA TURTLE TOURS IN TORTUGUERO, COSTA RICA: A HISTORICAL REVIEW OF THE ADVANCES, PERSISTENT PROBLEMS, AND CHALLENGES FOR THE FUTURE*

Ma. Jimena Gutiérrez-Lince[1], Marlenne Vázquez Cuevas[1], Jaime Restrepo[1], Andrés González[2], and Roldan A. Valverde[1,3]

[1]*Sea Turtle Conservancy, Gainesville, FL, USA*
[2]*Área de Conservación Tortuguero, Sistema Nacional de Áreas de Conservación*
[3]*Southeastern Louisiana University, Hammond, LA, USA*

Tortuguero, Costa Rica can be considered one of the most successful examples of conservation management of the Green sea turtle (*Chelonia mydas*). One of the main reasons for this success is the transformation the community experienced over the years, gradually shifting the initial approach they had to sea turtles, from an unsustainable harvest of the nesting females to obtain their meat and eggs, to a more sustainable ecotourism approach, where people from around the world come to observe the nesting females during the laying process in natural conditions. The system has evolved over time, changing its dynamism in different occasions, starting from uncontrolled walks on the beach, to a tour guide program developed in response to the increasing visitation, attempting to involve the local communities in the resource management, to a more sophisticated spotter system where the presence of the people on the beach is minimized to avoid the pressure tourists might have on nesting turtles. After 14 years implementing the spotter system, we considered relevant to review the evolution this experience has undergone over time, as well as analyze how the perception and satisfaction of the participants of these tours has changed with time. The results obtained from four different studies performed in different modalities of the tour were compared, all of them addressing similar areas of the tourist perception and satisfaction after participating in one of the night walks to observe the nesting females. Persistent, solved and new problems of the turtle watch experience and its organization were identified. Recommendations about possible strategies to address these problems, and challenges that might arise in the future were enumerated. This study contributes to reinforce the observation mechanisms of the program that ensure the optimal operation of the experience and maintain its viability as a conservation instrument.

EXPANDING WILDLIFE LIGHTING COLLABORATION FOR WIDER EFFECT*

Dianne Ingram[1] and Ben Frater[2]

[1]*US Fish and Wildlife Service*
[2]*Department of the Interior*

Protecting sea turtles from the negative impacts of artificial lighting has been a widely accepted and common practice for several decades. In more recent years, the consequences of artificial light on other taxa have become better understood by a multi-disciplined scientific community. This presentation will bring exposure to some of these collaborative opportunities that can yield more significant and longer-term ecological benefits. The rapid evolution of lighting technology presents a challenge to biologists trying to maintain their knowledge on the subjects. A solution to this dilemma is engaging the lighting scientists directly. Fortunately, many lighting scientists are eager to put their knowledge on the ground in a meaningful way. Biologists in turn can contribute by researching and communicating the impacts of artificial lighting on the various taxa residing within the vicinity of sea turtle nesting beaches. While some avenues for communication between biologists and lighting scientists are not plainly evident, finding and

promoting them is paramount. Universities, federal agencies, independent organization, non-profit organizations and private industry are all interested and active in the realm of efficient and renewable energy, development of dark sky initiatives and illumination standards, lighting research and the study and documentation of the effects of light on wildlife. For example, the Natural Sounds and Night Skies Division of the US National Park Service (NPS NSNSD) employs a team that restores acoustical and dark night sky environments using science, engineering and technology, and pioneers innovative techniques that identify management solutions to restore these public resources. Deepwater Horizon Oil Spill (DWH) Natural Resources Damage Assessment Restoration (NRDAR) Trustees are working with NPS NSNSD to quantify and assess artificial light trespass on the federal lands in Alabama and Florida that were injured during the oil spill. With this information, lighting plans will be developed and implemented by the Trustees and other voluntary participants. Another example of advanced lighting technology and research comes from the Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy's collaboration with the Solid-State Lighting (SSL) industry to help speed development of the science needed to advance the lighting technology and the products that people need. Since 2016, DWH NRDAR Gulf Restoration Office staff have engaged DOE SSL research and development (R&D) lighting scientists in ad hoc meetings, by presenting at a DOE SSL R&D Workshop, and by hosting a webinar reaching broad audiences to help bridge DOE SSL R&D lighting advancements and animal responses to light at night. By expanding our view and scope of advanced lighting technology and of the effects of artificial lighting to include multi-species and habitats, human health, non-profits and private industry, the benefits will have wider and more sustainable impact for restoring the night sky.

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION: THE WILDLIFE LIGHTING PROGRAM AND CERTIFICATION PROCESS

Lauren Jonaitis, Robbin Trindell, Tonya Long, and Luke Davis

Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL, USA

Many important sea turtle nesting beaches in the United States front densely developed coastal communities, many of which are world-renowned resort destinations. The large amount of exterior lighting required for public safety in these areas puts adult and hatchling sea turtles at risk as they attempt to locate the water after nesting or hatching. On an undeveloped beach, sea turtles use visual cues to locate the ocean, heading for the brighter, open horizon over the water and away from the darker landward dune. Artificial lighting on structures along the nesting beach can cause female and hatchling sea turtles to head landward, away from the water, into brightly lit roads, parking lots, and pools. Coastal communities require lighting on beachfront roads and buildings for public safety; thus, resource managers must recommend fixture and lamp options that meet lighting standards for human safety while reducing “attractiveness” to sea turtles on the adjacent nesting beach. To address this issue, the Florida Fish and Wildlife Conservation Commission (FWC) and Department of the Interior’s U.S. Fish and Wildlife Service (FWS) developed The Wildlife Lighting Program to provide options to reduce light pollution in ecologically sensitive areas while ensuring human safety and security. FWC and FWS developed specific Wildlife Lighting Criteria that fixtures, and lamps must meet to become Wildlife Lighting Certified. To be certified as Wildlife Lighting, fixtures must: 1.) produce the lowest lumens/wattage necessary for the needed purpose, 2.) meet or exceed full-cutoff to reduce reflection/sky glow and 3.) utilize long-wavelength lamps, which are less disruptive than white light to sea turtles. Once a year, manufacturers from all over the world submit their products to FWC to be reviewed as Wildlife Lighting Certified. If a submitted product meets all three criteria, then the manufacturer of that product is given an official Wildlife Lighting Certification letter and a Wildlife Lighting Certification number. The company is also allowed to use FWC’s Wildlife Lighting Logo on the approved fixture only, and FWC lists the product on the agency website. Currently there are 264 certified fixtures and lamps recommended for use in areas where artificial lighting is needed adjacent to ecologically sensitive areas, sea turtle nesting beaches, migratory corridors and Dark Sky Friendly communities. Each fixture is only considered certified if it meets specific criteria during installation and use; these criteria, or caveats, are included in the Certification letter and listed on the FWC Wildlife Lighting website. While Wildlife Lighting cannot be used anywhere on or adjacent to the nesting beach with impunity, when properly installed, these fixtures provide a viable option for coastal communities to reduce impacts to threatened and endangered sea turtles.

BUILDING PARTNERSHIP TO STRENGTHEN LEATHERBACK TURTLE CONSERVATION AT ABUN DISTRICT, TAMBRAUW REGENCY, PAPUA BARAT PROVINCE, INDONESIA

Sinus Keroman, Deasy Lontoh, and Fitryanti Pakiding

Lembaga Penelitian dan Pengabdian kepada Masyarakat, Universitas Papua, Manokwari

Jeen Yessa and Jeen Syuab beaches (formerly known as Jamursba Medi and Wermon) at the Bird's Head Peninsula of Papua host the largest nesting aggregations of leatherback turtles in the western Pacific. Since the mid-1980s, the leatherback population has been declining rapidly. Jeen Yessa and Jeen Syuab belong to community members who live in Saubeba, Womom, Warmandi, Wau, and Weyaf villages and they who control access to them. Both beaches are part of the Jeen Womom Coastal Park, which was established by the Minister of Marine Affairs and Fisheries of Indonesia (Ministerial Decree Number 53 /KEPMEN-KP/2017). Thus, support from local community as well as the government is critical to help the leatherback population to recover. UNIPA's leatherback conservation project consists of monitoring, community empowerment, and public relation programs. The public relation program aims to strengthen the conservation effort by linking the monitoring and community empowerment programs to local communities and Tambrauw as well as Papua Barat government. Specifically, the public relation team negotiated access with Jeen Yessa owners in 2017, which was then formalized into a cooperative agreement. In 2018, the agreement was renewed, and UNIPA currently have access to work at Jeen Yessa until mid-2019. Other than that, the public relation team meet regularly with the local community, the Tambrauw government, and the Marine Affairs and Fisheries Agency of Papua Barat since 2012. This regular coordination and discussion help ensure that the leatherback conservation continues to gain attention and moving forward. In many occasions, UNIPA also collaborates with other NGOs by supporting discussions, workshops, and trainings for stakeholders. Building partnership with other stakeholders was and still is challenging but with a positive result. The local community and the government now support UNIPA's leatherback conservation effort at Jeen Womom Coastal Park, which lays a firm foundation for the long term.

RECLAIM OUR COASTS (ROC): INCREASING THE QUANTITY AND QUALITY OF HABITAT FOR SEA TURTLES*

Cynthia J. Lagueux, Cathi L. Campbell, Alan B. Bolten, and Karen A. Bjorndal

Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, Gainesville, FL, USA

A major threat to sea turtle populations is the prevalence of anthropogenic debris on nesting beaches and in coastal waters. This debris poses four hazards to sea turtles: entanglement, ingestion, loss of critical nesting and foraging habitats, and the loss of access to food resources. The first two hazards can result in injury or death; the last two hazards can decrease productivity (body growth and reproduction) by limiting nutrient intake or forcing turtles to use suboptimal habitats. Anthropogenic obstacles and debris in sea turtle habitats were identified as a major threat to sea turtles during a conservation planning workshop for Florida sea turtles that we conducted in 2015 and in the Loggerhead Recovery Plan. As development on coastlines continues and threats from coastal erosion and derelict and ghost fishing gear increase, it is extremely important that we take active steps towards reducing these threats to sea turtles and their habitats. Florida's waters and beaches provide critical habitats for North Atlantic and Caribbean Sea turtle populations, including five species of sea turtles and for multiple management units. In 2016, we developed and implemented a program, Reclaim Our Coasts (ROC), to focus on removing derelict and abandoned obstacles from Florida's sea turtle nesting beaches and coastal waters. We have worked with local, State, and Federal governments; commercial fishing associations; non-governmental organizations; and research institutions on successful removal of obstacles. To date, we have removed more than 700 derelict traps and 26 tons of trap debris from the Key West National Wildlife Refuge, Florida (USA) and more than 110 tons of concrete, asphalt, fencing, and other debris from multiple nesting beaches throughout Florida. The permitting process can be highly variable, depending on a variety of factors, such as, existence of emergency orders from recent tropical weather events, ownership of property, and coastal habitat regulations, among others. Information about the impacts of debris in sea turtle habitat and lessons learned during the projects conducted by the ROC program during the past three years will be shared.

TURTLE TECH: USING MOBILE DISORIENTATION REPORTING AS A CONSERVATION TOOL

Tonya M. Long, Chris Anderson, Sara Burke, Lauren Jonaitis, Meghan Koperski, Glenn Reynolds, Kristin Rogers, and Robbin N. Trindell

Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL, USA

Nesting and hatchling sea turtles orient toward the water using visual cues, specifically, relative patterns of light and darkness within their field of view. On developed coastlines, artificial lighting near the beach interferes with natural orientation cues, thereby increasing hatchling mortality and deterring adult females from nesting. In 1987, the Florida Fish and Wildlife Conservation Commission (FWC) began collecting statewide data to better understand the distribution and frequency of these incidents, known as disorientation events. Since then, disorientation event reporting has become a valuable tool that helps inform a wide array of habitat management and policy decisions. With an annual average of 2500 disorientation reports received in recent years, all via mail, fax, or email, the time required for data processing by FWC staff created a perpetual backlog of data. As a result, the delayed detection of lighting impacts often prevented timely implementation of mitigative measures, thus prolonging the effects of problematic lighting on nesting and hatchling sea turtles. In 2018, FWC introduced a web and mobile application-based reporting system using the Environmental Systems Research Institute's (ESRI) Survey123, which imports data directly to an interactive map, eliminating the need for manual data entry. Disorientation event data can be automatically filtered and summarized at local and statewide scales to quickly calculate the metrics most commonly referenced for habitat management purposes. With the click of a button, the data can also be added directly to ArcGIS for detailed spatial analysis. Using this tool, FWC can monitor disorientations spatially and temporally in near-real time throughout the nesting season, providing an opportunity to promptly coordinate with local governments to adjust or implement light management strategies. Although the new system is still in its infancy, it has already substantially increased data processing efficiency and has been an effective means of identifying areas of concern. As both coastal development and sea turtle nesting continue to increase, this improved disorientation event reporting process will help FWC identify potential lighting issues as they arise, communicate information to our partners about current conditions, and develop targeted light management strategies.

VEHICLE BEST MANAGEMENT PRACTICES FOR SOUTH CAROLINA SEA TURTLE NESTING BEACHES

Mary-Catherine Martin[1], Felicia Sanders[1], Michelle Pate[2], Sarah Dawsey[3], and Melissa Chaplin[4]

[1]*Coastal Birds Program; South Carolina Department of Natural Resources, Bonneau, SC, USA*
[2]*Marine Turtle Conservation Program: South Carolina Department of Natural Resources, Charleston, SC, USA*
[3]*Cape Romain National Wildlife Refuge; United States Fish and Wildlife Service, Awendaw, SC, USA*
[4]*South Carolina Ecological Services Field Office; United States Fish and Wildlife Service, Charleston, SC, USA*

On South Carolina's coast sea turtle monitoring and management often involves the use of an all-terrain vehicle (ATV), utility task vehicle (UTV), or an off road or 4-wheel drive truck to carry supplies and provide an efficient means to survey miles of beach for sea turtle activity. In addition to sea turtle nesting, many of these beaches also support nesting shorebirds and seabirds. Use of these vehicles is often detrimental to nesting birds contributing to prolonged incubation interruption and egg and chick mortality. Over the last six decades seabird and shorebird populations have declined by 70% making their conservation critical. In the winter of 2016 the South Carolina Department of Natural Resources (SCDNR) Coastal Birds Program staff, SCDNR Marine Turtle Conservation Program staff, Cape Romain National Wildlife Refuge staff, and the US Fish and Wildlife Service Ecological Services endangered species biologist met to determine guidelines for vehicle use during sea turtle management activities which would minimize negative effects on nesting birds. We present these six guidelines known as "Vehicle Best Management Practices for South Carolina Sea Turtle Nesting Beaches." For example, vehicles are not allowed around the ends of islands where seabirds and shorebirds frequently nest yet only about 1% of sea turtle nests occur there. In South Carolina, the majority of sea turtle monitoring is conducted by volunteers. Volunteers received training on the guidelines of vehicle use as well as beach nesting bird ecology. This program has minimized negative impacts to beach nesting birds and may be useful in regional discussions about multi species management.

THE MANAGEMENT OF BEACH RESTORATION POLICIES AND SEA TURTLE CONSERVATION*

Mario Mota

National University, North Hollywood, CA, USA

Coastal erosion, whether from direct anthropogenic activities or because of climate change, is becoming more common. When eroded beaches get restored, the new shoreline has a direct impact on the nesting and incubation activities of sea turtles. Sea turtle conservation is, therefore, dependent on the beach nourishment management policies of local, state, and federal governments. A study of coastal restoration policies in Florida shows the delicate balance between the need to protect beach property and sea turtle conservation. Policies related to sand source, sand grain size, color, carbonate content, beach profile, and sand compaction can have positive or negative consequences on the nesting behavior and incubation of sea turtle clutches. Although beach restoration policies in Florida are aimed to protect sea turtles and other coastal wildlife, there can be situations where specific regulations related to the longevity of a restoration project or the aesthetics of a beach might not be the best policies for sea turtle conservation. What happens in these cases depends on many factors such as how strong conservation laws are, but since beaches are an important source of revenue for the State of Florida, sea turtle biologists need to be vigilant that their research is incorporated into the best practice policies for sea turtle protection and conservation.

15 YEARS OF INVESTIGATION AND RESTORATION OF THE NESTING POPULATION OF THE HAWKSBILL TURTLE (ERETMOCHELYS IMBRICATA) AT CHIRIQUÍ BEACH, COMARCA NGÄBE-BUGLÉ, PANAMÁ*

Maria Cristina Ordoñez[1], Genaro Castillo[1], Anne Meylan[2], Peter Meylan[3], Xavier Ow Young[1], and Roldan Valverde[1]

[1]Sea Turtle Conservancy, Gainesville, FL, USA
[2]Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL, USA (retired)
[3]Eckerd College, St. Petersburg, FL, USA

Marine turtle nesting beaches exist along much of the Caribbean coast of the Province of Bocas del Toro and the Comarca Ngäbe-Bugle, Panamá. The longest of these, Chiriquí Beach (09.013°N, 081. 712°W to 08.850°N, 81.573°W), was described by Archie Carr in 1956 as the most important Caribbean nesting beach for hawksbill turtles. By the early ‘80s, the population had experienced an estimated 98% decline due to decades of tortoiseshell exploitation to supply international trade. Beginning as early as the 1950s, Chiriquí Beach was leased to ‘veladors’ who gained exclusive rights to all hawksbill turtles nesting in each one-mile section of beach. Such intensive hunting pressure presumably contributed to the significant decline in hawksbill nesting documented by aerial and ground surveys in the 1980s. Encouraged by increased population levels at a few sites in the Caribbean where rigorous, long-term protection has been provided, we initiated a project to study and restore the remnant hawksbill populations along this coast. Beginning in 2001, meetings were held in Río Caña, Río Chiriquí, Kusapin, Chiriqui Grande, Bocas del Toro, Panama City, and at the CITES Wider Caribbean Region Hawksbill Dialogues to discuss with indigenous authorities, local communities, NGOs, wildlife agencies, and other interested parties, the feasibility of undertaking a major hawksbill study and restoration initiative in the Ngäbe-Buglé Comarca and Bocas del Toro Province. In June 2003, in collaboration with indigenous communities, the National Environmental

Authority (now MiAmbiente), and traditional authorities of the Ngäbe-Buglé Comarca, we began a new Sea Turtle Conservancy project at Chiriqui Beach as part of a larger cooperative effort to monitor and promote recovery of nesting hawksbills throughout the region. Project objectives are to: (1) restore the hawksbill nesting population, (2) establish index nesting beaches to monitor population trends of hawksbills in the southwestern Caribbean using standardized methods, (3) educate residents of Bocas del Toro Province and the Comarca about biology and conservation, (4) build local capacity to monitor and conserve sea turtles and (5) support local initiates to conserve natural resources. Standardized monitoring, research and protection efforts in collaboration with members of communities adjacent to Chiriqui Beach have been in place since June 2003. Local beach monitors conducted daily track surveys from June to October 2003, and throughout the nesting season (May to October) since 2004. In 2003, 381 hawksbill nests were recorded compared to 1,528 in 2017. The overall nesting trend at Chiriquí Beach continues to be positive over 15 seasons of monitoring. Nest productivity was assessed for a sample of the nests each year and revealed serious nest and hatchling predation by dogs. We conclude that although significantly depleted compared to historical records, Chiriquí Beach remains a regionally important hawksbill rookery and hosts the largest number of hawksbill nests of any beach along the coasts of Central America. The interest demonstrated by MiAmbiente, and by the General and Ño Kribo Regional Congress of the Ngäbe Buglé Comarca, gives us great hope that marine turtle conservation and protection will continue to improve in Bocas del Toro Province and the Ngäbe-Buglé Comarca in the future. Local support for marine turtle conservation in the communities bordering Chiriquí Beach is widespread. Capture of turtles with nets and harpoons in Bocas del Toro Province and the Comarca, although greatly diminished in the last 15 years, still represents the major threat to hawksbills nesting at Chiriquí Beach. Dogs continue to represent an important threat to nests and hatchlings at this site. Elimination of international trade in this species has been of primary importance to the observed increase in nesting.

#CARETTACARETTA: USING SOCIAL MEDIA & PHOTO IDENTIFICATION TO MONITOR TOURISM PRESSURE ON SEA TURTLES

Kostas Papafitsoros[1,2], Aliki Panagopoulou[1,3], and Gail Schofield[4]

[1]ARCHELON, the Sea Turtle Protection Society of Greece, Athens, Greece
[2]Weierstrass Institute Berlin, Berlin, Germany
[3]The Leatherback Trust, Fort Wayne, IN, USA
[4]School of Biological and Chemical Sciences, Queen Mary University, London, UK

Laganas Bay, Zakynthos Island, Greece hosts one of the largest breeding populations for the loggerhead sea turtle in the Mediterranean with an average of 1244 clutches per year along 6km of beach and is protected within the framework of a national park. In addition, Laganas Bay supports 10s of individuals of resident (non-migratory) males and immature turtles. Laganas Bay with its sandy beaches and warm waters, is also a popular tourist destination from May-October, which strongly overlaps with nesting (May-August) and hatchling (July-October) seasons of sea turtles. Consequently, encounters between humans and turtles occur frequently, and at a variety of scales; for instance, from small scale encounters (e.g., individuals snorkelling) to organised wildlife watching activity of turtles on boats containing large number of passengers. As a result, increasing numbers of photographs and videos of sea turtles are being uploaded each year on social media (e.g., Instagram, Facebook, Youtube). Here, we review and analyse more than 2000 publicly available social media photo/video uploads from the 2018 season. Whenever the quality of the photo/video allowed, individual turtles were matched (or added) to an existing photo ID database of unique individuals. We used this information to quantify how frequently the same turtles were observed in relation to others, which we termed "observation pressure". The preliminary results showed that the group of resident males and immature turtles are observed more frequently than migratory females (which begin departing from early July) and males (which depart in late May). This skew in observation pressure was particularly enhanced from August onwards, when the majority of migratory males and females had departed the bay to migrate to foraging grounds. The fact that this perhaps not surprising observation, is reflected in the social media uploads demonstrates that this tool could provide useful information on temporal trends in the presence of turtles in the bay. Of concern, if the tourism period remains stable (i.e., from May, peaking in August and ending in October), but the breeding period of adult turtles gradually shifts earlier in view of global warming, observation pressure on resident turtles might further increase. We estimate that each resident turtle contributes on average at least 37.500 euros to the local income, based on the fact that for the busiest second half of the season only around 20 individual resident turtles support the turtle spotting industry which generates an annual revenue of over 1.5 million euros. In addition to allowing the identification of individuals, social media imagery can indicate the type of observation (i.e., passive - just watching; active - touching or feeding individuals) and the potential level of disturbance. Overall, we demonstrate the potential utility of social media to provide insights on human-turtle interactions, facilitating the development of guidelines to enhance environmental education and behavioural codes of practice. Ultimately, as more people post their interactions with the sea turtles online, more will travel to Zakynthos to replicate these encounters. Therefore, it is essential to monitor and actively guide visitors to Zakynthos how to observe these animals and social media show high promise as a tool to achieve that.

THE BEACHES SAND QUALITY AFFECT LOGGERHEAD (*CARETTA CARETTA*) REPRODUCTIVE SUCCESS

Juan Patino-Martinez[1], Leno dos Passos[1], Inês Afonso[2], Jairson Veiga[3], and Rocío Moreno[1]

[1]*Maio Biodiversity Foundation, Maio, Cabo Verde*
[2]*Universidade de Aveiro, Portugal*
[3]*Universidade de Cabo Verde, Cabo Verde*

The absence of parental care in sea turtles makes the nesting site selection crucial for reproductive success. Characteristics of beaches including the quality of the sand, may affect the hatching success. The incubation environment of sea turtle clutches can be particularly heterogeneous, especially in some volcanic islands, where you can find different types of beach sand. Little is known about substrate variation on sea turtle nest sites and its effects on embryonic development, hatching success or hatchling fitness. Maio Island (Cabo Verde) is one of the most important world nesting areas of loggerhead sea turtle (*Caretta caretta*) and has black, white and mixed sand beaches which differ in composition. Such a sand diversity provides an optimal natural laboratory to study the influence of different substrates on egg incubation. During 2017 and 2018 we analyzed: i) inter and intra beach sand type variability, ii) sand preference of the nesting females, iii) nesting success, iv) nest density, v) hatching success and vi) indirect measures of hatchling fitness in the different substrates along the island. To test our hypothesis, we carried out two different experiments. In the first experiment, 105 nests were incubated in eight hatcheries with different types of sand: 2 hatcheries in white, 2 in black and 4 in mixed sand. In the second experiment, 225 eggs were experimentally incubated in three separate types of sand controlling moisture and temperature, to determine whether embryonic development and hatching success of loggerhead turtle is related to the characteristic of substrate. Analysis of sand composition showed that white substrate contains a higher percentage of carbonates than mixed and black sand. Our results showed that neither the nesting success nor the density of nests presented significant difference between the substrates. However, a significant higher hatching success and bigger and stronger hatchlings were found in the white substrate. The observed mean hatching success of white sand nests = 78.1 ± 18.2%, mixed sand = 46.1 ± 26.5% and black sand = 30.3 ± 20.2% was significantly different among nesting substrates. The temperatures were significantly higher in the black substrate, which may partially explain the lower hatching success of the nests in black substrate. However, it must be pointed out that eggs incubated experimentally at similar temperatures, showed a significantly lower hatching success in black sand than in white and mixed sand. Thus, we conclude that not only temperature but also sand composition, determine hatching success. Our results indicate that the nest site selection between different sand beaches or even in different areas of the same beach with different sand types, affect the hatching success and the physical condition of hatchlings and consequently the reproductive success.

REPRODUCTIVE SUCCESS, POPULATION STATUS AND ENVIRONMENTAL IMPACTS ON LOGGERHEAD SEA TURTLE (CARETTA CARETTA) IN MAIO ISLAND, REPUBLIC OF CABO VERDE: TESTING THE BEST NEST MANAGEMENT TECHNIQUES*

Leno dos Passos[1], Rocio Moreno[1], Inês Afonso[2], Manjula Tiwari[3], and Juan Patino-Martinez[1]

[1]Maio Biodiversity Foundation, Maio, Cape Verde
[2]Universidade de Aveiro, Portugal
3NOAA National Marine Fisheries Service, Marine Turtle Ecology & Assessment Program, La Jolla, CA

We present the results of the first intensive monitoring of loggerhead turtle (*Caretta caretta*) nesting in Maio Island, archipelago of Cape Verde, West Africa. On 110km of coastline, we studied 38 km of sand beaches that hold almost 100% of nesting activity. We registered a total number of nesting activities at all sites of 10985 (2016), 12806 (2017) and 30665 (2018) and that 4063 (37%, 2016), 5429 (42.4 %, 2017) and 13000 (42.4%, 2018) resulted in clutch deposition. 2018 was an exceptional year where nesting activities at all sites increased almost three times over last year. Our results showed that nesting levels in this island are important for regional and global loggerhead conservation. The Northeast Atlantic (Cape Verde) constitutes the third largest nesting aggregation for this species in the world after the south-eastern USA and Oman. Between 812 and 2600 nesting females per year have been estimated for Maio island. Besides female poaching (50 -150 females per year), nest flooding (28%-51%) and nest crab predation (41%) are the biggest current threats in Maio island. Our study shows that there is strong inter site hatching success differences (ranging from 0.8% to 93%). Thus, if we want to increase the production of hatchlings, different management strategies will be needed depending on the site. High incubation temperatures related to strong female bias sex-ratio (80%--99% depending of the sand color) has been registered and may become a serious conservation threat in the future.

SEVEN DECADES OF KEMP'S RIDLEY CONSERVATION*

Luis Jaime Peña

Gladys Porter Zoo, Brownsville, TX, USA

Saved from extinction by more than half a century of cumulative regulatory actions, conservation efforts, and research applied toward its recovery, the Kemp's ridley nevertheless remains the most endangered sea turtle species in the World. 2018 marked the 40th anniversary of the Binational Kemp's Ridley Sea Turtle Restoration and Enhancement Program, one of the longest running in situ conservation efforts in the World. This presentation will show the history of the conservation of this species as well as the history of the Binational Program - including Andres Herrera's famous 1947 film; how the species came close to disappearing forever in the mid-eighties; and how the work of countless individuals brought the Kemp's ridley back from the brink of extinction. An update on the work and activities of the Binational Program up to the 2018 nesting season will also be presented.

THE OLIVE RIDLEY PROJECT'S MARINE TURTLE RESCUE CENTRE: 2017-2018: A REVIEW

Claire Petros

Olive Ridley Project

The Olive Ridley Project (ORP) is a UK charity that was initially created to better understand the phenomenon of olive ridley sea turtles washing ashore in the Maldives entangled in fishing nets. The charity wanted to provide veterinary care for sea turtles entangled in the abandoned nets in the Maldives and has since expanded its scope to increase the awareness of ghost nets in the Indian Ocean and their detrimental effect on wildlife. Many olive ridley turtles were being found entangled, floating or washed ashore on many atolls within the Maldives. The Marine Turtle Rescue Centre's team consists of a full-time veterinarian, a Maldivian intern, and international volunteers throughout the entire year. It is also the first veterinary centre, and currently only veterinary centre in the country! The Olive Ridley Project provides injured turtles with appropriate medical care until they are deemed sufficiently fit to be released. The centre is also used as an outreach program for local schools, hosting regular field trips and presentations. It will also serve as a training centre for young Maldivians in a country where no other opportunities for training in veterinary medicine or animal husbandry are currently available. In the sixteen months that the rescue centre has been open, it has admitted forty-four turtles, of which four of the seven species have been represented (*Lepidochelys olivaecea*, *Chelonia mydas*, *Caretta caretta*, *Eretmochelys imbricata*), from nine different atolls, some travelling distances of almost 400km and travelling by both seaplane and speedboat. We have successful released over twenty turtles, with some still receiving care and others moved on to future homes. Of the forty-four patients admitted, thirty-six were olive ridleys, four were hawksbills, two green and one loggerhead. Twenty Olive Ridley turtles required surgery (most frequently resulting in amputations), two hawksbills required fishing hook removals. Two of the three green turtles had previously been kept inappropriately as pets, (as was the Loggerhead). The Loggerhead was the first of its species to be treated at a rescue centre in the Maldives, and currently the only known Loggerhead to be reported as hatching in the Maldives. This project is still in its infancy. As its reputation spreads, we hope that more turtles will find their way to our care. As we are continuing to grow, our aim is to also improve our veterinary facilities at the same time.

CRACK IN THE EGG TRADE – DRIVERS OF SEA TURTLE EGG POACHING IN COSTA RICA

Helen Pheasey

Durrell Institute of Conservation and Ecology, University of Kent, Canterbury, Kent, UK

Sea turtles and their eggs are protected under Costa Rican Law #8325 and Wildlife Law #7317. Despite this nesting beaches across Costa Rica, both inside and outside of protected areas, suffer high rates of illegal extraction of sea turtle eggs. The consumption of turtle eggs goes back generations and is ingrained in the culture, particularly in coastal communities. Today the majority of consumers purchase eggs rather than extract them directly. The aim of this research was to try and understand the drivers of illegal extraction and a willingness to break the law. Semi-structured interviews (n=52) and informal interviews (n=29) were undertaken with illegal harvesters, law enforcement officials, community members and staff at conservation projects, to try and identify the drivers of illegal turtle egg extraction. Illegal harvesters were local community members and people migrating to nesting beaches specifically for turtle nesting season. Substance misuse, primarily crack cocaine, marijuana and to a lesser extent alcohol, was identified to be the primary motivation of illegal egg extractors, who sold eggs or exchanged them directly for narcotics. Despite custodial sentences of up to three years, low levels of law enforcement in combination with high motivation to take eggs, results in low sale prices for illegal eggs.

TRACKING POACHED EGGS – THE CHALLENGES AND REWARDS OF USING DECOY TURTLE EGGS*

Helen Pheasey[1], Kim Williams-Guillen[2], and Sarah Otterstrom[2]

[1]*Durrell Institute of Conservation and Ecology, University of Kent, Canterbury, Kent, UK*
[2]*Paso Pacifico*

The illegal extraction of sea turtle nests is a major threat to the survivorship of many turtle populations. Stewardship programs on in-situ nesting beaches are often under resourced to protect turtle nests from poachers. An innovative new technology developed by the conservation organisation Paso Pacifico may assist in solving this problem. The InvestEGGator is a 3D printed decoy turtle egg, embedded with a GPS-GSM tracking device; we field tested this technology on four sea turtle nesting beaches on the Caribbean and Pacific coasts of Costa Rica in 2017 and 2018. Fake eggs were deployed in over 101 nests (43=green Chelonia mydas, 57+ = Olive ridley Lepidochelys olivacea and 1 Loggerhead Caretta caretta). Each beach presented unique challenges which affected the likelihood of a nest being poached, the detectability of the decoy by the poachers and the data received from the egg. Our deployments suggest that minimizing the size discrepancy between natural and artificial eggs and placing artificial eggs in the middle of the nest may reduce detections of the trackers. We tracked a nest from the beach, 155 km inland and identified a possible handover and final consumer location. Here we provide a summary of our results and recommendations for future users.

AN ASSESSMENT OF SEA TURTLE HATCHERY MANAGEMENT PRACTICES IN INDIA*

Andrea D. Phillott[1], Abhidnya Unhale[2], and Nupur Kale[3]

[1]*FLAME University, Pune, Maharashtra, India*
[2]*Pune, Maharashtra, India*
[3]*Dakshin Foundation, Bengaluru, Karnataka, India*

In situ incubation of sea turtle nests is preferred but threats such as poaching, predation, and habitat loss can require eggs to be transferred to a hatchery as an ex situ conservation strategy. However, hatchery management practices that do not result in high hatchling productivity will negate the potential benefits of incubating eggs in a secure environment. We used surveys and face to face interviews to collect information from hatchery personnel in India about hatchery practices and productivity in terms of number of eggs or nests protected and hatching success. Our results include detailed descriptions of hatchery infrastructure and practices for collecting, transporting and incubating eggs, and holding, rearing and releasing hatchlings from hatcheries in Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh and Odisha. Factors most likely to contribute to conservation of sea turtles, including those with a potentially negative impact upon hatching success and hatchling survival, are identified for each state. Strategies to improve hatchery management practices and mitigate the potential impacts of climate change are provided. Targets for hatcheries are also proposed to ensure high productivity and appropriate hatchling sex ratios that will contribute to the effective conservation of leatherback, green, hawksbill and olive ridley sea turtles in the region. The strategies and targets discussed are also applicable to sea turtle hatcheries worldwide.

POST-WAR TOURISM DEVELOPMENTS AND COASTAL LIGHT POLLUTION: EFFECT ON SEA TURTLES IN SRI LANKA

R. S. Rajakaruna and Chethiya S. T. Waththuhewa

University of Peradeniya, Sri Lanka

Sea turtles are the best-known example of an organism adversely affected by artificial lighting. Increases in artificial light which occurs as coastal lines are developed, pose a significant threat to nesting females as well as hatchling migrations. In recent years, Sri Lanka underwent massive increases in coastal development following the cessation of nearly three decades of civil war in 2009 and thereafter has witnessed an unprecedented post-war tourism boom beyond its expectations. The number of international tourist arrival to Sri Lanka has sharply increased from 438,475 in 2008 to 2,116,407 arrivals in 2017 breaking all historical records. Beach holidays been one of the most favoured tourist attractions, many new hotels have been built along the coastal lines especially, in southwestern Sri Lanka. Major sea turtle nesting sites are also located along this area. This study assessed the increase in artificial light along the major nesting beaches using geographical information system analysis. The night-time lights data produced by the NOAA National Geophysical Data Centre was overlaid onto sea turtle nesting data for a period of ten years from 2008 to 2017, before and after the war. We identified major nesting sites that face the greatest threat from artificial light some of which include the nesting sites along the southwestern and eastern coastal line. Southern and southwestern coast always had high human population and tourism also had been largely concentrated along these coasts. Although there is increased in the light pollution along these beaches a significant increase was shown in the eastern coast which was previously inaccessible, war affected area. However, the eastern beach has recently been identified as a major nesting site. As development continues

around the coastline of Sri Lanka, we strongly recommend continued monitoring of lighting impacts at adjacent turtle nesting beaches. Artificial lighting close to nesting beach can deter females from emerging to nest or fail to find ocean following oviposition. It can also mask a hatchling's ability to see natural light horizons and hence disrupt sea finding, reducing survival chances. Here we highlight the need for light-mitigation strategies to be implemented as standard as development increases along the coastlines not only due to tourist hotels but also the light generated by industrial and urban development projects.

DRONES FOR TURTLES: NEW APPROACH TO CONTROL POACHING OF NESTING LOGGERHEAD SEA TURTLES ON BOAVISTA, CAPE VERDE, WITH NIGHT VISION UNMANNED AERIAL VEHICLES*

Thomas Reischig

Turtle Foundation, Köln, Germany

Cape Verde is home to the world's third largest nesting population of the loggerhead sea turtle (*Caretta caretta*), which is one of the 11 most threatened sea turtle populations in the world. Despite legal protection, particularly nesting females are still rampantly poached. About two-thirds of this population nests on the Island of Boavista. Alerted by the report of 1,200 turtles killed on Boavista in 2007 alone, Turtle Foundation launched its local conservation project in 2008. Regular nocturnal patrols on the nesting beaches with mixed groups of rangers and international volunteers was initially successful, reducing poaching by more than 95% on the beaches protected by Turtle Foundation. In recent years, however, poaching has increased again as poachers have learned to understand the working scheme of the patrols. This increase of poaching incidents was again responded by adding more patrol groups. It became apparent that a continuous increase of patrol groups on a total of more than 50 kilometers of nesting beach to prevent poaching will be too expensive and therefore not sustainable in the long term. Therefore, Turtle Foundation decided to develop a new anti-poaching strategy and deliver technical support to the local police in developing and implementing a new beach surveillance technique based on unmanned aerial vehicles (UAVs, "drones") with night vision capability. The ultimate aim of the project was to overcome the so far prevention-oriented method, where only by the presence of patrols the poachers should be kept away from the beaches, to be replaced by a three-step approach of detection, intervention and prosecution of poaching activity. In collaboration with the local government and other conservation NGOs working on Boavista, a task force was established consisting of two local drone operators, who were trained in the beginning of the nesting season 2018, and two policemen. The team was equipped with a commercial long range quadrocopter carrying a thermal infrared camera. During the nesting season 2018, the drone task force regularly operated on beaches especially threatened by poaching. For each mission, a target beach was randomly selected and covered by surveillance flights several times per night. Between beginning of August and end of October 2018, more than 70 missions with around 400 individual drone flights were carried out while managing various environmental and technical challenges. Although no poachers were caught, poaching rates dropped considerably compared to the previous years despite unusual high nesting activity in 2018. We attribute this to the combined effect of a recently tightened local law for the protection of sea turtles and the publicly known but unpredictable presence of the drone task force. However, the pure deterrent effect might not be sustainable if persistent poachers are not captured and prosecuted. Therefore, the method is now evaluated and will be adapted accordingly in order to fully develop into an efficient supplement or even alternative to conventional beach patrolling in the future. To our knowledge, this is the first application of thermal night vision drones to protect sea turtles from poaching.

SEA TURTLES TRADE IN THE CARIBBEAN: OVERVIEW OF THE LEGAL FRAMEWORK AND TRADE OF SEA TURTLES IN THE CARIBBEAN REGION FOCUSING ON THE ISLAND ARC OF THE LESSER ANTILLES*

Claire Saladin

Widecast, IUCN SSC WHSG, IUCN WCEL

The Caribbean or West Indies are composed of 23 Sovereign States and 18 Dependencies of 4 Sovereign States, and are considered as a Subregion of the American Continent. Nestled in a warm tropical climate, with temperatures varying from 25° to 32° all year long, 6 of 7 Species of Sea Turtles, all included in the IUCN Red List of Threatened Species, forage nest and use migratory corridors there. The geopolitical diversity of the Region leads to a complex policy framework concerning Sea Turtles. This presentation proposes an overview of the legal framework involving Sea Turtles and a study of their trade in the Caribbean Area, focusing on the Island Arc of the Lesser Antilles.

USING EXPERT OPINION TO DETERMINE THE RELATIVE IMPACT OF COASTAL MODIFICATIONS ON MARINE TURTLE NESTING GROUNDS

Kristen Nelson Sella, Lucia Sicius, and Mariana M.P.B. Fuentes

Florida State University, Department of Earth, Ocean and Atmospheric Science, Tallahassee, FL USA

Marine turtles utilize sandy beaches as nesting grounds, which can be impacted by a variety of coastal modifications. In the context of limited resources, managers need to prioritize which impacts from coastal modifications to mitigate. Previous studies have explored the potential impacts of specific types of coastal modifications on marine turtles such as beach armoring or sand nourishment projects. However, data on the relative impacts of coastal modification activities is not often available. To address this, we determined the relative impact of twelve coastal modification activities (beach armoring, beach cleaning, beach sand placement, coastal construction in the dune, in water, landward of the dune and on the beach, light pollution, other shoreline stabilization, sand fences, special events, and stormwater outfalls) on marine turtle nesting grounds by eliciting information from experts on the impacts of coastal modifications on marine turtles and their nesting grounds. Experts were selected through a literature review of studies that have been conducted on coastal modifications and its impacts on marine turtles, their membership in marine turtle specialist groups, and the personal knowledge of the principal investigators. Thirty-eight experts were approached and 21 surveys were completed (55.2% response rate). Experts were asked to answer a series of pair-wise comparison matrices that compared the impacts from each coastal modification activity. The relative weights of the perceived impacts of each of the modification were analyzed using Analytical Hierarchy Process (AHP). Beach armoring, light pollution, and other shoreline stabilization structures (such as groins and jetties) were weighted by our experts as having the greatest impact to marine turtle nesting grounds and non-permanent coastal modifications (e.g., special events and beach cleaning) were weighted by experts as having the lowest impact to marine turtle nesting grounds. Experts that worked outside the United States placed a higher weight on light pollution than the experts that worked within the United States, implicating that different modifications may be a greater threat in different regions. This could potentially be an indication that policies in place within the United States to minimize threats such as lighting pollution have been successful. Managers can use this information to prioritize their efforts and resources to manage marine turtle nesting grounds. Future work may include developing a framework to prioritize management actions.

EFFECT OF THE FIRE ANT PESTICIDE HYDRAMETHYLNON (AMDRO®) ON THE NEST SURVIVAL AND HATCHLING ORIENTATION OF LOGGERHEAD SEA TURTLES*

Heather E. Smith[1], Shelby R. Hoover[1], Michael Salmon[1], Heather Seaman[1], Christina M. Coppenrath[2], Sarah E. Hirsch[2], and Justin R. Perrault

[1]*Florida Atlantic University, Boca Raton, FL, USA*
[2]*Loggerhead MarineLife Center, Juno Beach, FL, USA*

Invasive fire ants are voracious predators of ground nesting birds and reptiles and are spreading rapidly throughout tropical and temperate climates. The pesticide AMDRO® has been widely used on marine turtle nesting beaches to protect nests and hatchlings from these predators but no studies have assessed its effect on any reptile species. In other vertebrates, contact with AMDRO® can result in visual impairment, dermal abrasions, and reduced reproductive success. In this field study, we examined its impact on hatching success, emergence success, and orientation behavior in loggerhead sea turtles (*Caretta caretta*) in Juno Beach, Florida. Pesticide granules were placed on the sand above the nest days in advance of an emergence; corn grit granules served as the vehicle control and were placed above nests for comparison to the AMDRO® treated nests. Sand samples were collected to determine if the toxicant persisted in the environment, and preliminary analyses indicate that the pesticide remained in the sand after dosing. We found that the toxicant had no effect on hatchling morphology, hatching success, or emergence success. It also had no effect on the ability of hatchlings to orient toward the ocean (a visually mediated response). However, we did notice more ant and crab predators at treatment nests than are normally seen at our study site. Thus, while AMDRO® might not directly impact reproductive success or hatchling behavior, it had the unanticipated effect of possibly increasing nest vulnerability to predators. We hope that the results of this study will help to inform wildlife management personnel on the use of this pesticide for fire ant removal on vulnerable sea turtle nesting beaches.

A BLUEPRINT FOR NAVIGATING THE SEA TURTLE LIGHTING INDUSTRY*

Rachel Tighe[1], Rick Herren[1], and Kristi Spohn[2]

[1]*Sea Turtle Conservancy, Gainesville, FL, USA*
[2]*SESCO Lighting, FL, USA*

For decades, we've known that artificial lights cause adult and hatchling sea turtles to disorient, depleting their energy reserves and causing mortality. Fixtures that shield the source of light, keep the light low to the ground, and use long wavelengths (560 nm or longer), reduce the risk of disorientations. Even though the technology available today can eliminate or reduce light pollution on nesting beaches, there remains a disconnect between understanding the problem and finding the solution. Using funding administered by the National Fish and Wildlife Foundation as a result of the 2010 Deepwater Horizon Oil Spill, Sea Turtle Conservancy (STC) has retrofitted thousands of lights on more than 200 properties using sea turtle friendly-lighting. Throughout this process, STC has built lasting partnerships with key stakeholders in the lighting industry. The purpose of this presentation is to provide resources on where to find sea turtle-friendly lighting, assist biologists and conservationists in navigating the lighting industry, and discuss the benefits of forming relationships with lighting professionals. For example, distributors and lighting agencies may be able to negotiate lower prices for conservation projects. Lighting agencies can provide photometric plans using their product to ensure a project is in compliance with local building and safety codes. Lighting agencies can also work directly with their manufacturers to alter an existing fixture or design a new fixture for a specific project. As an added bonus, sea turtle experts can educate lighting professionals about sea turtle-friendly lighting and local lighting ordinances through these types of partnerships. After interacting with biologists and conservationists, lighting professionals will be better equipped to serve their customers and ensure that other beachfront projects are in compliance with local ordinances using the best available sea turtle-friendly technology. The result is that more people will advocate for sea turtle-friendly lighting and assist in darkening nesting habitat, ultimately reducing disorientation rates.

TO PAY OR NOT TO PAY TO PROTECT TURTLE EGGS: LESSONS LEARNED FROM THE EASTERN PACIFIC HAWKSBILL INITIATIVE IN EL SALVADOR AND NICARAGUA

Jose Urteaga[1], Mike Liles[2,3], Eduardo Altamirano[3,4], Sofia Chavarria[2,4], Ani Henríquez[2,4], Velkis Gadea[3,4], Alexander Gaos[3,5], Alejandra Rivera[3,4], Heydi Salazar[3,4], and Ingrid Yañes[3]

[1]*Stanford University, Emmett Interdisciplinary Program in Environment and Resources, ICAPO*
[2]*ProCosta, Usulutan, El Salvador*
[3]*Eastern Pacific Hawksbill Initiative, San Diego, CA, USA*
[4]*Fauna & Flora International, Cambridge, England*
[5]*Ocean Associates Inc, under contract to the Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration*

In Nicaragua and El Salvador, various government and NGO programs use direct payments as an approach to engage local communities in sea turtle conservation, specifically to prevent sea turtle eggs from being poached. Through these programs, egg collectors receive a payment in cash or in kind after they help to protect turtle clutches instead of selling them on the black market for human consumption. While seemingly effective, direct payments are controversial. During the last two decades, scientists and practitioners have argued about the appropriateness of direct payments as a tool to engage wildlife users in conservation. Those in favor argue that direct payments facilitate cooperation across stakeholders' groups, avoiding conflicts frequently sparked by coercive approaches. In addition, proponents of direct payments underscore that these are socially just, relieving often poor and marginalized local people of bearing the cost of conservation. Moreover, in some contexts, direct payments seem to be more cost-effective when compared with alternative strategies. On the other hand, opponents to the use of direct payments argue that they might erode preexisting communities' intrinsic motivations for pro-social and/or pro-environmental behaviors. Evidence also suggests that while direct payments might be effective in the short term, they are ineffective in the long run because once projects institute the payments, local communities quickly normalize them as a rightful practice, perpetuating the need for these types of programs. In addition, by implementing direct payments, conservation agencies might shape a transactional relationship with local communities instead of the desired collaborative partnership. Consequently, once funding expires, conservation achievements rapidly regress to a similar or even worse situation than prior to the conservation intervention. In this study, we aim to evaluate the effectiveness of using direct payments in three conservation projects of Eastern Pacific hawksbill, *Eretmochelys imbricata*, in Padre Ramos and Aserradores in Nicaragua, and Bahia de Jiquilisco in El Salvador. To achieve our research goals, we use a mix method approach. We draw data from several sources including participant observation and 60 semi-structured interviews with key informants conducted between 2016 and 2018. We use nest monitoring data to evaluate the rates of nest protection at each site, compared to the variation in turtle egg prices. We describe how the conservation project's structure and implement the direct payments schemes at each location. Then, we contextualize our findings within the literature on incentives for conservation and common pool resource theory. Finally, we summarize the lessons learned from these cases. We conclude that direct payments are highly effective at our research locations, including the conversion of nest protection from nearly zero percent to over ninety percent pre- and post-payment implantation, respectively, likely because they align with pre-existing local norms of appropriation of turtles. While the implementation of direct payment seems to reinforce the extractive value that local communities attach to sea turtles, we find that by creating stewardship, conservation projects enhance community support for conservation beyond the pure demand and supply logic. For example, most of the egg collectors remain loyal to the direct payment program even when prices for eggs on the black market surpasses prices offered by conservation projects. We also find that there are no blueprints for the implementation of direct payment programs and that the ultimate social impacts of the direct payments are contingent on other activities implemented by the project.

USING WAVE RUNUP MODELING TO INFORM SEA TURTLE NEST RELOCATION*

Matthew Ware[1], Joseph W. Long[2], and Mariana M.P.B. Fuentes[1]

[1]*Florida State University Marine Turtle Research, Ecology, and Conservation Group, Tallahassee, FL, USA*
[2]*Department of Earth and Ocean Sciences, University of North Carolina, Wilmington, NC, USA*

Inundation events caused by wave wash-over or groundwater intrusion can be extremely detrimental for incubating sea turtle embryos. Since sufficient gas exchange with the surrounding environment is required for proper embryonic development, inundation for prolonged periods can result in embryonic mortality. In an effort to increase sea turtle hatchling output, management strategies such as nest relocation have been applied, sometimes resulting in unnecessary nest manipulation. To improve the identification of beach locations potentially exposed to inundation caused by wave wash-over, wave runup models were tested in Fort Morgan, Alabama for the 2016 nesting season. The potential exposure of sea turtle nesting sites to wave wash-over was determined by comparing observed nest elevations to the predicted combined elevation of wave runup, tide, and surge (i.e., total water level). Total water level was calculated using three different definitions of beach slope: foreshore, nest, and dune-to-water (DTW), and two LiDAR-derived elevation estimates: the most recent survey from 2016 and a time-averaged digital elevation model (DEM). Models using the time-averaged DEM performed as well as, or better than, those using the 2016 LiDAR survey in the majority of comparisons. Wash-over state was correctly identified for up to 83.3% of sites when using nest slope in the wave runup calculation. However, DTW slope performed the best when predicting the wash-over frequency of a site. Mapping of the predicted 98th percentile of wave runup indicated that only 11.2% of nesting sites were exposed to wave wash-over, in contrast to the 21.3% of nests which were relocated. Wave runup models have not previously been used to inform sea turtle conservation actions; however, it holds promise for improved targeted management interventions. Wave runup models can also be used to investigate past storm events, forecast approaching storm impacts, and supplement sea level rise scenarios for coastal species management at multiple spatial scales.

EDUCATION AND OUTREACH

A PROPOSAL TO GET LOCAL YOUNG ADULTS INVOLVED IN ENVIRONMENTAL CONSERVATION PROJECTS IN THE COMMUNITY OF TORTUGUERO, COSTA RICA

Sílvia Agulló Aguila[1] and Roldán A. Valverde[1,2]

[1]*Sea Turtle Conservancy, Gainesville, FL, USA*
[2]*Southeastern Louisiana University, Hammond, LA, USA*

Tortuguero National Park, situated in the northeastern Caribbean coast of Costa Rica, is a key nesting beach for the Green turtle (*Chelonia mydas*), hosting one of the two largest populations around the world. The community has always had a strong impact on sea turtles due to their proximity and culture, and, despite a solid ecotourism program based on sea turtles established in the 1990s, illegal practices still occur, causing the decline of the population. Changing people's attitudes towards the environment is essential for the conservation of sea turtles in Tortuguero. Environmental education has acted as an avenue for enhancing the understanding of environmental issues and affective commitment to the environment (O'Brien & Stoner, 1987). Educating on essential values to face the lack of self-esteem/confidence, concerns, sensitivity and empathy, sense of identity and responsibility, is also a need in Tortuguero. This proposal is based on a field, informal environmental education program that accompanies the young adult's personal growth creating a link with nature and consequently, encourages them to take a positive role in the community. As an example, a program called Junior Research Assistants was developed and run by the Sea Turtle Conservancy since 2008, where around one hundred students from high school have participated in nesting sea turtles data collection. Although young adults are the key to a future aware and committed society, they don't have many other activities adapted to their age, interests and needs. One of the main objectives of this initiative is to involve the young adults in the community through small teamwork projects and work along with the Tortuguero National Park, other NGO's and local communities. To start, a survey of the young adult's general interests has been carried out and a subsequent proposal has been defined. Based on the results, going on a field trip to discover Cahuita National Park will be the main course of the project, dividing them into groups with different responsibilities for the process' organization and execution. This will turn into a longitudinal activity for them during the season, working on different competencies, being the sea turtle fieldwork and Costa Rican biodiversity awareness the most important ones. Some of the other options proposed are organizing fund-raising projects (e.g., handicrafts, raffles, food selling) and activities for the kids, taking English classes, and working on outreach, communication and social media skills. Finally, an evaluation of each activity and the whole plan will be carried out to assess the effectiveness and success of the program. As stated by Ramsey and Rickson (1977) "Increasing knowledge leads to favorable attitudes, which in turn leads to action promoting better environmental quality". Thus, it is important that young adults discover their natural environment, so there will be environmental awareness and a possible commitment in the future community.

AN INNOVATIVE SMARTPHONE APP TO CURB HAWKSBILL ILLEGAL TRADE IN CARTAGENA, COLOMBIA*

Diego Amorocho and Juan Sebastian Ayala

World Wildlife Fund (WWF)

In Cartagena, the touristic hotspot of the Colombian Caribbean, the illegal trade of endangered hawksbill (*Eretmochelys imbricata*) tortoiseshell, including handcrafts made with it, has not been eradicated. The scutes and dorsal part of the shell from critically endangered marine turtles killed near Cartagena bay are transformed to be sold in the streets as bracelets, earrings, spoons, necklaces and other items. The local tourism police in charge of environmental issues and customs agents are not sufficiently trained or empowered to cope with illegal wildlife trade. Tourists arriving in cruise ships, flights and terrestrial vehicles are not informed of the problem either. These limitations hamper current conservation efforts and need to be urgently addressed to halt further population decline of hawksbill turtles in the Caribbean. In order to eradicate this issue and empower police and customs officials to detect and confiscate tortoiseshell items, WWF have developed and launched a smartphone application (Cero Carey). This project offered technical workshops to the Colombian Environmental Police to identify illegal tortoiseshell items, learn about the country conservation legal framework and be updated on the current plight of marine turtles in Colombia and abroad. Over 50 trained officers put in practice learned and acquired skills conducting seizes and uncover operations to tackle illegal wildlife trade vendors in Cartagena street markets. Between 2017 and 2018 more than 100 tourism representatives (from hotels and company tours) were trained in turtle friendly tourism best practices and the use of Cero Carey. Since October 2017 more than 2,000 visitors to Cartagena were informed about illegal wildlife trade of sea turtle products, how to avoid purchase and to how to help stop killing hawksbills in the nearby area in the Colombian Caribbean using their smartphones. Due to these training workshops and the Cero Carey app use by citizens the Environmental Police seized more than 300 pieces made of hawksbill scutes between 2017 and 2018 in Cartagena. These products were valued in $1600 USD approximately. This project has shown that the use of technological tools such as mobile applications can have a positive impact on wildlife conservation. Using Cero Carey hawksbill turtles are now being protected in Cartagena City.

USING A VIDEO AS AN ENVIRONMENTAL EDUCATION METHOD

Candela Buteler[1,2] and Francisco Cognigni[1]

[1]*Karumbé*
[2]*CREMA. Centro Rescate de Especies Marinas Amenazadas*

Environmental education is a training process that allows awareness of the importance of the environment, promotes the development of values and new attitudes that contribute to the rational use of natural resources and the solution of environmental problems we face. It is developed through a practice that links the knowledge of the community, values and attitudes that promotes a critical and responsible behavior with the environment. One of the objectives of the environmental education is the use of didactic elements to understand the environmental needs and by this way, to improve relation with the environment. It can use innovative resources in pedagogy, in natural or social sciences searching a critical knowledge that seeks to transform and build a more sustainable, equitable and participatory society. The environmental education is a very important part of every conservation program. It can be made by making activities with in schools, activities with tourist, museums or communities and the best idea is to include young and old people as the audience. A good way to attract attention to the public is by an audiovisual method. We made a video through small videos and photos collected during the years we have been working in this area and with the help of the projects we have known with the proposal to show the biology of the sea turtles, the problematic of their conservations and the way that the biologist or related people can work in different conservations programs. The objective of this video is to show how are the activities that a biologist can made in this area, because we consider that is poorly known, at the same time that we show the biology and problematics of sea turtle. It could be use in visitor centers, in schools or through social networks to spread the importance of the care of the environment and how people can affect sea turtle life.

COMMUNITY WELFARE TOWARDS SEA TURTLES CONSERVATION AT KALPITIYA PENINSULA OF SRI LANKA

Lalith Ekanayake and Y.K. Karunarathna

Bio Conservation Society (BCSL), Sri Lanka

Five species of sea turtles come ashore to nest in Sri Lanka while their feeding habitats & migratory routes located around the island. The species are namely green turtle, leatherback, olive ridley, loggerhead and the Hawksbill. Kalpitiya peninsula located in the Gulf of Mannar at Northwestern coast of Sri Lanka. The fishing communities in the Kalpitiya Peninsula depend on seasonal, artisanal gill net fisheries targeting pelagic shoaling fish. Sea turtles often get entangled in the sea and lagoon causing damage for fishing nets. In response, fishers either beat the turtles' heads until they rendered unconscious, or hack off the turtles' body parts to make disentanglement easier. The turtles are then either discarded at sea, or brought back to shore for illegal processing of their meat for local consumption. So coastal communities must be educated about the importance of conserving the sea turtles and coastal ecosystems including various habitats such as coral reefs, mangroves, sea grass beds etc. The aims and objective of this programme is to encourage the fisher's families for the conservation of sea turtles and coastal biodiversity while continuing BCSL education and awareness programmes. Although many families having toilets still there are some families among fishers doesn't have proper toilet facilities. It is a big problem for the sanitary condition of the villagers as well as badly affect to the environment and beauty of the nature in the area. So we have built 20 toilets for the needy fisher's families in the Kandakuliya village. Moreover, we have conducted Batik training programme for the ladies in the fisheries community. They can earn additional income for their day today living expenses by selling the Batik garments. While uplifting their living condition we are expecting their support for the sea turtle and coastal biodiversity conservation activities. Moreover we have continued our awareness programmes for the fisheries community on sea turtle and coastal biodiversity conservation. Field activities such as beach cleaning and Pandanus (Screwpine) replanting in the beach were conducted with the support of community members. The active participation of coastal communities for the conservation activities increased due to welfare programmes. When comparing their living conditions, actually welfare programmes are not bribing and just encouragement for the conservation.

PUPPET SHOWS AS A TOOL TO RAISE AWARENESS ON SEA TURTLE CONSERVATION IN THE PACIFIC OF NICARAGUA

German Garcia[1], Velkiss Gadea[1], Nancy Barahona[1], Heydi Salazar[1], Carlos Hernández[2], Ariel Salinas[2], and José Urteaga[3]

[1]Fauna & Flora International
[2]Experimental Maraña
[3]Emmett Interdisciplinary Program in Environment and Resources, Stanford University

Environmental education is an important tool to transform people's attitudes and behaviors towards the environment. However designing effective environmental education programs is a challenging task for small conservation projects that face limited resources and heterogeneous social contexts. Previous research suggest that in order to be effective, education programs need to be fun, culturally sound, and participatory. One way to achieve these characteristics is to articulate environmental education messaging with cultural expressions such as music and theater. Following this logic, during 2018, in collaboration with community groups, we developed the puppet show "Trip to the Center of the Carapace". This show was presented to families of the coastal communities of the Pacific coast of Nicaragua located near some of the most important nesting beaches of Hawksbill (*Eretmochelys imbricata*), Leatherback (*Dermochelys coriacea*), Olive Ridley (*Lepidochelys olivacea*) and Green turtle (*Chelonia mydas*). During 2018, we presented the puppet show in 14 communities, reaching an audience ranging from 100 to 200 people per event. In most of these communities, the direct use of turtles is one of the most important stressors. For example, a sizeable number of local people actively engage in the illegal extraction of turtle eggs and the trade of hawksbill jewelry. In addition the by catch of turtles prevails in various sites at different levels. Thus, the puppet show script was incepted with content related to the following themes: a) current legislation on marine turtles in Nicaragua, b) ecological and economic importance to society at local and regional level, and c) responsible fishing. In addition to the thematic content, through the dramatic storyline, the show seeks to create awareness based on emotions, incentivizing dialogue, the exchange of experiences, and strengthening the audience's empathy towards the turtles. Ultimately, the shows aims to empower the community as protagonists in the protection of sea turtles. To evaluate the effect of the play, we designed a survey aiming to measure attitudes and perceptions towards turtles before and after the exposition to the puppet show. We conducted the pre and post surveys to a sample of 30 people (15 children and 15 adults) attending the show, totaling 420. In this presentation, we synthesize the participatory process conducted for the development of the show, its implementation and its evaluation, our lessons learned and recommendations for future steps.
Participation in this symposium is supported donors, organizations and institutions in my country as well sponsors, partners and committee from the ISST.

COMMUNITY-BASED EVIDENCE FOR POTENTIAL RECOVERY OF HAWKSBILL NESTING IN GUANAJA, HONDURAS*

Emily C. Hyatt[1,2], Robert Gammariello, Jr.[1,2], Cindy Gerke[2], Lidia Salinas[2], and Stephen G. Dunbar[1,2,3]

[1]*Marine Research Group, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, CA 92350*
[2]*Protective Turtle Ecology Center for Training, Outreach, and Research, Inc. (ProTECTOR, Inc.), Loma Linda, CA 92350*
[3]*Protective Turtle Ecology Center for Training, Outreach, and Research, Honduras (ProTECTOR – Honduras), Tegucigalpa, Honduras*

Guanaja, in the Bay Islands of Honduras, is heavily vegetated, with a small human population concentrated in the densely populated municipality of Bonacca Cay. However, in the past 5-9 years, successful nesting of hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*), and loggerhead (*Caretta caretta*) on Guanaja has been limited due to direct take of both nesting turtles and deposited eggs. Further, increased coastal development has prompted the utilization of sand as a construction material, which is often sourced from nesting beaches and can result in shoreline erosion and the loss of established nests. The purpose of this investigation was to confirm the presence of sea turtle nesting and characterize a potential nesting recovery site for sea turtles in this area of the Bay Islands. Initial efforts were focused on the identification of key nesting beaches based on anecdotal reports from residents and environmental characteristics, such as the length and slope of beach faces and the amount and type of abutting vegetation. Questionnaires were distributed within the areas of Bonacca Cay, Savannah Bight, and West End, from which data were retrieved through a combination of direct personal interviews and the anonymous submission of surveys to local volunteers. Surveys, which were distributed in both English and Spanish, assessed age and occupational demographics, as well as questions regarding direct observations of turtles and nests, including personal consumption and collection of turtle eggs and meat. Date and location of collection and observation were requested if known. We assessed anecdotal evidence as qualitative rather than quantitative data, and corroborated reports with direct observations. More than half of survey respondents affirmed personal collection or purchase of turtle meat or eggs on the island, and survey responses indicated positive identification of hatchling individuals of each of the three species mentioned. However, the current nesting season yielded identification of only hawksbill and green nesting females. To increase the likelihood of observations, a formal proposal was submitted and approved by the municipal government of Bonacca Cay regarding the implementation of protections for sea turtles that utilize the terrestrial and marine habitats under the jurisdiction of the local Guanaja government. Signs were posted, and naval enforcement was put in place to restrict access to crucial beaches during peak nesting season from May through November. Nightly patrols were conducted on West End beach between July and September 2018 to locate turtles as they came to nest. Following the onset of these protective measures, patrol data yielded observations of six individual E. imbricata females from a total of twelve crawls, ten of which resulted in the deposition of eggs. Initial results of this study provide strong evidence of the potential for recovery of turtle nesting through the collaborative efforts of local volunteers, government officials, and investigators on the island of Guanaja. This may also serve as an example of protective measures that can be applied in other localities around the world where turtle populations are in decline due to direct take and loss of nesting habitat.

THE POWER OF SCIENCE DANCE FOR SEA TURTLE CONSERVATION: METHODS AND IMPACTS

Lekelia Jenkins

Arizona State University, Tempe, AZ, USA

This presentation will discuss science dance as a means of science communication and science education. Science dance is movement based-on or exploring a scientific concept or practice. Often these dances are made to raise awareness, educate, increase engagement, challenge perceptions, or aid inquiry and discovery. This presentation will focus on the participatory methods I developed and used to create a science dance about reducing sea turtle bycatch. This dance won first place in the inaugural International Sea Turtle Society's Dance Your Research contest, in which it was presented as a video. Subsequently the dance was reconstructed as a live show and performed at a First Friday event in conjunction with hands on activities about sea turtles. I created the dance using a logistically-friendly and reproducible, two-hour workshop format. There were two groups of participants. I asked the first group, who were experienced dancers, to read a research paper which I had color-coded to highlight the four key findings of the paper. Each dancer selected one of the findings of the paper to express with movement. I then asked them to create about 15 seconds of movement to express the finding they had chosen. The second group of participants were novice dancers (some of whom were marine scientists). To this group, I presented a short lecture on the research and led them through structured choreographic exercises to aid them in creating movement. During the workshops, I facilitated each group in refining their chosen movements through additional choreographic exercises. We then incorporated the choreography of both groups into a dance which expressed the findings of the research. All participants had opportunities to express their knowledge, views, opinions, and affinities with the topic of sea turtle conservation and also to ask questions during the process. After performing and filming the science dance, each participant completed a short interview about their experience expressing the research through movement. Themes that came up consistently through the interviews were: 1) participants found conceptual connections between the sea turtle research being depicted and their own interests/area of study, 2) participants gained a heightened sense of the importance of sea turtle conservation efforts, 3) participants learned new information about sea turtles, especially their longevity and that they breathe air. Also, 4) the scientists who danced developed new insights about conservation efforts and broadened their view on the role of non-scientists in sea turtle conservation. This conference presentation will include a video excerpts of the dance and of the participant interviews to more fully illustrate the findings listed above.

USING STORYTELLING AS AN APPROACH TO BRIDGE THE GAP BETWEEN SCIENTISTS AND THE PUBLIC*

Amy Lanci

Contractor for Ocean Associates, Incorporated

Positive changes for important conservation issues (such as the current status of sea turtles as an endangered species) happen faster when they are backed by the support of the general public. Consumers can be empowered to make different choices with their wallets when they are made fully aware of their daily environmental impact (i.e. buying stainless steel straws or boycotting plastic bags) while simultaneously spurring on innovative technologies and legislative action needed for national and international impact. For all of this to happen, the gap between conservation scientists and the general public needs to be bridged by communicating sound science (backed up by strong data), in a way that the general public can absorb and understand the information. Not only does direct communication provide scientists a conduit for getting the most-up-to-date and accurate information to the world more immediately, but it has the power to stir up public interest while cutting down the risk of misinterpreted findings. While technical details, numbers and scientific theories are useful when explaining research results with scientific peers, this same method may fall short when used on the general public, as they are made up of people with varying levels of education and knowledge. A more effective way for scientists to communicate with the public is through storytelling. Effective storytelling places the listeners into the storyteller's footsteps while catching their attention and raising awareness of what the "big picture" is. In this case, the storytellers are the scientists, the listeners are the public and the story is the quest to answer important questions surrounding the conservation for sea turtles. When done well, storytelling has the power to: 1) Establish trust 2) Create emotional connection and 3) Initiate mutual understanding and recognition of valuable scientific findings between scientists and the public. When all three of these results are met, scientists and the public are more likely to see eye-to-eye and walk hand-in-hand to implement the necessary measures to aid in the conservation of sea turtles and other environmental issues.

THE GEORGIA SEA TURTLE CENTER MARINE DEBRIS INITIATIVE: CITIZEN SCIENCE AND EDUCATION IN MARINE CONSERVATION AND RESEARCH

Jeannie Miller Martin[1], Jenna Jambeck[2], Kira Stearns[1], and Terry M. Norton[1]

[1]Georgia Sea Turtle Center, Jekyll Island, GA, USA
[2]University of Georgia, Athens, GA, USA

The Georgia Sea Turtle Center (GSTC) on Jekyll Island, Georgia is the state's premier sea turtle rehabilitation, research and education facility. The center is open to the public and engages visitors with an Interactive Learning Center, daily education programming and Rehabilitation Pavilion with viewable turtle patients. The primary component of the GSTC's mission is to promote responsibility for ecosystem health and empower individuals to act locally, regionally, and globally to protect the environment. One way the center achieves this mission is via the growing issue of marine debris. Marine debris not only threatens marine environments, but negatively impacts major waterways and tributaries leading to the ocean. More than 267 species worldwide are affected, and debris jeopardizes the livelihood of coastal citizens by threatening local fisheries. The Georgia Sea Turtle Center Marine Debris Initiative (GSTC-MDI) was established to raise awareness and help combat this threat in 2012. The GSTC-MDI consists of two components – Education and Citizen Science. During the initial two years of the program, elementary school presentations, Garbage in the Water and Scute's Ocean Adventure, were taught at all the schools in Glynn County. Approximately 2000 children were educated about marine debris and environmental stewardship. 100% of classrooms exposed to these programs exhibited significant improvement on pre- and post-tests ($p < 0.05$). This curriculum has since become a central component of all GSTC in house and outreach programming. The second portion of project involves Citizen Science using the NOAA/SEA-MDI Marine Debris Tracker App. GSTC Volunteers use the Marine Debris Tracker App, perform beach cleanups, plot the location and type of marine debris found on and around the coast. Since program launch, GSTC-MDI volunteers have contributed over 19,000 hours, removed and logged over 320,000 pieces of debris from the coastal environment. Most of the debris removed consists of plastics, specifically cigarette butts and other cigarette related materials. Data collected from the app was utilized to generate geospatial analysis of the debris found on Jekyll Island in conjunction with sea turtle nesting data. Thus, leading to more effective management of the beaches and better coordination of volunteers during clean-ups. This inaugural review led to a University of Nebraska graduate student assessing island visitor cigarette disposal behavior for her master's project. Information gained from the GSTC's Citizen Science program is used in the Learning Center, education programming, and shared with multiple regional, national, and international collaborators including: NOAA, UGA, Ocean Conservancy, and Rivers Alive. The GSTC-MDI program team joined NOAA and other agencies in the Southeast to form the Southeast Regional Marine Debris Working Group whose primary focus is to address regional marine debris issues. Most recently the MDI team was involved in the formation of the Georgia Marine Debris Disaster Response plan created in 2017. This multi-tiered approach of debris management, data analysis to inform management strategies, and educational outreach to raise awareness to help prevent the issue as proven highly effective. Thus, making the GSTC-MDI an excellent model for other conservation agencies working to combat threats caused by marine debris.

"AMAR AL MAR" ENVIRONMENTAL EDUCATION AND AWARENESS PROGRAM*

Maria Isabel Miranda Marin

Grupo Tortuguero de las Californias AC

For the past 20 years, Grupo Tortuguero de las Californias AC has been working on different projects focused on increasing our scientific knowledge of marine turtles in North western Mexico, and raising awareness among coastal community members through community monitoring of feeding and nesting grounds, festivals, conferences, and workshops. In 2014, as part of an outreach effort to include communities around the Gulf of Ulloa, one of the areas with highest bycatch rates reported worldwide, we launched 'Chapuzon Submarino', an environmental program focused on marine turtles, that relies on gamification, arts, and a holistic approach to promote empathy towards all living creatures and respect of the environment in children and scholars from primary to high school. Chapuzon Submarino aimed also at pushing for participants to take personal initiatives to reduce our threats and impacts on marine turtles. As a consequence of this, we realised that garbage disposal and accumulation was a major issue in the communities we were working, therefore, in 2018, we launched a new program called "Amar al Mar" (Loving the Sea in English), which focuses specifically on solid waste and plastic debris and aims at working with communities in their entirety to reduce plastic pollution and garbage production in coastal areas. We are working in 6 communities where no infrastructure exists to manage solid waste responsibly. Most garbage is deposited in open-air dumpsites and periodically ends at sea due to winds and rains, therefore we are working with community members and helping them promoting initiatives to reduce local waste production, as well as improve the current management system. We are also working with children in primary, secondary and high schools, and their parents, to explain what the effects of plastic on the environment and on human health are. Until now we have reached more than 500 children in primary schools and 100 in high schools, plus their parents and teachers. Next steps will include evaluating the impact of our educational initiatives on local communities. Our goal is to implement an infrastructure to ensure that toxic waste (i.e. batteries) are disposed of correctly, plastic is recycled or at least collected to be recycled, and community members systematically use reusable products (i.e. cotton bags instead of plastic bags).

"WARRIORS OF THE RAINBOW" EMPOWERING CHILDREN TO PRESERVE THEIR NATURAL PARADISE*

Damaris Marin-Smith

Campamento Tortuguero Ayotlcalli A.C.

One of the biggest challenges in the area of conservation is to convince the community members to change their habits and attitudes toward the environment. Even more challenging is when that community has a history of poor education, apathy, and a high rate of criminal activity. Such is the case of the in the "Costa Grande" region of Guerrero, Mexico, which includes a trio of magnificent beaches; Playa Blanca, Playa Larga and Barra de Potosi. This region is the home of Campamento Tortuguero Ayotlcalli AC. (CTA), established in September of 2011. Our mission has been to educate the population in regard to the protection and conservation of three species of marine turtles that nest in this beautiful area; Olive Ridley (Golfina), Black Sea Turtle (Prieta), and Leatherback (Laud). After spending much time and effort trying to raise awareness with adults (locals and visitors), we have realized that in the long term, children are the key to making the required changes that will reverse the imminent extinction of these marine turtles. To that end, in 2016 CTA implemented an annual comprehensive educational summer program that focuses on environmental education. The curriculum includes a variety of topics: values, reading, writing, science, environmental science, math, arts, nutrition, and physical education. Our student group, or 'Rainbow Warriors', consists of children from many different backgrounds and educational levels. These students interact by participating in hands-on, interactive, and fun activities while learning the dynamics of their own community and their relationship with mother nature, along with all of her creatures. After two weeks of training, our Rainbow Warriors are inspired to go back to their own community to perform actions that demonstrate their learning and commitment to the environment. They participate in school and group presentations to share their knowledge with the children that were not able to attend the camp. Our students are later invited to participate in activities related to sea turtle conservation. Such activities include night patrolling (searching for nests, identifying species, finding and relocating the clutches) monitoring the hatchery, assisting with releases and participating in our educational presentations given to the public prior to each release. We hope this creates future leaders that will make not only wise decisions with respect to the conservation and protection of all local species, but will also educate others in the community. Students are eligible to become group leaders at thirteen years of age. At this point they are invited to participate as volunteers interacting with other international volunteers who act as role models. Our students feel a great sense of pride when they achieve this level of leadership. In addition, our area has been evolving and changing year by year giving us another educational opportunity. Due to the natural beauty of our beaches, many foreign citizens have established their homes in Playa Blanca, Playa Larga and Barra de Potosi. We have cultivated a relationship with our foreign residents that has led them to become involved in activities that promote friendly, clean and healthy ecosystems. Some of them have even generously sponsored the summer camp participation of economically disadvantaged children. A small group of them have our team of volunteers and taken on the challenge of patrolling the beach and assisting with other activities that focus on the rescue and conservation of marine turtles.

CONSERVATION-BASED NATIONAL SERVICE IMPACTS AT THE GEORGIA SEA TURTLE CENTER, JEKYLL ISLAND, GA, USA

Jeannie Miller Martin

Georgia Sea Turtle Center, Jekyll Island, GA, USA

The Georgia Sea Turtle Center (GSTC) on Jekyll Island, GA is a sea turtle rehabilitation, research and education facility open to the public and offers an interactive Exhibit Gallery and Rehabilitation Pavilion with viewable turtle patients. Promoting responsibility for ecosystem health and empowering individuals to act locally, regionally, and globally to protect the environment is one component to the GSTC's mission. One way the center achieves this mission is through training of vet students, volunteers, and AmeriCorps national service participants. The AmeriCorps GSTC program was created in 2009 and over 120 individuals have provided the GSTC with critical infrastructure while gaining valuable professional skills to further their career. National service members have served over 57,000 hours, valued at over 1.2 million dollars. Members serve in all departments of the GSTC and notable outputs include: educating over 145,000 guests in specialized educational programs, recruiting 350 volunteers, treating 5597 turtles of 25 difference species, and triaging 729 birds. Field based conservation and research teams have encountered 589 nesting female sea turtles with 350 being tagged for the first time, monitoring 1426 sea turtle nests, marking 1475 individuals of 48 species in mark-recapture projects and placing radio transmitters on 331 individuals of 48 species to study movement in developed areas in an effort to develop conflict reduction solutions. In addition to the direct impacts on wildlife, AmeriCorps GSTC service also has significant impacts on the members' personal and professional development. A causal-comparative, quantitative study to determine service impacts of the AmeriCorps GSTC program was completed. Alumni of the program that served from 2009-2017 participated in a retrospective pre-post survey measuring leadership skills and career self-efficacy. Paired samples t-tests showed significant differences after service in all leadership skills as well as their usage ($p < 0.05$). Paired samples t-tests also showed that there was a significant difference in career decision self-efficacy before and after AmeriCorps GSTC service ($p < 0.05$). Difference of proportion Z-testing identified significant differences in decision to stay in the conservation field through both higher education and career selection ($p < 0.01$). These results support the notion that conservation-based national service can have a significant impact on participants in multiple areas of life, including future career choice. Additionally, confident, competent individuals entering the work force will also improve the entire field of conservation.

TALKING TURTLES: EXPLORING THE RELATIVE EFFICACY OF DIFFERENT VISITOR EDUCATION PROGRAMS AT JEKYLL ISLAND, GEORGIA

Katie A. Mascovich[1], Lincoln R. Larson[2], and Kimberly M. Andrews[1]

[1]Odum School of Ecology, University of Georgia, Athens, GA, USA
[2]Department of Parks, Recreation & Tourism Management, North Carolina State University, Raleigh, NC, USA

Wildlife education programs can increase visitors' knowledge and enhance engagement in conservation behaviors. However, few studies have directly compared the efficacy of education programs with different structures. We compared learning and behavioral outcomes for participants in two programs (one high capacity and low interaction; the second, lower capacity and high interaction) focused on nesting sea turtles on Jekyll Island, Georgia, USA. Both programs increased participants' knowledge of sea turtle biology and their intent to participate in environmentally conscientious behaviors. Effects on attitudes toward sea turtles were minimal. Similar gains in behavioral outcomes were observed in both program types with no significant differences detected. Results suggest that managers and educators can employ different program delivery methods to achieve conservation-oriented outcomes.

SLOW DOWN FOR SEA TURTLES: INCREASING BOATER AWARENESS OF GREEN SEA TURTLES IN SOUTHERN CALIFORNIA

Sabrina Mashburn

SoCal Sea Turtles

East Pacific green turtles reside in southern California year-round. They are part of the threatened Eastern Pacific Distinct Population Segment (DPS), which is ecologically and evolutionarily significant, and has unique adaptations to life in temperate waters of the eastern Pacific. One of the most remarkable features of southern California's sea turtles is that they continue to inhabit waters in close proximity to large metropolitan areas, such San Diego, CA and Long Beach, CA., often adjacent to highly industrialized coastal areas. Green turtles in this area are subjected to numerous anthropogenic impacts (e.g. boat strikes, entanglement in marine debris), yet there are currently no programs in place to increase boaters' knowledge about sea turtles in order to mitigate these impacts. This project aims to increase public awareness and knowledge of sea turtles in Southern California, while encouraging boaters to reduce vessel speed in bodies of water where sea turtles have stranded or have been observed. This project was started as the result of a Master's thesis project, which included an oral survey conducted at marinas and waterfront businesses in 2015-2016. Most recreational boaters surveyed did not know that sea turtles live in southern California. None of the boaters surveyed knew that sea turtle sightings can be reported to NOAA. Responses to the survey were used to inform a public awareness campaign, which now includes tri-fold brochures, an active website, and 65 reflective aluminum signs that are in the process of being placed outside of waterfront businesses in San Diego County, CA. Two marinas have already agreed to display the aluminum signs in areas with high boater traffic within sea turtle foraging habitat. Other marinas and waterfront businesses have expressed interest in hosting signs, and it is anticipated that all 65 signs will be on display in Southern California by the end of 2019. Plans are in place to expand the reach of the project across Southern California, in partnership with the NOAA Long Beach Office and Aquarium of the Pacific. This project aims to reduce the number of sea turtles struck by boats in Southern California while educating boaters about these threatened marine reptiles by 2020.

APPLYING CITIZEN SCIENCE TO INCREASE SURVIVAL RATE OF COLD STUNNED SEA TURTLES IN COASTAL NEW YORK*

Maxine Montello[1] and Wendy McFarlane[2]

[1]*Riverhead Foundation for Marine Research and Preservation, Riverhead, NY USA*
[2]*Manhattanville College, Purchase, NY, USA*

The aim of this project was to attract and train an integrated team of volunteers and interns that would implement an efficient beach monitoring program for rescuing New York (NY) cold stunned sea turtles for the 2018/2019 season. The Riverhead Foundation for Marine Research and Preservation (RFMRP) strives to decrease the on-site response time and increase the survival rate of these critical patients through creation of a widespread and rapid monitoring program, alongside quality veterinary and rehabilitative care for all sea turtle patients. RFMRP's beach patrolling program was modeled after the highly successful Mass Audubon cold stun response team, developed by Robert Prescott. In NY state waters, hypothermia is the leading cause of stranding and mortality in sea turtles. The RFMRP is the primary response team for sea turtles in NY, and is the only facility permitted to rehabilitate sick/injured sea turtles including Kemp's ridleys (*Lepidochelys kempii*), Atlantic greens (*Chelonia mydas*), Northwest Atlantic loggerheads (*Caretta caretta*) and leatherbacks (*Dermochelys coriacea*). While the RFMRP covers a vast geographical area throughout coastal NY, they currently have a small rescue/rehab team of only four people. As the cold stun season heightens, staff are unable to be in the field patrolling as their efforts are needed to care for critical patients in house. As such, RFMRP is highly dependent on volunteers willing to dedicate their time and energy to collecting and transporting cold stuns. Through the use of historical data, specific beach stretches were identified as high frequency "hotspot" stranding locations where rescue efforts may be targeted. The first step of this project was to increase the amount of community outreach and provide cold stun lectures throughout the state of NY. A targeted lecture series helped recruit significant numbers of interested volunteers for beach patrol, and raised awareness about procedures for handling cold stunned turtles. In 2018, a two-level training program was offered to college students and local patrons throughout the state of NY; Level I Beach Walker and Level II Emergency Response Team. To be classified as a Level I Beach Walker, patrons must have attended a Cold Stun Lecture prior to the upcoming cold stun season. These Level I volunteers assist RFMRP with weekly beach patrols of designated areas, calling the hotline should a sea turtle be found. Level II Emergency Response Team members must attend a Cold Stun Lecture as well as attend an in-field Emergency Cold Stun Training Course. In addition to beach walking, Level II volunteers are trained to transport turtles to RFMRP's facility. All courses are taught by technicians and educators from RFMRP. It is hoped that these additional outreach and training efforts will lead to greater community involvement, and most importantly greater overall success rate for rehabilitation and release of critical cold stun patients.

BUILDING THE NEXT GENERATION OF SCIENTISTS USING TODAY'S RESEARCH*

Rebecca Mott

Inwater Research Group, Jensen Beach, FL, USA

Creating education programs can be daunting and leaves researchers wondering where to start. The most important thing to remember when building education programs based on research is to maintain authenticity. Giving students an opportunity to experience what scientists do first-hand establishes a more enriching and memorable atmosphere for learning. It not only helps create future biologists but also future citizens with a strong sense of environmental stewardship. Our field is inherently built for promoting experiential learning. There is an intrinsic interest from school-aged children to learn more about marine animals. Sea turtles are engaging to most students and an incredible way to introduce numerous topics. Using sea turtles as a conduit, we can integrate math, language arts, social studies, and even art, while using science as the primary educational platform. For example, nesting beach data can be transformed into math lessons using percentages, ratios, and models such as charts and graphs. Tagged turtles offer an opportunity to discuss distance, migration, and international policy. Diet studies open the door for lessons on food webs as well as predator-prey relationships. Creating programs using research can span anything from educational videos, to curriculum, to simply sharing data with teachers. Since 2014, Inwater Research Group (IRG) has developed programs for schools in Florida that teach students about the importance of sea turtle conservation through research. The programs highlight the type of research conducted at IRG and place students in the role of biologist. In one lesson students learn how to sample populations and extrapolate date while incorporating math, and learning how data can drive conservation through policy change. In another program students learn about different forms of energy, build their own circuit in LED bulb, and then retrofit the bulb with a turtle-friendly light fixture. Experiences like these allow students to reinforce state education standards while driving home the importance of conservation through hands-on learning. By keeping science as the platform from which we build our programs, we're maintaining the authenticity of what students are learning and they feel both engaged and invested in the outcomes. From here, they are more likely to practice sea-turtle friendly behaviors, and share the information with others.

DIVERS FOR TURTLES: HARNESSING THE POWER OF THE DIVE INDUSTRY FOR SEA TURTLE CONSERVATION*

Brad Nahill

SEE Turtles, Portland, OR, USA

The dive community is a potent force for ocean conservation efforts around the world. Divers and dive businesses have helped create marine protected areas, new conservation legislation, and financial support for organizations working to protect the ocean. Divers For Turtles is a new effort by SEE Turtles to engage and harness the energy of the dive industry to increase support for sea turtle conservation programs around the world and to improve diving practices for sea turtles and other wildlife. Our mission is to educate and inspire divers, snorkelers, and the dive industry to help protect sea turtles and the ocean. Divers For Turtles is bringing together divers, dive shops, training organizations, and dive equipment manufacturers to increase support and awareness for sea turtle conservation. The campaign addresses both newer issues like underwater camera sticks, chemical sunscreens, and plastic pollution, as well as old problems that still

threaten sea turtles like the trade in turtleshell products and poaching of turtle eggs and meat. We will provide resources for outreach on a variety of issues, including tips for protecting the ocean both in and out of the water, new products for dive enthusiasts, and tangible ways for the dive industry to bring sea turtles back from the edge of extinction. The campaign's website and social media will be a central hub for ways to support ocean conservation, including diving practices, lifestyle tips, volunteer opportunities, advocacy efforts, and donations to conservation efforts. Divers For Turtles is creating a community that has a voice for sea turtle conservation and has lasting positive impacts for all aspects of ocean conservation.

MAKING THE CONNECTION: FINDING THE LOVE BETWEEN PEOPLE AND TURTLES- A DATA-DRIVEN APPROACH

April Nason[1], Donovan Plum[1], and Kathleen Martin[2]

[1]Mount Saint Vincent University, Halifax, Nova Scotia, Canada
[2]Canadian Sea Turtle Network, Halifax, Nova Scotia, Canada

The Canadian Sea Turtle Centre (CSTC) is a small free-choice learning center for the general public that welcomes approximately 10,000 individuals annually. It operates from June to October in Halifax, Nova Scotia, on the east coast of Canada. The purpose of the CSTC is to educate members of the general public about sea turtle biology and conservation, with a focus on the Canadian Atlantic leatherback and loggerhead populations and the work being done by the Canadian Sea Turtle Network (www.seaturtle.ca) and its partners to conserve these animals. The CSTC is located in one of the busiest tourist locations in the province and hosts local, national and international visitors. In this study we used qualitative and quantitative data from both visitors to the CSTC and from sea turtle experts presently working in North America in an attempt to determine the factors that may motivate an individual to become interested in conserving sea turtles. This research had three components: a short, 11 question, online survey and two sets of phenomenological interviews. The survey group of CSTC visitors was limited by age (19+ years). 52 individuals responded to the online survey (advertised through the Canadian Sea Turtle Network social media channels). From these 52 respondents, 8 were interviewed (5 in person and 3 using online video conferencing). The visitor data was contrasted with 10 interviews conducted with sea turtles experts (2 in person and 8 using online video conferencing) in varying stages of their careers. Sea turtle "experts" were defined as individuals who have full-time careers in sea turtle conservation and/or science. Survey results showed that 63.3% of visitors connected to the human aspects of the CSTC compared to 36.7% of visitors that connected with the animals themselves. The greatest source of connection was overwhelmingly the CSTC staff person with whom the visitors spoke. 73% of visitors made changes to their lives as a result of their visit where as 23% felt they were already environmentally conscious in their daily lives. Of the adult visitors I interviewed, 2 were directly interested in leatherback sea turtles, 2 were indirectly connected with turtles, 2 were overall animal lovers, 1 loves all things from the ocean and 1 is a self-proclaimed environmentalist. Of the experts I interviewed, few sought out a career in sea turtles. Like the visitors, they had similar motivating factors: turtles, animal lovers, nature, ocean life, along with a drive for research and travel. The experts, however, each had 2 or more of these motivating factors and a lot of perseverance. In conclusion, it is possible for adults to refocus their lives towards sea turtle conservation, but educational programs will appeal to a larger number of individuals by relating the sea turtles to the broader factors of animals, nature and the ocean through direct personal conversations with enthusiastic staff.

THE IMPORTANCE OF COMMUNICATION FOR THE CONSERVATION OF SEA TURTLES IN EQUATORIAL GUINEA

Jesus Mba Mba, Alejandro Fallabrino, Fidel Esono, Carolina Martinez, and Angela Formia

TOMAGE, Bata, Equatorial Guinea

Communication is a fundamental tool to inform the public about the critical situation of sea turtle populations in Africa. Since 2007, the project TOMAGE (Marine Turtles of Equatorial Guinea) is dedicated to disseminating information on its conservation initiatives and on how the Equatoguinean people can commit to and help protect sea turtles. In fact, in Equatorial Guinea there is widespread lack of knowledge on the critical status of sea turtles and the legislation protecting them. Starting from the year 2000, we have observed a growing trend in the consumption of sea turtle meat, offered in numerous restaurants in the urban areas. With the aim of reversing this situation, TOMAGE has launched a series of television and radio campaigns in the local and national media, broadcasting as many as 10 clips and documentaries. Within the framework of this campaign, we delivered educational material to the general population, and local and national authorities (including wildlife inspectors and guards). In addition, more than 20 lectures on marine turtle conservation were held, targeted to different academic levels, ranging from primary to university education. In addition, a series of 25 workshops was held with the participation of coastal communities, where sea turtle capture and consumption are greatest. At the Spanish Cultural Center in Bata, we mounted two exhibitions on sea turtles that were visited by approximately 400 people. In 2009, TOMAGE created an Ecomuseum in the coastal town of Tika that has been a pole of attraction for local tourists, of more than 30 different nationalities, interested in learning about these endangered creatures. All these activities have allowed us to considerably increase public knowledge on sea turtle status and conservation. However, direct capture of turtles for consumption continues to be a concern. This activity is deeply rooted in the Equato-Guinean culture, as evidenced by the high market offer of meat and the high price it fetches. It is therefore imperative to increase communication efforts and dissemination strategies. In the same way, it is essential to continue working with community leaders to raise awareness among the greatest number of stakeholders.

VOLUNTEERS FOR SEA TURTLE MONITORING IN ST. CROIX, US VIRGIN ISLANDS

Romina Ramos[1], Jennifer Valiulis[1], Claudia Lombard[2], Kelly Stewart[3,4], Caroline Pott[5], Hilary Lohmann[6], and Austen Stovall[6]

[1]*St. Croix Environmental Association*
[2]*U.S. Fish and Wildlife Service*
[3]*The Ocean Foundation, Washington, DC, USA*
[4]*NOAA, La Jolla, CA, USA*
[5]*Department of Planning & Natural Resources/Coastal Zone Management/East End Marine Park*
[6]*National Coral Reef Management Fellow- USVI*

The Caribbean island of St. Croix, the largest of the three U.S. Virgin Islands provides essential nesting habitat to three endangered sea turtle species: leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles. In recent years, local support for sea turtle monitoring in protected areas and public beaches has increased the number of committed volunteer coordinators, volunteer meetings, trainings, facilitative resources and incentives. Volunteers involved in sea turtle conservation receive training and subsequent approval from managing authorities to participate in: morning censuses, daytime and night patrols, turtle tagging and nest excavations. In addition to field work, volunteers contribute to beach clean-ups, outreach events, and support the Virgin Islands sea turtle stranding network - STAR (Sea Turtle Assistance and Rescue). Through the combined efforts of four organizations: The St. Croix Environmental Association (SEA), Friends of the East End Marine Park, Sandy Point National Wildlife Refuge (USFWS) and The Ocean Foundation, nesting sea turtle monitoring is expanding within the St. Croix community. This collaborative work is enhancing the East End Marine Park community and their relationship to management efforts. Volunteer monitoring results in local biologists learning more about habitat use by marine turtles on a variety of beaches throughout the USVI. Biologists are looking to better understand the habitat use and nest distribution of all three species, as well as ongoing threats to nesting turtles. SEA provides training with standardized methods for The Friends of the East End Marine Park to monitor nesting beaches. The number of sites has tripled since 2016, from 3 to 9 beaches, although monitoring was reduced last year (2017) due to the impacts of Hurricane Maria. The opportunity to shadow experienced biologists at Sandy Point during leatherback nighttime patrols and day time track surveys, improves volunteer skills resulting in increased data accuracy. With adequate data collection, biologists can identify beaches that are significantly important, as well as specify locations that require increased patrols or environmental attention, and allocate resources accordingly. Sandy Point National Wildlife Refuge recently gained volunteers from meetings and outreach initiatives from coordinators. Volunteers who assist biologists in field work are often motivated to conduct turtle surveys year-round and observe other nesting beaches, as well as help with other refuge tasks such as trail maintenance, beach clean-ups and outreach events. Some of the challenges with volunteer monitoring for projects include: long-term commitment, accuracy of data, leadership training and volunteer retention. The Sandy Point Project remains the longest term project of its kind in St. Croix with more than 40 years of data collection. It serves as a valuable resource for volunteers, biologists, and researchers alike to promote sea turtle conservation and volunteer monitoring in the Virgin Islands.

NOKEN AS AN OUTREACH MEDIA TO SUPPORT LEATHERBACK CONSERVATION EFFORTS IN WEST PAPUA

Evangelista Randa, Kartika Zohar, and Fitryanti Pakiding

Lembaga Penelitian dan Pengabdian kepada Masyarakat, Universitas Papua, Manokwari

Jeen Womom beach in the Abun District, Papua Barat province, Indonesia hosts the largest nesting activity of leatherback turtles in the western Pacific. The population, however, has been rapidly declining since the 1980s. Universitas Papua (UNIPA) has been directly involved in the leatherback conservation project there. In supporting conservation efforts at the nesting beach, one of the methods used is outreach targeted especially at local community members. We provide information to the community about leatherback, threats they face, and efforts to help the population recover. Making a noken, a traditional Papuan bag, has become popular in recent years. It has become an item produced by many indigenous Papuans in various places as a source of income. Noken has been produced since ancient times in the Papuan community, but its production has been declining because the raw material of noken is diminishing in nature. Now noken is made with synthetic yarn, which is also highly demanded by many people in Papua. Considering noken’s economic potential, UNIPA has developed a program for making noken in communities living in the villages near Jeen Womom. This program aims to transfer the skills to make noken to Abun community members as a way to earn livelihood, especially in anticipating the development of ecotourism in this region. In addition to teaching and training the community members to make noken, information about leatherback conservation efforts was also delivered during the training. We explained the dangers of consuming the sea turtle meat and eggs, and threats that sea turtles face. In addition, we expect that the community would minimize plastic bag use by using noken. The training has taken place between June and October 2018, and it will continue until December 2018. There are at least 42 nokens produced, and are ready to sell. To make a medium-sized noken requires at least 1-2 days with a duration of 3-4 hours per day. There were at least 32 people who were trained to have the basic skills in making a noken. The participants who have been trained come from three villages in Abun District namely Wau, Warmandi, and Saubeba villages. Challenges that UNIPA team faced in conducting this program include having to supply the yarn because it cannot be found in the village. Also, it took a long time for community members to develop the skills to make a good noken. Through this innovative effort of making nokens, we hope that local community members not only gain a skill to improve their livelihood but they would also be more motivated to contribute to biodiversity conservation in general and to leatherback conservation in particular.

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

Irma Elizabeth Galvan Tejada

Vida Milenaria A.C.

In 2000, “vida milenaria”, the non-governmental organization was stablished legally, to continue working and in the same year the protected area was extended. Actually 35 kilometers in 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 aware 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, we achieved this with a simple formula: inspection + protection + education.

JUNIOR RESEARCH ASSISTANTS PROGRAMS: TORTUGUERO (COSTA RICA) AND RÍO CAÑA (PANAMA) KIDS CONSERVING SEA TURTLES*

Guillermo López Torrents, Georgina Zamora Quílez, Sílvia Agulló Aguila, Raúl García Varela, and Roldán A. Valverde

Sea Turtle Conservancy, Gainesville, FL, USA

In 2019, Sea Turtle Conservancy (STC) turns 60 since Mr. Joshua B. Powers funded it in 1959 in response to renowned ecologist Dr. Archie Carr’s award-winning book, The Windward Road. Many challenges have been accomplished by this NGO, among which stands out its commitment to the education of communities about sea turtles. Education has been taking place since the foundation of the STC, initially to save the Caribbean Green sea turtle (*Chelonia mydas*) from immediate extinction, evolving to raise awareness and protect sea turtles across the globe. In 1993 the educational program was established in the United States, especially in Florida where 90% of continental USA nesting happens. In Central America, the STC enhanced the educational program by creating on-site Education and Outreach programs (EOP) for the Tortuguero (Costa Rica) and Bocas del Toro (Panama) projects, since 2008 and 2015 respectively. Among all the initiatives and activities of the EOP is the Junior Research Assistants Program (JRAP). Focused on local kids, the JRAP educates young generations from communities directly related with important nesting areas by giving them scientific and field training, what strongly connects them to their natural environment. Briefly, the general idea is to teach groups of local kids about sea turtle nesting monitoring and train them to participate in morning surveys, night walks and educational activities during all nesting season. Currently the STC carries out JRAPs in Tortuguero and Río Caña communities, the objective, knowledge taught, training and workflow are the same, but the JRAP must be adapted depending on the culture, education level and lifestyle of the community. Tortuguero is a small tourist town located in the northeastern Caribbean coast of Costa Rica, and hosts the largest nesting colony of green turtles in the western hemisphere. The JRAP started there in 2008 managed by the STC and considered a unique initiative for local kids. Since then, over a hundred kids ages 12–17 actively participated in the program. Because of the JRAP some kids decided to study Biology or Tourism in college to build a career for nature conservation. In 2018, the EOP dedicated around 80 hours to different activities involving the program, being one of the most successful among the STC's educational agenda. Río Caña is a Panamanian indigenous community located in the Ngäbe Buglé Comarca, a region organized similarly to a province, also touched by the Carribean Sea and on its beach a few thousand leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*) nests can be counted every year. In 2016, the JRAP was created in collaboration with the local public school. Parental permits and schedule are coordinated by the school while the STC runs all the activities. Between May and October 2018, 30 hours were dedicated to the program and 16 kids from 12 to 15 years old participated. Suitable and effective educational programs can avoid future threats for sea turtles and ecological problems, giving them visibility will enhance others to implement similar activities, prevention is better than cure.

PROMOTING MARINE CONSERVATION IN GRADES K-2: GEORGIA SEA TURTLE CENTER – SCUTE'S OCEAN ADVENTURE

Aislinn Wright, Jeannie Miller Martin, Jenna Jambek, Kira Stearns, Lori Lopel, and Nicki Thomas

Georgia Sea Turtle Center, Jekyll Island, GA, USA

The Georgia Sea Turtle Center, located on Jekyll Island, GA, USA, has a mission of conservation-based rehabilitation, research, and education. Marine debris is a serious threat to marine species, with all species of sea turtles being impacted. The GSTC obtained grant funding from NOAA and the Southeast Atlantic Marine Debris Initiative to provide standards-based educational opportunities to local first graders. Elementary classes in Glynn County, Georgia were offered a Scute's Ocean Adventure puppet show program, and 1,102 students were provided educational programming. Pre and post-testing was completed by 515 students. Paired t-testing was completed on tests and resulted in a statistically significant ($p<0.0001$) increase in test scores between the pre and post-tests. All schools were provided a copy of the Scute's Ocean Adventure book to have in their libraries. This success, built on the success of previous grant efforts, strengthened the relationship between the GSTC and Glynn County School District. Additionally, it prompted the creation of a new conservation literacy initiative called Scute Approved Reading, which reviewed books for scientific accuracy and age-appropriateness. Books deemed "Scute Approved" were shared with teachers to promote literacy programs in schools.

INTRODUCING LEATHERBACK SEA TURTLE AND CONSERVATION EFFORT IN WEST PAPUA

Kartika Zohar[1], Fitryanti Pakiding[2], and Deasy Lontoh[1]

[1]*Research and Community Service Institution, University of Papua (UNIPA), Manokwari, Papua Barat Province, Indonesia*
[2]*Agriculture Technology Department, University of Papua (UNIPA), Manokwari, Papua Barat Province, Indonesia*

Jeen Yessa (Jamursba Medi) and Jeen Syuab (Wermon) are beaches at Bird's Head of Papua in West Papua, Indonesia. They are supporting 75% of leatherback nesting activity in the western Pacific every year. Since the early 1980s, however, the Bird's Head leatherback population has been rapidly declining, at around 6% every year. The State University of Papua (UNIPA) has been leading leatherback research and conservation at Bird's Head for over a decade. Efforts to protect turtles and nests at the nesting beach need to be supported by outreach at nearby coastal areas because threats to turtles typically come from outside the beaches. To bring awareness to issues affecting marine turtles, we have been conducting an outreach program that aims to introduce marine turtles and ongoing conservation efforts. The program targeted students from elementary to high schools on the coast but also to the general public. We visited schools and organized an event called Pekan Penyu Manokwari or Manokwari Turtle Week. During school visits, we presented materials about marine turtles and stories about ways to help them. To gauge how much the students understood, we asked questions about the materials given, and rewarded them with a prize when they demonstrated they understood. We also asked them to help campaign for the turtles by making posters or short videos. Some of the students learned how to make reusable bags from old t-shirt as a way to recycle and reduce plastic bag use. Between May and June 2017, we visited a total of 19 schools in the Bird's Head, and reached 1,096 people. We organized Manokwari Turtle Week in collaboration with the Marine Affairs and Fisheries Department of Papua Barat province. It was a week-long event in early November 2017 where information about marine turtles in West Papua and our conservation project in Abun District was given to the public through three panel discussions on a local radio station, 1000 infographics, and twenty or so posters spread throughout the town. Students in elementary, middle, and high schools were invited to compete on presenting turtle conservation message on postcards, posters, and videos. University students were challenged to design a sticker with a conservation message. The final event was held on UNIPA campus on November 7th, 2017 and attended by 300 people. Tallying the commitment cards revealed that approximately 92% of participants could identify which species of marine turtle nest in Papua Barat province correctly, 88% understood that marine turtles are endangered and in need of protection, and 27% pledge to help by not buying or consuming marine turtles and their eggs. We also invited 10 important figures in marine turtle conservation in Papua Barat to the event, and they received an award from the Governor of Papua Barat. We hoped that through the Manokwari Turtle Week, the people of Manokwari, especially the students, understood that protecting marine turtles is not just a responsibility for certain groups but it is a responsibility for all.

FISHERIES AND THREATS

PLASTIC DEBRIS AND SAND TEMPERATURE MEASUREMENTS ALONG A SEA TURTLES NESTING BEACH IN THE WEST COAST LAGOS, NIGERIA: PRELIMINARY REPORT*

Oyeronke M. Adegbile[1] and Marc Girondot[2]

[1]Nigerian Institute for Oceanography and Marine Research 3 Wilmot point road Victoria Island Lagos
[2]CNRS, AgroParisTech et Université Paris-Sud 11, France

Plastic is present on Lagos beaches not only as large items but also as smaller debris, ubiquitous and widely distributed all over the coast. Lagos, the most populous coastal state is no exception to the huge distribution of plastics waste along the beaches. An analysis of data collected during the international Coastal Clean-up in Lagos, Nigeria indicated that all 10 top plastic items recorded globally by the Ocean Conservancy, also top the list of debris cleaned up in Lagos in September 2017 on beaches situated along the West Lagos Coast, an area where three sea turtle species have been reported to nest annually. Presence of plastics in and on the beaches poses a problem to sea turtle hatchlings on the beach and a possibility of changes in sand temperature values as plastics has a tendency to retain large amounts of heat in response to comparably moderate increases in temperature. The preliminary findings of temperature experiments in beaches along the West Coast of Lagos, Nigeria are also reported in this paper. There's need to measure sand temperature values on a long-term basis along the Lagos and Nigerian Coast to be able to ascertain the impacts of plastics on the beach sand temperature and consequently on the hatchling sexes as sea turtles hatchlings sexes are determined by temperature.

CHALLENGES CONFRONTING SEA TURTLE CONSERVATION IN BANGLADESH

Rafat Adnan

Marinelife Alliance, Cox Bazar 4700, Bangladesh

Sea turtles are facing dangers in Bangladesh from bycatch, eggs poaching, predation, nesting beach alteration and mass tourism which includes lighting. Several threats put sea turtles at the edge of extinction in the Bangladesh marine waters. Marinelife Alliance is trying to restore the sea turtle population by field-based activities. Communities are mostly beach users and fishermen hence it is necessary to educate and include them in the conservation activity to ensure success and reduce bycatch in marine fisheries. While doing the restoration process of sea turtle we are facing different challenges every day. Our most recent challenge is rohingya people who steal turtle eggs to sell them in order to provide food for their family. Our team already took initiative to reduce this issue. The very common threat to sea turtle nesting is hotel and resort establishment alongside beaches. People now buying beach land for hotel construction. There is no mechanism to save beaches from tremendous alteration where nesting habitat may lose forever. We are trying to overcome all the challenges by beach-based conservation activities as well as producing hatchlings. Satellite tracking helping us to explore migration routes of sea turtle of Bangladesh and we are taking measures to conserve offshore habitat from bycatch. We need regional and international collaboration to solve the Rohingya problem. Huge environmental impact already noticed and reported by various departments both on land and sea. This extra mitigation is quite difficult in an originally overpopulated and problematic locations.

REPORT FROM A WORKSHOP TO ADDRESS RECREATIONAL FISHING INTERACTIONS WITH SEA TURTLES*

Susan Barco

Virginia Aquarium, Virginia Beach, VA, USA

A half-day workshop addressing recreational fishing, primarily hook and line, interactions with sea turtles will be held prior to the 2019 ISTS meeting. The purpose of this workshop will be to share ideas and generate discussion surrounding the problems associated with sea turtles hooked by recreational anglers. Discussion will include: 1) frequency and timing of pier interactions in the US mid-Atlantic, southeast and gulf coasts; 2) consistent and effective data collection to determine the scope of the problem; 3) managing response to hooked turtles (immediate release versus rehab, triage, etc.); 4) demographics and overall health of hooked turtles; 5) effects of hooking and hooks left in place on health (e.g. serious injury determination); 6) habituation to foraging at piers; 7) detecting ingested hooks in the field; and 8) feasibility of developing and implementing mitigation measures, outreach and messaging. Following selected presentations, the group will discuss the above topics with a goal of developing global approaches to reporting, response, management, outreach, and mitigation. Since the number of participants in the workshop is limited, other conference attendees may be interested in the results of the group presentations and discussions and, as the workshop coordinator, I propose to synthesize workshop findings into a conference talk for a broader audience. Workshop presenters will be asked if their finding can be shared and, although I am listed as the only author of the talk, all presenters and perhaps some attendees will be listed as contributors to the presentation.

REDUCING REHAB BURDEN: DEVELOPING IMMEDIATE RELEASE CRITERIA FOR HOOKED SEA TURTLES*

Erin Bates, Allyson McNaughton, Sarah Rose, and Susan Barco

Virginia Aquarium Stranding Response Program, Virginia Beach, VA, USA

Virginia Aquarium Stranding Response (VAQS) experienced elevated reports of sea turtles incidentally hooked by recreational anglers and an influx of turtles admitted as rehabilitation patients with the start of the Virginia Pier Partner Program (VPPP) in 2014. From 2009 to 2013, VAQS received an average 6 ± 7 SD incidentally hooked turtle reports per year, with 4 ± 3 SD admitted as rehab patients each of those years. With the start of the VPPP, VAQS received 25 reports and admitted 16 hooked sea turtles. Annual numbers increased to 57 reports with 35 admits in 2017 and 66 reports with 45 admits to date in 2018. Admitted hooked turtles have spent up to 480 days in rehab with duration influenced by presence of injuries sustained during hook interaction, severity, location and size of hook, method of hook removal, presence of secondary hooks, and presence of clinically significant injuries or infections not related to the hook interaction. To limit rehab burden and allocate resources appropriately, VAQS and veterinary staff developed Immediate Release Criteria (IRC) in 2017 for trained individuals to assess health status of these turtles upon admission. The turtle was first assessed for presence of hook(s) and, if present, ease of hook removal. Vital statistics, mucous membrane color/capillary refill, and mentation were documented, and each turtle was checked for clinically significant injuries, lesions, and epibiont coverage. Packed cell volume (PCV) and total solids (TS) were measured, and the turtle's body condition index (BCI) was calculated. The results of the examination were compiled on the IRC form and the turtle either met criteria for immediate release or needed additional veterinary assessment and/or diagnostic tests to determine health status. Starting in 2018, those animals that did not meet IRC were further classified based on a tiered system to streamline diagnostics and facilitate analysis. Animals that met IRC were classified as Category I. Category II turtles required veterinary assessment to determine whether additional diagnostics were indicated, or hook removal required greater manipulation or sedation. Category III turtles required antibiotic treatment, were in critical condition, or had other serious health concerns necessitating a longer stay in rehab. After diagnostic results were received and/or hook(s) were removed, Category II turtles were re-assessed and either considered for release or placed in Category III. Prior to implementation of the IRC (2014-2016), an average 33.3% (n=30/90) incidentally hooked turtles spent two weeks or less in rehab. In 2017, 54.3% (n = 19) spent two weeks or less in rehab with six meeting IRC. Thus far in 2018, 62.2% (n=28) spent two weeks or less in rehab with seven turtles meeting IRC. Several of the turtles released within two weeks were placed in Category II after subjective interpretation of mucous membranes and/or BCI outside of the accepted range, but upon veterinary assessment were considered ready for release. Using those results, the IRC will be modified for future years to better capture "presumed healthy" animals. Continued use of the IRC will facilitate consistent evaluation of hooked turtles while reducing unnecessary time in rehab.

REDUCING THE IMPACT OF ARTIFICIAL LIGHT ON SEA TURTLES

Natalia Bayona

Sea Turtle Conservancy, Gainesville, FL, USA

Sea turtles are impacted directly and indirectly by human activity in the water and on land. There is widespread consensus that problematic or poorly managed lighting on nesting beaches has a negative impact on adult and hatchling sea turtles. Artificial lights confuse and disorient adult and hatchling sea turtles, resulting in fewer females nesting on illuminated sections of beach and hatchlings wandering toward landward sources of light and often dying in the process. Since 2010, Sea Turtle Conservancy (STC) has received grant funding from the National Fish and Wildlife Foundation (NFWF) to implement a successful beachfront lighting retrofit program in Florida. The retrofit process includes identifying problematic beachfront properties that are willing to retrofit, collecting pre-retrofit meter readings and night photos, developing personalized lighting plans that utilize approved sea turtle lighting technology, and awarding grant funding to property managers for the purchase of turtle friendly lights. Once lights are installed, STC collects post-retrofit meter readings and photos to ensure that the retrofits are in compliance with the lighting plan and local ordinances. When data are available, STC analyzes disorientation and nesting data from permitted sea turtle monitoring groups to record possible changes in nest disorientation rates in front of retrofitted properties. For the past eight years, STC has retrofitted problematic beachfront lights on 209 single-family homes, condominiums, hotel, and restaurants, resulting in the darkening (restoration) of an estimated 27.7 miles of coastline (44.6 km). Results from retrofits include measured reductions in lumens reaching the beach, reductions in nest disorientation rates and, as an added bonus, decreases in energy costs. A standardized protocol for retrofitting beachfront properties combined with educational outreach has resulted in benefits for local officials, lighting industry professionals, and property owners and can serve as an effective solution to reduce lighting impacts on sea turtle nesting beaches for the foreseeable future.

AN ILLUMINATING IDEA TO REDUCE BYCATCH IN THE PERUVIAN SMALL-SCALE GILLNET FISHERY*

Alessandra Bielli[1,2], Joanna Alfaro-Shigueto[1], Philip Doherty[3], Brendan J. Godley[3], Clara Ortiz Alvarez[1], Andrea Pasara Polack[1] and Jeffrey Mangel[1]

[1]*Pro Delphinus, Lima, Peru*
[2]*College of Life and Environmental Sciences, University of Exeter, Penryn, UK* [3]*University of Exeter, Penryn, UK*

Gillnets are the largest component of the Peruvian small-scale fisheries (SSF) with over 3000 active vessels. Recent studies show that this fishery has high bycatch rates of sea turtles, marine mammals and seabirds, resulting in possible population declines. By applying knowledge about marine sensory ecology, bycatch reduction technologies (BRTs) can alert non-target species to the presence of fishing gear through acoustic and visual signals. In this study we deployed (a) light emitting diodes (LEDs) or (b) a combination of LEDs and acoustic alarms (pingers) on the floatline of paired gillnets (control vs experimental net) that were soaked overnight. Bycatch and target catch data were recorded during 1471 fishing sets (185 trips) on small-scale vessels departing from three Peruvian ports between 2015 and 2018. Bycatch probability for sea turtles and cetaceans, as well as catch per unit effort (CPUE) of target species were predicted using a generalised linear mixed model (GLMM) for both experimental and control nets. During the experiments, a total of 173 sea turtles and 101 cetaceans were captured incidentally. The presence of LEDs on the floatline resulted in an approximate threefold reduction of bycatch probability of sea turtles (from 0.050 ± 0.029 (SEM) in control nets to 0.015 ± 0.009 in experimental nets) and cetaceans (from 0.031 ± 0.015 in control nets to 0.008 ± 0.004 in experimental nets). The presence of the LED-pinger combination resulted in an approximate tenfold reduction of bycatch probability of sea turtles (from 0.085 ± 0.042 in control nets to 0.002 ± 0.002 in experimental nets) and cetaceans (from 0.067 ± 0.033 in control nets to 0.003 ± 0.002 in experimental nets). The predicted CPUE for target catch was not affected by the presence of LEDs or the LED-pinger combination. This study highlights the efficacy of LEDs as a multitaxa BRT for small-scale gillnet fisheries in Peru. Results also suggest that LEDs augment the efficacy of pingers in reducing bycatch. These results are promising given the global ubiquity of small-scale net fisheries, the relatively low cost of LEDs and the current lack of solutions to bycatch. We would like to thank the participating fishers and members of the team Pro Delphinus who made this research possible.

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PRESENCE OF ORGANOCHLORINE PESTICIDES IN EMBRYOS AND HATCHLINGS OF OLIVE RIDLEY SEA TURTLES WITH CONGENITAL MALFORMATIONS IN MEXICO

Rodolfo Martín del Campo, Annelisse Bárcenas-Ibarra, Miguel Betancourt Lozano, and Alejandra García Gasca

Centro de Investigación en Alimentación y Desarrollo, C.P., Mexico

The olive ridley sea turtle nesting in the northwestern coast of Mexico shows a greater rate of congenital malformations compared to other species nesting in the Yucatan Peninsula. Northwest Mexico is characterized by technified agricultural activities where pesticides have been used for decades, eventually reaching the ocean. Organochlorine pesticides are considered persistent compounds; they can be magnified through the trophic chain and transferred to the eggs with possible consequences in development. It has been reported that organochlorine pesticides contribute to health problems, alter embryonic growth, and may cause mortality or reduction of the reproductive fitness in sea turtles. In order to know if the exposure to pesticides is related with the development of congenital malformations, the concentrations of chlorine pesticides in malformed embryos and normal hatchlings from a nesting beach in the northwestern coast of Mexico were compared. The presence of heptachlor and DDE was identified in both groups, however endosulfan was only detected in malformed embryos. Endosulfan is a dangerous organochlorine pesticide (insecticide and acaricide); it became a controversial compound due to its toxicity. It has been reported as endocrine disruptor, presenting neurotoxic, embryotoxic and teratogenic effects in mammals. In addition, it has been suggested that endosulfan may interrupt the signaling pathway of retinoids during cell development and differentiation. This pesticide (together with other chemical compounds and environmental factors) could participate in the development of malformations in sea turtles.

MICROPLASTIC INGESTION UBIQUITOUS IN MARINE TURTLES*

Emily M. Duncan[1,2,3], Annette C. Broderick[1], Wayne J. Fuller[1,4,5], Tamara S. Galloway[2], Matthew H. Godfrey[6], Mark Hamann[7], Colin J. Limpus[8], Penelope K. Lindeque[3], Andrew G. Mayes[9], Lucy C. M. Omeyer[1], David Santillo[10], Robin T. E. Snape[1,5], and Brendan J. Godley[1]

[1]*Marine Turtle Research Group, Centre for Ecology and Conservation, University of Exeter, Penryn, Cornwall, UK*
[2]*College of Life and Environmental Sciences: Biosciences, Geoffrey Pope Building, University of Exeter, Stocker Road, Exeter, UK*
[3]*Marine Ecology and Biodiversity, Plymouth Marine Laboratory, West Hoe, Plymouth, UK*
[4]*Faculty of Veterinary Medicine, Near East University, Nicosia, North Cyprus, Mersin 10, Turkey*
[5]*Society for Protection of Turtles, PK65, Kyrenia, North Cyprus Mersin 10, Turkey*
[6]*North Carolina Wildlife Resources Commission, Beaufort, NC, USA*
[7]*College of Science and Engineering, James Cook University, Townsville, Australia*
[8]*Department of Environment and Science, Threatened Species Unit, Brisbane, Queensland 4001, Australia*
[9]*School of Chemistry, University of East Anglia, Norwich Research Park, Norwich, UK*
[10]*Greenpeace Research Laboratories, School of Biosciences, Innovation Centre Phase 2, University of Exeter, UK*

Despite concerns regarding the environmental impacts of microplastics, knowledge of the incidence and levels of synthetic particles in large marine vertebrates is lacking. Here we utilize an optimised enzymatic digestion methodology, previously developed for zooplankton, to explore whether synthetic particles could be isolated from marine turtle ingesta. We report the presence of synthetic particles in every turtle subject to investigation (n=102) which included individuals from all seven species of marine turtle, sampled from three ocean basins (Atlantic (ATL): n=30, 4 species; Mediterranean (MED): n=56, 2 species; Pacific (PAC): n=16, 5 species). Most particles (n=811) were fibres (ATL: 77.1%: MED: 85.3% PAC: 64.8%) with blue and black being the dominant colours. In lesser quantities were fragments (ATL: 22.9%: MED: 14.7% PAC: 20.2%) and microbeads (4.8%; PAC only; to our knowledge the first isolation of microbeads from marine megavertebrates). Fourier transform infrared spectroscopy (FT-IR) of a sub-sample of particles (n=169) showed a range of synthetic materials such as elastomers (MED: 61.2%; PAC: 3.4%), thermoplastics (ATL: 36.8%: MED: 20.7% PAC: 27.7%) and synthetic regenerated cellulosic fibres (SRCF; ATL: 63.2%: MED: 5.8 % PAC: 68.9%). Synthetic particles being isolated from species occupying different trophic levels suggests the possibility of multiple ingestion pathways. These include exposure from polluted seawater and sediments and/or additional trophic transfer from contaminated prey/forage items. We assess the likelihood microplastic ingestion presents a significant conservation problem at current levels compared to other anthropogenic threats.

EFFICACY OF USING HAND-HELD METAL DETECTORS TO DETERMINE THE PRESENCE OF RECREATIONAL FISHING HOOKS IN SEA TURTLES*

Alexandra Epple, Sarah Rose, and Susan Barco

Virginia Aquarium & Marine Science Center, Virginia Beach, VA, USA

Incidental hooking by recreational anglers poses an underreported and largely unaddressed threat to sea turtles. Since the implementation of an outreach campaign to increase reporting of hooked sea turtles by recreational hook and line anglers, the Virginia Aquarium Stranding Response Program has increased data collection, investigated mitigation measures, and adjusted triage of hooked turtles. From 2017 to 2018, VAQS documented 122 turtles that were hooked by recreational anglers (2017 n=57, 2018 n=65). Though the presence of internal hooks can easily be determined through radiography, metal detectors appear to present a useful field substitute. This cost effective and rapid detection technique could be employed when resources are limited and/or turtles appear otherwise unharmed and healthy. Consistent use of hand-held metal detectors could reduce unnecessary patient stress and rehabilitation costs. However, no published data exist on their efficacy. During 2017, incidentally hooked turtles brought into rehab were tested for presence of hooks using two hand-held security metal detectors to determine their accuracy. Models were chosen based on a pilot study and were the Garrett Pro-Pointer (PP) and the Adams Electronic ER3000 (AE). Metal detector results were validated using radiography. All participants were given brief written instructions on how to use the detectors and scan turtles. A detection was considered 'correct' when the scanner accurately determined whether a hook was present and 'incorrect' if a false negative (scoring a turtle as hook-free when a hook was present) or false positive detection (scoring a turtle as hook present when it was hook-free) was recorded. In 2017, 32 turtles (20 with hooks, 12 without hooks) were tested during 194 trials with different observers. During the 116 trails in which a hook was present, the AE resulted in 10.2% (6 of 59) and the PP resulted in 1.8% (1 of 57) false negatives. Though there was a weak significant difference between the two devices (X^2=3.62, df=1, p=0.057), most false negatives occurred on the same loggerhead turtle, which was likely too large for either device to be consistently effective. During the 78 trials with no hook, the PP resulted in 12.8% false positives (5 of 39), while the AE resulted in 10.3% false positives (4 of 39; X^2=0.13, df=1, p=0.72). Since there was little difference between the two devices, the Pro-Pointer was selected as the preferred detector because of its simple sensitivity settings, easy detection technique, smaller size, waterproofing, and lower cost. In 2018, 32 turtles (11 with hooks, 19 without hooks) were tested during 62 trials using only the PP. Of the trials in which a hook was present, 4.8% were false negatives (1 of 21). Of the trials in which a hook was not present, 4.9% were false positives (2 of 41). Overall, the detection rates were relatively similar to the previous year; there was no significant difference in the rate of false negatives between years (X^2=0.56, df=1, p=0.45), and there was a weak significant difference in the rate of false positives (X^2=3.72, df=1, p=0.054). With the caveats that some instruction and practice are necessary, and that effectiveness decreases in larger turtles, these data suggest that the use of the PP metal detector to determine the presence of hooks in sea turtles may provide an acceptable rate of detection for field deployment, especially when radiographic equipment is not available, or resources are limited. Additionally, providing reasonable verification of hook absence in the field could spare turtles the stress of transport and admission into rehabilitation. Further testing to resolve the limits of detection in relation to hook and turtle size are being conducted.

TURTLE EXCLUDER DEVICES FOR SMALL TRAWLS IN THE SOUTHEASTERN U.S SHRIMP FISHERY*

Meghan Gahm[1], Jeffrey Gearhart[2], and Martin O'Connell[1]

[1]*University of New Orleans, New Orleans, LA, USA*
[2]*National Marine Fisheries Service, Southeast Fisheries Science Center, Pascagoula, MS, USA*

In the southeastern United States, skimmer trawls, pusher-head trawls, wing nets, and small (headrope length less than 12 ft.) try nets are exempt from using a turtle excluder device (TED) and instead must adhere to tow time restrictions as a mode to mitigate sea turtle bycatch. However, observer and stranding data indicates that these tow times may often be exceeded and result in mortality of sea turtles. The National Marine Fisheries Service (NMFS) published a notice of proposed rulemaking in December 2016 to extend TED requirements to other trawl types, however, there has been limited development of specialized TEDs for these smaller trawls. In anticipation of a regulatory change, we developed and identified three versions of a top-opening TED with a minimum width of 28 inches and height of 24 inches as the best option for small trawl gears. Prototypes were initially equipped within small try nets and tested for gear performance and sea turtle exclusion in Panama City Florida. The final prototypes were then tested for target shrimp retention, bycatch reduction, and usability of TEDs in the commercial fisheries. A paired comparison test was conducted in 10 ft. and 8 ft. try nets aboard the NMFS R/V Caretta, three commercial skimmer trawls in vessels <26 ft. in Louisiana and Mississippi, and two commercial wing nets in the Miami-Dade Biscayne Bay Pink shrimp fishery. The loss of shrimp was significant, averaging from 5.57% to 22.32% with a high overall reduction of unwanted bycatch and total catch. This preliminary research indicates that TEDs can function properly in small trawl types, however additional studies need to be conducted to minimize the shrimp loss and improve the overall TED effectiveness specific to each fishery and trawl type evaluated.

MAPPING THREATS AND HUMAN/SEA TURTLE INTERACTION HOTSPOTS IN CENTRAL AFRICA THROUGH A CIVIL SOCIETY ORGANIZATION DYNAMIC LED BY RASTOMA (THE CENTRAL AFRICAN NETWORK OF SEA TURTLE CONSERVATION ACTORS)*

Alexandre Girard[1], Alexis Guilleux[1], Isidore Ayissi[1,2], Samuel Mbungu[1,3], Rodrigue Ngafack[1,4], Roland Missilou[1,5], and Joana Hancock[1]

[1]*RASTOMA, Central Africa*
[2]*ACBM (Cameroun)*
[3]*ACODES (Democratic Republic of Congo)*
[4]*AMMCO (Cameroun)*
[5]*Forestry Economy Ministry (Congo)*

Since 2012, the Rastoma network is federating coastal conservations NGO toward a common objective: maintaining sea turtle populations in their natural habitats on the long term in Central Africa. To ensure conservation action efficiency, it is crucial to build a strategy where actions are prioritized toward most important sea turtle habitats and most impacting threats. The member of the Rastoma network therefore worked together to establish a map highlighting interaction hotspots. Data mobilization from field NGO is often the limitative factor in such process. Rastoma launched a survey and solicited its members (12 NGOs in 6 countries of Central Africa: Democratic republic of Congo, Republic of Congo, Gabon, Equatorial

Guinea, Cameroun and Sao Tomé and Principe) in order to get the local knowledge necessary to design an initial landscape of the areas of concern for sea turtle along the Atlantic Coats of Central Africa. The map presented is produced from the local information collected through this process and it has been made possible thanks to the strong commitment of civil society members within the Rastoma network. It presents both the threats recorded by coastal NGO and the sea turtle habitats and populations information available from previous SWOT nesting activities mapping and from local knowledge. When possible, threat impact and sea turtle population importance are documented using semi quantitative criteria. Overlaps of threat layers and habitats/population layers highlight interaction hotspots where to focus conservation efforts. In addition, this map represents a useful and straightforward advocacy tool. It will be shared with national and regional organisations to influence public and private strategies and coastal development planification in the 6 countries covered by the Rastoma network.

COMPARING PHYSIOLOGICAL DISTURBANCES OF BYCAUGHT SEA TURTLES IN TWO TYPES OF FISHERIES, IN SOUTHERN BRAZIL

Daphne Wrobel Goldberg[1], Marcelo Pires Nogueira de Carvalho[2], Karina Flaiban[3], Caiame Nascimento[4], Luiz Maçaneiro[5], Mariana Karam Britto[6], Gilberto Sales[7], Juçara Wanderlinde[4], and Bruno Giffoni[4]

[1]RRDM - FURG / Programa de Monitoramento da Biodiversidade Aquática na Área Ambiental I, Brazil
[2]Universidade de São Paulo, São Paulo, Brazil
[3]Universidade Estadual de Londrina, Paraná, Brazil
[4]Fundação Pró-Tamar, Salvador, BA, Brazil
[5]SEAMARU - Consultoria em meio ambiente e pesca
[6]Bióloga autônoma
[7]Centro TAMAR/ICMBio, RN, Brazil

Sea turtle bycatch in different types of fishing gear may cause high rates of post-release mortality, contributing to the rapid decline of endangered populations. Turtles that survive incidental capture may present sublethal effects such as physical injuries, physiological disturbance as well as behavioural and reflex impairment. This study is an initiative of Projeto Tamar to reduce late mortality in fisheries and it aims to evaluate the physical and physiological conditions of sea turtles immediately after being caught in two different types of gear: longline and trawling. In order to increase our knowledge on the sub-lethal effects of bycatch, blood samples were withdrawn from the dorsal cervical sinus of 18 turtles, from which 15 were *Caretta caretta*, two were *Chelonia mydas* and one was *Lepidochelys olivacea*. Thirteen loggerheads were captured in longline and two in trawling; two green turtles were captured in trawling and the only olive ridley was captured in longline. All turtles captured were immature, with CCL between 40 and 81 cm (67.53 ± 10.66), except for one adult loggerhead (CCL: 84.5 cm), considering the minimum values for nesting females in Brazil (CCL: 82 cm). The three individuals captured in trawling (two loggerheads and one green turtle) showed symptoms of drowning (lethargy, respiratory deficiency and foam in nares and mouth) and two of them died on board. Blood chemistry analyses revealed higher serum lactate (mean = 29.8 ± 4.26 mmol/L; N = 4), glucose (mean = 211.5 ± 53.97 mg/dL; N = 4) and corticosterone (mean = 36.61 ± 3.6 ng/mL; N = 4) levels for drowned turtles, captured in trawling, especially for the ones that died on board. This might be explained by the fact that capture by trawling leads to forced submergence, which requires increased anaerobic metabolism, producing higher levels of lactate (for gluconeogenesis). Moreover, bycaught turtles struggle to get back to the surface to breathe and both, physical and physiological stress may prompt an increase in corticosterone and blood sugar levels. On the other hand, longline-captured individuals exhibited lower serum lactate (mean = 16.73 ± 5.03 mmol/L; N = 14), glucose

(mean = 106.71 ± 18.42 mg/dL; N = 14) and corticosterone (mean = 13.56 ± 7.19 ng/mL; N = 13) levels if compared to trawling-captured turtles. Turtles captured by shallow-set longline also struggle to escape, however, sometimes they are capable of surfacing to breathe, while hooked. No significant differences in serum ion levels were observed among bycaught turtles. The results presented here suggest that lactate and glucose serum levels might be used as biochemical predictors of delayed mortality of captured sea turtles. Additionally, under trawl conditions, the turtle must recover from any physiological disturbance before it is released back into the water, reducing late mortality rates for these animals.

HOPPER DREDGING IMPACTS ON SEA TURTLES IN THE PARANAGUÁ ESTUARINE COMPLEX, PARANÁ, BRAZIL

Daphne Wrobel Goldberg[1,2], Ana Paula Loureiro Bracarense[3], Liana Rosa[4], and Carolina Jorge[5]

[1]*RRDM - FURG*
[2]*Programa de Monitoramento da Biodiversidade Aquática na Área Ambiental I*
[3]*Centro de Ciências Agrárias, Departamento de Medicina Veterinária Preventiva - Universidade Estadual de Londrina*
[4]*Laboratório de Ecologia e Conservação, Centro de Estudos do Mar, Universidade Federal do Paraná (UFPR)*
[5]*Universidade Federal do Paraná - Programa de Monitoramento de Praias da Bacia de Santos (PMP-BS)*

The Paranaguá estuarine complex (PEC) is an important foraging ground and resting area for juvenile green turtles *Chelonia mydas*, using habitats as the seagrass meadows and coastal islands. The region is considered some of the most productive ecosystems in the world and a World Heritage Site (UNESCO), however the PEC has been heavily affected by human activities, such as unplanned coastal development, commercial fishing, vessel traffic, environmental contamination from domestic, agricultural and industrial run-offs, marine debris and port and dredging operations. The most common dredge type used in both onshore and offshore dredging activities is the trailing suction hopper dredge, since it operates faster, at greater depths and at lower costs. Although they present great advantage to entrepreneurs, these dredges have been directly responsible for the incidental capture and death of many turtles worldwide. Because of the potential impacts of port operations and other anthropogenic activities on the local ecosystem, regular environmental monitoring has been carried out in the PEC since 2007. Dredging activities in the PEC area have been intensified since 2010, causing a considerable increase in water turbidity and reducing the seagrass meadows, the main food item for green turtles in the region. Therefore, since September 2015, the region is part of the Santos Basin Beach Monitoring Project (PMP-BS), to meet the requirements set by the Brazilian Institute of Environment (IBAMA) for oil and gas production at the Pre-Salt Pole of the Santos Basin. The systematic monitoring of the local beaches has allowed access to debilitated and dead specimens of turtles, mammals, and marine birds. Stranded animals were identified, photographed and in case of turtles, measured with a flexible tape. Injured or debilitated animals were referred to the rehabilitation centre of Centro de Estudos do Mar-CEM/UFPR and all carcasses were necropsied to determine the cause of death, whenever possible. From September 2015 to December 2017, 1870 sea turtle carcasses freshly dead or moderately decomposed (mummified carcasses could not be evaluated due to the advanced stage of decomposition) were evaluated to determine potential anthropogenic interaction and whether the observed injuries were the result of dredge interactions. Dredging lesions were differentiated from propeller injuries, which are typically multiple linear-parallel lacerations and/or fractures. Dredging related lesions were confirmed in only 27 individuals, 26 *Chelonia mydas* (CCL mean = 41.13 ± 8.08 cm) and one adult *Lepidochelys olivacea* (CCL=75 cm), and were characterized by massive injuries, severe crushing wounds, carapace and/or other bones fractures, evisceration and eventually death. However, considering the average size of the individuals using the PEC (CCL mean = 40.45 ± 12.39; n=2854) and the diameter of the suction tubes, which exceed 1.5m, it is likely that the number of incidental captures by hopper dredges in the area based on stranded animals might be underestimated. In addition, the impact of suctioning during dredging operations can sometimes destroy the carcasses and the massive draghead could pulverize a juvenile turtle beyond recognition. Besides physical harm, indirect impacts such as physical removal of substratum and associated biota and burial of benthic communities may alter the seabed characteristics and, consequently, the entire food chain, reducing food availability to sea turtles and other coastal species. To minimize dredging impacts on sea turtle populations, different mitigation measures have been proposed, such as alternative dragheads, turtle relocation, rigid deflectors, onboard observers, environmental windows, non-hopper type dredges, inflow and overflow screening. Considering what has been exposed so far, it is recommended that hopper dredging operations should only be carried out in sea turtle aggregation areas if appropriate mitigation measures can be implemented and adequately enforced.

A POTENTIAL PLASTIC INGESTION HOT SPOT FOR GREEN TURTLES (CHELONIA MYDAS) IN URUGUAY

Daniel Gonzalez-Paredes[1,2], Andrés Estrades[1], Florencia David[1,3], Marina B. Reyes[1,4], María Dolores Guitard[1], Gabriela M. Vélez-Rubio[1,5], and Alejandro Fallabrino[1]

[1]*Karumbé NGO, Montevideo, 11600, Uruguay*
[2]*College of Science and Engineering, James Cook University, Townsville, Queensland, Australia*
[3]*Facultad de Ciencias Veterinarias, Universidad Nacional de Rosario, Argentina*
[4]*Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina*
[5]*Centro Universitario Regional del Este (CURE), Universidad de la República, Uruguay*

Plastic pollution is now considered to be one of the main threats to the marine environment. Most plastics are persistent and highly buoyant waste products. Consequently, plastic pieces undergo fragmentation, and the fragments are concentrated in oceanic and coastal gyres by the combined action of winds and ocean currents. These garbage patches often pose a threat to marine turtles because they overlap with important in-water turtle habitats. Turtles are impacted by plastics as a result of ingestion, bioaccumulation, and entanglement, among others. Turtles face plastic pollution in both neritic and oceanic habitats. Dozens of turtles are found stranded every year along the coast of Uruguay, showing clear evidence of interaction with plastic debris. Uruguayan waters are a key foraging and development area for marine turtles in the Southwestern Atlantic Ocean. These waters host a mixed stock of early juveniles (mean CCL=40.1±7.2 cm) of green sea turtles (Chelonia mydas), feeding mainly on macroalgae and gelatinous macrozooplankton. This population now faces considerable levels of plastic pollution. From 2015-2018, the gut contents of 181 dead green turtles (stranded or bycaught) were examined; 63.5% (n=115) of which showed the presence of ingested macroplastics (>5mm). Moreover, blockage of the digestive tract by plastics and the consequent starvation was estimated as the cause of death for 20% (n=36) of these turtles. In the same period, 103 alive wild green turtles (41 injured and 62 uninjured) were monitored to determine the presence of plastics in their digestive tracts; with the collection of faecal material samples (n=174). For the majority (80%; n=103) of these individuals, macroplastics were present in their feces (in 37 injured, and 45 uninjured turtles). Hence, plastic ingestion represents a major threat to this stock population, causing injury and severe health problems, and potentially even death. In order to deal with the plastic pollution hazard in Uruguay, Karumbé NGO, in collaboration with James Cook University, is developing a research project in the Uruguayan waters to evaluate the impact of plastic pollution on the sea turtle's health. This research includes; i) hydrodynamic and oceanographic dispersal models to determine the drift trajectories and dynamics of plastic debris, and ii) evaluation of the impacts and effects caused by plastic ingestion on the health of the green sea turtles. The expected outcomes will allow the development of a risk assessment of plastic ingestion for Chelonia mydas related to exposure levels of plastic pollution in Uruguay. The magnitude of plastic pollution hazard for sea turtle populations remains unclear. Quantifying the impacts and mapping hot spots for plastic ingestion become essential for the effective design of mitigation strategies. Therefore, we consider the Karumbé NGO's actions as an important effort contributing toward the conservation of the green turtle in the Southwestern Atlantic zone.

PREDICTING HATCHLING ORIENTATION ACCURACY BY LIGHT INTENSITY*

Shigetomo Hirama[1], Ray Carthy[2], Morgan Wideroff[1], and Blair Witherington[3]

[1]Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, FL, USA
[2]U.S. Geological Survey, Florida Cooperative Fish and Wildlife Research Unit, Gainesville, FL, USA
[3]Inwater Research Group, Jensen Beach, FL, USA

Hatchling orientation associated with a light cue is a well-studied subject in sea turtle biology. Yet, a clear understanding of the relationship between artificial light intensities and hatchling orientation accuracies is lacking. Previously, researchers have quantified hatchling orientation accuracy by conducting arena assay tests or by measuring the tracks that left on the beaches, which requires significant efforts. The aim of our study was to derive models to predict hatchling orientation accuracy using light intensity data, which are relatively easy to collect. In 2016 and 2017, we collected three parameters that quantified hatchling orientation from Playalinda (n = 174), Cocoa Beach (n = 74), Wabasso Beach (n = 129), Juno Beach (n = 213), Boca Raton (n = 210), Fort Lauderdale (n = 16), and Miami Beach (n = 76), Florida, using previously described methods. The three parameters that indicated hatchling orientation were angular range (spread of hatchling tracks, possible range: 0 ° – 360 °), modal divergence (deviation of ocean direction from "mode" direction, possible range: 0 ° – 180°), and frequency of "correct" orientation (criteria of angular range <90 ° and modal divergence <30 °) (Witherington 1996). In the seven beaches, we also measured the light intensities in four directions (seaward, landward, and two directions parallel to shoreline) using a photometer. We regressed the light intensity data (sum of south and north, sum of all directions, difference of dune and ocean, sum of dune and ocean, et al.) against the mean orientation parameters of the beaches. The results of the linear regression analyses showed strong correlations (r^2 = 0.77 – 0.90). We present models that stakeholders can use to predict hatchling orientation accuracy by plugging light intensity data into the linear regression models using our published interactive website.

DEVELOPING A TURTLE EXCLUDER DEVICE (TED) FOR THE MULTISPECIES DEMERSAL FINFISH TRAWL FISHERY IN SURINAME*

Michael Hiwat

WWF Guianas, Paramaribo, Suriname

The World Wildlife Fund (WWF) has been active in Marine Turtle protection in Suriname since the late 1960s. Awareness on the use of Turtle Excluder Devices (TEDs), which practically eliminate turtle bycatch in shrimp trawls, is now an important component of WWF's marine turtle program. The use of TEDs has been obligatory since 1999 in the seabob (*Xiphopenaeus kroyeri*) and shrimp (Penaeus spp.) trawl fishing sectors in Suriname. In the demersal finfish trawl sector, however, no TEDs are currently being used, although turtles are known to be captured occasionally. In contrast to seabob and shrimp trawlers, a net drum is used on most finfish trawlers to recover the trawl. This prohibits the use of rigid-frame shrimp TEDs. In 2011, WWF Guianas, in cooperation with the Fisheries Service of National Oceanographic and Atmospheric Administration (NOAA) and the Suriname LVV Fisheries Department, executed preliminary sea trials with a "foldable" FFF (Flexible Flatbar Flynet) TED, a TED specially designed for finfish trawls. The results were satisfactory, with a minimal loss of target catch. The FFF TED, however, was designed for use in a larger trawl so this caused problems with the handling of the device on deck, and loading/unloading the TED on the net drum, thereby creating unsafe conditions for the crew. It was concluded that the size of the TED should be reduced, or that an alternative TED should be tested. Following an evaluation workshop held by WWF in 2014, testing of a new flexible TED or Cable TED started within the FAO REBYC-II LAC project in Suriname in 2017. The fishermen, the department of fisheries and the NOAA gear specialist all agreed that a flexible Cable TED (CTED) would be the best option for Surinamese finfish trawlers as these can easily be winded on a net drum, thereby preventing difficult or unsafe working conditions for the fishing crew. In cooperation with NOAA, two prototype CTEDs were built for testing in the Suriname finfish fishery and testing started in late 2017. More trials were done in 2018, evaluating different modifications to the CTEDs. While preliminary results are positive, further design adjustments are needed to maximize the retention of target catch. Only then the TED will be acceptable for implementation within the Surinamese finfish trawl fisheries.

QUANTITY OF PLASTIC INGESTED BY HAWKSBILL SEA TURTLES IN THE CENTRAL PACIFIC OCEAN*

Melissa R. Jung[1], George H. Balazs[2], T. Todd Jones[3], Thierry M. Work[4], Alexander Gaos[3], and Jennifer Lynch[5]

[1]*College of Natural and Computational Sciences, Hawaii Pacific University, Kaneohe, HI, USA*
[2]*Golden Honu Services of Oceania, Honolulu, HI, USA*
[3]*Pacific Islands Fisheries Science Center, National Marine Fisheries Service, Honolulu, HI, USA*
[4]*U.S. Geological Survey, National Wildlife Health Center, Honolulu Field Station, Honolulu, HI, USA*
[5]*Chemical Sciences Division, National Institute of Standards and Technology, Kaneohe, HI, USA*

The ingestion of marine plastic debris is a known increasing threat to all sea turtle populations. Effects from plastic ingestion range from sublethal types such as exposure to harmful chemicals or dilution of nutrients to lethal obstructions, perforations, or plications. Critically endangered hawksbill sea turtles have been found to ingest far greater quantities than other sea turtles (Lynch, 2018). In particular, the Central and Northwest Pacific and Southwest Atlantic Oceans have been identified as hotspots of ingestion for multiple species. Despite many hawksbill sea turtle populations declining and the urgent need to monitor plastic ingestion in this species, only 11 studies (82 individuals) across the globe and two studies specific to the Central Pacific (2 individuals) have assessed hawksbill plastic ingestion, leaving large data gaps. The entire gastrointestinal tracts of five hawksbill sea turtles (one pelagic-phase post-hatchling and three neritic-phase stranded in Hawaii plus one pelagic-phase hawksbill captured as bycatch in the American Samoa longline fishery) from the Central Pacific Ocean were examined for plastic debris. The color, type, and size are recorded for each individual piece collected. The number of plastics from each turtle was counted, weighed, and standardized by turtle weight (kg). White (53.84%) was the most common color and fragments (76.92%) were the most common type ingested. Ingested debris sizes ranged from a 0.8 cm x 0.01 cm x 0.01 mm (line) to 5 cm x 3 cm x 1 mm (fragment). The percent frequency of occurrence of ingestion was

80% with an average of 13 ± 12.6 pieces and 0.69 ± 0.84 g of plastic per turtle (calculations include the one non-detect). An average of 1.07 ± 2.17 g/kg was observed when the size of each turtle was considered. This concentration is lower than the recently estimated ingestion quantity (8.8 g/kg) for this species and region (Lynch, 2018). By adding five turtles to the original sample size of only two, the new regional average ingestion of debris in Central Pacific hawksbills is 3.3 g/kg. This remains the highest ingestion quantities globally, exceeding green turtles from the NW Pacific (1.9 g/kg) (Lynch, 2018) and post-hatchlings of three species stranded along Florida's east coast (2.07 g/kg) (White et al., 2018), further emphasizing that hawksbills in the Central Pacific are the most at risk among sea turtle species and locations. The two turtles foraging in the pelagic Central Pacific had much greater concentrations per body weight than the three neritic-phase turtles. The post-hatchling had ingested 17x more than the other pelagic-phase turtle and at least 63x more than the neritic-phase hawksbills. Future studies are needed on plastic ingestion in sea turtles for all species, but increased monitoring of rare hawksbill sea turtles is crucial along with determining if the amounts of plastic ingested are harmful or not. Because of greater amounts of plastic ingestion, efforts within hawksbill populations should focus on younger pelagic-phase turtles, in particular post-hatchlings. While monitoring should continue and expand around the world, hotspot regions, like the Central Pacific, should receive extra attention.

HABITUAL HOOKERS AND THE PIERS THEY JUST CAN'T QUIT

Meghan Koperski[1], Karrie E. Minch[2], and Morgan Wideroff[2]

[1]*Florida Fish & Wildlife Conservation Commission, Imperiled Species Management, Tallahassee, FL, USA*
[2]*Florida Fish & Wildlife Conservation Commission, Fish & Wildlife Research Institute, FL, USA*

The Florida Fish and Wildlife Conservation Commission's (FWC) Sea Turtle Stranding and Salvage Network (FLSTSSN) collects data on stranded (i.e., dead or debilitated) and incidentally captured (e.g., hook and line capture at fishing piers) sea turtles in Florida. The Imperiled Species Management Section (ISM) of FWC monitors the outcome of any live stranded or incidentally captured sea turtles following admission to a FWC-permitted rehabilitative care facility.The number of incidentally pier-caught sea turtle captures via hook and line documented by FLSTSSN is understood to likely represent a subset of total encounters, as fishers may not know whom to contact, do not have appropriate resources or experience to safely land the sea turtle or fear repercussions for unintended harming of a protected species.Recently, multiple organizations have implemented educational programs to improve reporting and handling of turtles caught via hook and line, including from fishing piers. While FWC does not oversee a specific pier-based educational program, FWC recognizes the earliest such program in Florida to be Loggerhead Marinelife Center's Responsible Pier Initiative (RPI), initiated at the Juno Beach Fishing Pier during 2013. FWC staff compared statewide captive facility data for incidentally pier-caught sea turtles during the five years following RPI implementation (2014 - 2018) and the previous five years (2009 - 2013) to identify any differences on reporting and rehabilitation of incidentally pier-caught turtles, which may be due to enhanced pier-based education efforts. From 2014 - June 2018, turtles incidentally caught via hook and line were reported and admitted to a sea turtle rehabilitation facility for evaluation and treatment on 233 occasions from 35 different Florida piers. This constitutes a significant increase from the previous five-year period (2009 - 2013) when turtles incidentally caught were reported and admitted to a sea turtle rehabilitation facility on 36 occasions from 17 different piers. From 2009 – 2013, Kemp's ridley and green turtles were the species most often reported caught at piers (n = 15 and 14, respectively), followed by loggerhead turtles (n = 7). In contrast, during 2014 - 2018 green turtles accounted for over 60% of pier captures (n = 142), followed by Kemp's ridley (n = 51) and loggerhead turtles (n = 40). Pier-caught turtles had a high rate

(>90%) of successful rehabilitation (i.e., release) during both periods. Following release, sea turtles previously hooked at a pier were subsequently recaptured at a pier on one to three occasions for a total of 36 recapture events during 2014 – June 2018. This represents a significant increase from the recapture rate (n = 1) from 2009 - 2013. Of the turtles recaptured at piers during 2014 – June 2018, greater than 90% of individuals were encountered at the same pier as their initial capture. During this period, only six piers were involved in recapture events, with over 86% of recapture events (n = 31) occurring at two piers (Navarre Beach Fishing Pier, Santa Rosa County and Deerfield Beach International Fishing Pier, Broward County), both of which participate in the RPI. The rise in reported encounters generates questions regarding the overall impacts of turtles incidentally captured during recreational fishing, including at Florida piers. Additionally, the expected increase in pier-caught turtle admissions to rehabilitation facilities and the largely unanticipated increase in recapture events of individual turtles highlight emerging challenges for sea turtle conservation. Additional analysis is required as FWC and federal resource agencies work to understand and resolve complex issues including management of turtles that have been recaptured on multiple occasions and methods to effectively minimize incidental capture during recreational pier-based fishing.

INCREASING TRENDS IN GREEN TURTLE (CHELONIA MYDAS) STRANDINGS IN SOUTHERN CALIFORNIA, USA FROM 1980-2018: A CAUSE FOR CONCERN? *

Robin A. LeRoux[1], Erin LaCasella[1], Tomo Eguchi[1], Christina Fahy[2], Joel Schumacher[1], Garrett Lemons[1], Justin Viezbicke[2], Justin Greenman[2], Joe Cordaro[2], Peter H. Dutton[1], and Jeffrey A. Seminoff[1]

[1]NOAA-SWFSC, La Jolla, California USA
[2]NOAA-WCRO

The presence of green turtles off the coast of southern California has been known about since the early 1900s. These turtles originate from nesting beaches in Mexico, where the population was once decimated by egg collection and killing of juveniles and adults. Today, however, the Mexican population has increased significantly, and the green turtle recovery is among the most impressive conservation success stories globally. In southern California, green turtles have been observed in a variety of open coast, lagoon, and bay habitats throughout the region, and they are present year-round at several of these sites. Their increasing presence throughout the region is clearly a result of conservation success, but it has resulted in increased human-turtle interactions and strandings. Both live and dead green turtles strand throughout the year along the U.S. West Coast, with a majority occurring in the Southern California region. When possible, we collected a variety of morphometric data, as well as signs of human interaction (e.g., boat strikes, fishing gear, power plant entrainments), some of which could be indicative of cause of mortality. Spatial distribution of strandings were examined to determine if there are stranding "hot spots," or specific areas or anthropogenic threats to help focus management efforts. The number of annual strandings in relation to large scale oceanographic events, such as El Niño and the recent warm water event off of California in 2016-2017, were also assessed. Over 200 green turtle strandings were recorded in Southern California between 1980 and September 2018. Prior to 2016, annual green turtle strandings in the area ranged from 0 to 10. However, 2016 - 2017 showed dramatic increases in stranding events with 25 recorded in 2016 and 27 recorded in 2017, and 10 recorded as of September 30, 2018. In addition to wild animals, SeaWorld San Diego, CA, released a cohort of turtles hatched at the park in 2009. Fifty-seven animals were released in the Summer/Fall of 2016, and 10 of these animals have since stranded. Temporal distributions indicate that there is a seasonal trend to green turtle strandings, with a large portion (45.5%) occurring in the late summer/early fall months of August, September and October. Strandings with some level of probable

human interaction were recorded on over 60% of the 209 stranding events since 1980 (e.g. probable boat strikes, power plant entrainment or discarded fishing line). Probable boat strikes made up 53.4% of the strandings since 2012, whereas overall probable boat strikes accounted for only 22% of the total strandings from 1980 to present. The significant increase in probable boat strikes in the area in the last 6 years is a cause for concern. Power plant entrainments accounted for 27.8% of overall strandings; however, only 10.5% of strandings were recorded as entrainments since 2012. The reduction in entrainments is primarily due to the closure of the San Onofre nuclear power plant in 2012. However, animals continue to get entrained at other power plant facilities in the region. A majority of power plant entrainments were released alive. Demographic patterns indicate that juveniles make up a majority of strandings (78.5%), which could be in direct relation to the successful recovery of green turtles at the primary nesting rookery in Mexico over the last 20 years. With the green turtle population recovering rapidly and the human population and associated activities in coastal habitats also increasing, we expect to see more human-turtle interactions in Southern California in the near future.

A GLOBAL APPLICATION OF THE SEA TURTLE CLIMATE VULNERABILITY ASSESSMENT

Matthew Lettrich[1], Dorothy Dick[2], Christina Fahy[3], Roger Griffis[4], Heather Haas[5], T. Todd Jones[6], Irene Kelly[6], Dennis Klemm[7], Ann Marie Lauritsen[8], Emily Markowitz[4], Bianca Santos[9], Christopher Sasso[10], Barbara Schroeder[11], Jeffrey A. Seminoff[12], and Carrie Upite[13]

[1]*ECS Federal in support of NOAA Fisheries Office of Science and Technology*
[2]*Ocean Associates in support of NOAA Fisheries Office of Protected Resources*
[3]*NOAA Fisheries West Coast Regional Office, Portland, OR, USA*
[4]*NOAA Fisheries Office of Science and Technology, Silver Spring, MD, USA*
[5]*NOAA Fisheries Northeast Fisheries Science Center, Woods Hole, MA, USA*
[6]*NOAA Fisheries Pacific Islands Fisheries Science Center, Honolulu, HI, USA*
[7]*NOAA Fisheries Southeast Regional Office, St. Petersburg, FL, USA*
[8]*US Fish and Wildlife Service, St. Petersburg, FL, USA*
[9]*NOAA Oceanic and Atmospheric Research International Activities, Silver Spring, MD, USA*
[10]*NOAA Fisheries Southeast Fisheries Science Center, Key Biscayne, FL, USA*
[11]*NOAA Fisheries Office of Protected Resources, Silver Spring, MD, USA*
[12]*NOAA Fisheries Southwest Fisheries Science Center, La Jolla, CA, USA*
[13]*NOAA Fisheries Greater Atlantic Regional Fisheries Office, Gloucester, MA, USA*

Climate change and the related ecological changes have significant implications for the conservation of sea turtles. Sea turtle embryo survival rates and sex ratios are tightly coupled with nest incubation temperatures, and some populations are already affected by increasing beach temperatures. Nesting and foraging habitat are also affected by sea level rise and storms, which may impact or reduce suitable habitat, especially in areas of high human activity. Temperature, pH, and salinity can further affect the abundance, distribution, and quality of turtle's prey. While understanding these individual impacts can guide local conservation actions, considering climate impacts across the entire sea turtle life cycle, both annually and inter-annually, and across multiple species and populations can help identify broader sea turtle conservation strategies in a changing climate. A climate vulnerability assessment is one approach that allows us to broadly evaluate the expected changes in a range of climate variables (e.g., beach incubation temperature, sea surface temperature, ocean acidification, sea level rise) and characterize the sensitivity and adaptive capacity afforded by specific life history traits. NOAA Fisheries has developed a framework to assess the vulnerability of sea turtles to climate change. We use available population-specific existing information (a

combination of population background narratives) and expert elicitation to score each population's sensitivity and capacity to adapt to climate change. We then combine separate components into a relative vulnerability score. The framework provides a relatively rapid assessment of a population's likelihood to experience declines in abundance, shifts in distribution, and/or shifts in phenology with expected changes in climate and ocean conditions. We use ensemble global climate model projections to 2055 to assess climate vulnerability within a management-relevant timeframe. Variability in expert opinion, derived from uncertainty associated with the amount and quality of population-specific information, is integrated within the assessment framework. Practically, our approach highlights those populations that may require urgent attention considering limited resources available for conservation and research. We apply this framework to the global suite of sea turtle populations based on the Distinct Population Segment (DPS) framework defined by the Endangered Species Act, and Regional Management Units (RMUs) where DPSs have not been designated. In late 2018 and early 2019, 21 sea turtle experts will complete the scoring process for 51 sea turtle populations. This assessment will provide managers and researchers with population-specific climate vulnerability information that can inform sea turtle management actions and future research.

LOW PROFILE GILLNET COMPARITIVE GEAR STUDY TO REDUCE SEA TURTLE BYCATCH*

Eric Matzen[1], Henry O. Milliken[2], Rick Usher[3], and Kathryn Roy[3]

[1]*NMFS, NEFSC, PSB*
[2]*National Marine Fisheries Service*
[3]*A.I.S. Inc.*

In 2013, the Northeast Fishery Science Center and the Atlantic States Marine Fisheries Commission sponsored a workshop with scientists and fishing industry stakeholders to discuss gear modifications that could result in reducing sturgeon and sea turtle bycatch without significant reduction in the capture of targeted species, primarily monkfish (*Lophius americanus*) and winter skate (*Lophius americanus*). Based on studies that were conducted in coastal waters off New Jersey and southern Virginia, it appeared that a low profile net was successful in reducing the bycatch of Atlantic sturgeon. Since no sea turtles were encountered in either study, it was not known if the low profile net configuration would reduce sea turtle bycatch. To test this hypothesis, the NEFSC developed this study in an area of high loggerhead abundance to focus on the bycatch of loggerhead sea turtles. Observed bycatch of sea turtles in the large mesh monkfish fishery were predominantly loggerhead, but other species, including Kemp's ridley (*Lepidochelys kempi*), have also been documented. This project tested the effectiveness of experimental gillnets in reducing the bycatch of loggerhead sea turtles (*Caretta caretta*) in the US monkfish gillnet fishery. Data were also collected on other sea turtle species interacting with the gear. The experimental gillnets were eight meshes deep (12” mesh) with 24” tie-downs at each float. These nets were compared with traditional, commercial gillnets (control) that were twelve meshes deep (12” mesh) with 48” tie-downs at every other float. A commercial fishing vessel (F/V Salvation), owned and operated by Charlie Locke, was contracted to conduct sea trials during February and March of 2017. An A.I.S., Inc. (AIS) observer, approved by NMFS in the capture and handling of sea turtles, was deployed onboard the vessel to collect operational, environmental, and biological data throughout the duration of the study. The two gillnet treatments were fished in pairs; each pair consisted of one control string (4 nets at 300 ft. per net) and one experimental string of the same number and length. The pair of nets was set close to each other, in the same direction, and on similar seafloor types. Comparable soak times were achieved by alternating the order of the first net hauled on each set between experimental and control throughout the duration of the study. The vessel completed 120 hauls, 60 control gillnets and 60 experimental nets, producing 60 pairs of comparable data.

There was no significant difference in the capture of loggerhead sea turtles between treatments. Fourteen loggerheads were captured in the control nets and eight were captured in the experimental nets resulting in a $P(T \leq t)$ one tail value of 0.125 and a $P(T \leq t)$ two tail value of 0.248 (see Table 1). It is interesting to note that during the first seven trips of the study, ten loggerhead turtles were captured in the control nets while none were captured in the experimental nets. During the final five trips of the study, eight loggerheads were captured in the experimental nets and four were captured in the control nets. The median surface temperature during the final five trips was 51.44° F as compared to a median surface temperature of 62.06° F when loggerheads were only captured in the control nets.

IMPACTS OF THE CARIBBEAN SARGASSUM SEAWEED INFLUX ON SEA TURTLE NESTING ECOLOGY*

Andrew S. Maurer[1], Seth P. Stapleton[2], and Craig A. Layman[3]

[1]*Department of Applied Ecology, North Carolina State University, Raleigh, NC, USA*
[2]*Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota, St. Paul, MN, USA*
[3]*Department of Applied Ecology, North Carolina State University, Raleigh, NC, USA*

Sargassum macroalgae has been arriving on western Atlantic shorelines in unprecedented quantities since 2011. Arrivals of the seaweed are episodic and difficult to predict, yet the economic, ecological, and conservation ramifications may be widespread and severe. Here, we document coastal Sargassum biomass accumulation at Long Island, Antigua, and describe impacts on the resident hawksbill sea turtle (*Eretmochelys imbricata*) nesting population. We collected data on hawksbill nesting and shoreline Sargassum abundance during a peak Sargassum arrival year in 2015. We first compared spatial trends in hawksbill crawl counts and Sargassum accumulation during the 2015 nesting season. We then examined the distribution of crawls in 2015 relative to minimally impacted nesting seasons (2008-2010; 2016). Further, we used temperature data loggers to assess the impact of Sargassum on the nest incubation environment. Our results suggest that Sargassum displaces crawl activity from preferred areas of the nesting beach. Temperature data suggest that Sargassum's effects on below-ground nest temperatures may differ with moisture conditions, producing a cooling effect when dry and a warming effect when wet. These findings have important implications for regional sea turtle conservation, as the macroalgae has the potential to inhibit access to key windward nesting habitats and alter incubation temperatures (which is particularly important given that temperature affects egg survival and primary sex ratios in sea turtles). Nesting beach managers and conservationists should monitor the Sargassum "invasion" closely, as it creates complex trade-offs for beach management. Removal practices often generate impacts that must be weighed against ecological and economic effects.

SATELLITE TAGGED SEA TURTLE MOVEMENTS ASSOCIATED WITH RED TIDE*

Kristen Mazzarella[1] and Daniel Evans[2]

[1]*Mote Marine Laboratory, Sarasota, FL, USA*
[2]*Sea Turtle Conservancy, Gainesville, FL, USA*

Red Tide is a harmful algal bloom caused by the toxic dinoflagellate, *Karenia brevis*, which most frequently occurs in the eastern Gulf of Mexico. A toxic red tide bloom that began off southwest Florida in October 2017 has persisted throughout 2018 and is still ongoing as of October 2018. During this time Florida Fish and Wildlife Conservation Commission documented 982 sea turtle deaths and 142 live stranded sea turtles in seven Gulf Coast counties. Of these, 504 (474 dead, 30 live) were attributed to red tide. This is the largest number of stranded sea turtles attributed to a single red tide event in Florida. Little is known about the behavior of sea turtles in or around an area experiencing a red tide event. Between June 29, 2017, and October 17, 2018, seven adult male loggerheads released from rehabilitation and three post-nesting female sea turtles (one green and two loggerheads) were satellite tagged and tracked into red tide areas. The Optical Oceanography Laboratory at University of South Florida developed a multilevel map which integrates satellite remote sensing, numerical models and water samples into the Near Real-Time Integrated Red Tide Information System (IRIS). Using IRIS and Movebanks' Environmental Data Automated Track Annotation System, we accessed the Normalized Fluorescence Line Height from MODISA satellites and layered it with sea turtle location data in Google Earth and Movebank's graphical user interface, DYNAMO, to investigate turtle movements in association with high red tide concentrations. Information regarding turtle behavior during red tide blooms and their potential avoidance of blooms is critical to management of these threatened species during toxic algal blooms, which have been increasing in duration and magnitude in recent years.

EVALUATION OF MINERALS AND METALS IN SEA TURTLES (*ERETMOCHELYS IMBRICATA*, *CHELONIA MYDAS* AND *CARETTA CARETTA*) AT MEXICAN CARIBBEAN SEA

Maribel Escobedo Mondragón

UNAM, Universidad Nacional Autónoma de México

The pollution of the Mexican Caribbean Sea is having an increased impact and the growth in the tourism industry has accentuated the problem, one of them is due to heavy metals. The objective of this study was to determine baseline concentrations of 47 minerals and metals in blood and scutes of three species of nesting sea turtles clinically healthy, 60 loggerhead turtles (*Caretta caretta*), 100 Green turtles (*Chelonia mydas*) and 19 hawksbill turle (*Eretmochelys imbricata*) at for zones in the Mexican Caribbean Sea (Holbox Island, National Park of Puerto Morelos Reefs, National Park of Contoy Island and Xcacel-Xcacelito sanctuary.

HISTORICAL TRENDS IN NEW YORK STATE COLD STUNNED SEA TURTLES: 1998-2018

Maxine Montello[1] and Wendy McFarlane[2]

[1]*Riverhead Foundation for Marine Reserach and Preservation, Riverhead, NY, USA*
[2]*Manhattanville College, Purchase, NY, USA*

Long Island Sound and the Great Peconic Bay are known habitats for foraging juvenile populations of sea turtles within the southern barrier lagoons and eastern bays. Every winter, sea turtles strand throughout these habitats as a result of climate-related cold snaps that typically occur quickly in the late fall and lead to cold stunning, a physiological temperature shock similar to hypothermia. It is thought that rapidly decreasing water temperatures prevent these sea turtles from naturally migrating to warmer waters. Cold stunning events tend to last longer than a few weeks and typically affect juvenile Kemp's ridley (*Lepidochelys kempii*), juvenile green (*Chelonia mydas*) and sub-adult loggerhead (*Caretta caretta*) sea turtles. Furthermore, each year is unique and unpredictable in terms of the timing and magnitude of cold stunning. The Riverhead Foundation for Marine Research and Preservation (RFMRP) is the sole rehabilitation facility for cold stunned sea turtles in NY and responds to the second largest number of cold stuns in the Greater Atlantic Region. Each year, NY beaches are patrolled for cold-stunned individuals by RFMRP staff, trained volunteers and members of the general public. All animals processed are provided with a NY number (NYXXXX-Year), and a complete physical and blood analysis. In addition, species, date, location and cause of stranding are identified upon arrival and recorded on data sheets provided by the Sea Turtle Stranding and Salvage Network (STSSN). Data collected over the past two decades by the RFMRP was reviewed in order to analyze historical trends. From this data, number stranded per season, species composition, size class, and rehabilitation success rate were compared. Since 1998, a total number of 385 (not including data for the upcoming 2018/19 cold stun season) sea turtles were recovered from New York state waters or beaches, between the months of October and February. These 385 cold stuns were comprised of 3 different species; 208 *L. kempii* (54.0%), 140 *C. mydas* (36.4%), 36 *C. caretta* (9.4%), and 1 *C. mydas/C. caretta* hybrid in 2007 (0.2%). Over the course of 19 years, stranding frequency varied from 4-49 turtles per season, with an average of 19 per season. However, a large increase in average stranding was observed starting in 2007; coinciding with a greater effort in public outreach and education. Average stranding numbers from 1998-2006 were 7 per season, increasing to 29 per season from 2007- 2018. In addition to variation in stranding numbers, there was also a noticeable change in success rate for release candidates ranging from 0 – 16 (0 -100%) sea turtles released each season. From this data, it is suggested that more frequent stranding can be attributed to environmental factors, as well as a clear increase in public awareness (E.g., Cold Stun Lecture series) and associated training for volunteers. Examination of historical data allows for refining of rescue/rehabilitation procedures along with development and implementation of citizen science programs, as critical components for sea turtle conservation efforts.

GHOST CRAB PREDATION RISK OF GREEN SEA TURTLE (*CHELONIA MYDAS*) HATCHLINGS ON ANDERSEN AIR FORCE BASE, GUAM

Josefa Munoz

University of Guam Sea Grant Program, Mangilao, Guam

In 2016, the U.S. Endangered Species Act listed the Central West Pacific green sea turtle (*Chelonia mydas*) as Endangered, which is the highest protection level afforded under the ESA framework. Marine turtles rely not only on their marine habitat but also rely on suitable nesting habitat for survival. Females deem an area suitable for nesting based on both the number and location of predators. On Guam, nest predators include wild pigs, monitor lizards, feral dogs, ants, and crabs. In particular, ghost crabs (*Ocypode spp*.) can be a hindrance both within the egg chamber and during hatchlings' journey to sea. Although crab predation has been observed on AAFB nesting habitat, predation data is currently unavailable. The present study attempts to assess predation on AAFB that would help drive future management decisions. Predation risk was assessed to identify rate of nest depredation by crabs. Crab density was measured by counting crab holes and tracks per m2 in randomly chosen locations near *C. mydas* nests. Crab density was used as a proxy for the number of crabs that may be encountered by hatchlings on AAFB nesting habitat. Crabs were found at a very high density however results showed that *C. mydas* egg mortality due to crab predation is not a major threat given the resulting low magnitude of depredation. In addition, use of galvanized wire fences to surround nests proved to be successful for preventing crab predation. This study recommends the use of galvanized wire fences as a method of conservation management against non-human predators. Future studies will include predation risk assessment of other predators (e.g., wild pigs, monitor lizards) on AAFB nesting habitat.

PREDATION OF TURTLE EGGS AND NESTLINGS BY TATERA INDICA AND GOLUNDA ELLIOTI IN SRI LANKA: A FIRST TIME OBSERVATION*

Pinidiya Arachchilage Channa Nishantha Bandara Suraweera[1], S.M.P. Prasanna[1], D.D.G.L. Dahanayaka[2], and Mayuri R. Wijesinghe[3]

[1]*Department of Wildlife Conservation, Battaramulla, Sri Lanka*
[2]*Department of Zoology, The Open University of Sri Lanka, Nawala, Nugegoda, Sri Lanka*
[3]*Department of Zoology and Environment Sciences, University of Colombo, Colombo 03, Sri Lanka*

The Bundala National Park (BNP) located in the southern coastal region of Sri Lanka is the first wetland in Sri Lanka to be declared as a Ramsar site. The BNP, due to its high biotic richness and uniqueness of the ecosystem, has also been recognized as a Man and Biosphere Reserve by UNESCO. The area comprises a mosaic landscape with both terrestrial and aquatic components. A substantial part of the BNP is covered by shallow brackish water lagoons and estuaries. The strip of beach that borders the BNP has been identified as an important turtle nesting ground in Sri Lanka. Five species of sea turtle nest in the beaches from Uraniya to Hambanthota, which includes the stretch bordering the BNP. Sea turtles are threatened worldwide and hence, the Department of Wildlife Conservation (DWC) Sri Lanka has taken an initiative to protect nests and hatchlings of these turtles. One such measure is to maintain ex-situ hatcheries. Eggs on the beach and nestlings that are released from hatcheries often fall prey to wild pigs (*Sus scrofa*) and monitor lizards (*Varanus bengalensis*). Here we report observations of two rat species predating upon eggs and nestlings of these sea turtles. The two rat species were identified as antelop rat (*Tatera indica*) and bush rat (*Golunda ellioti*). Rats although adapted to feed primarily on plant matter i.e., on leaves, roots and grains are also known to feed on insects, reptiles and bird eggs. The observations of the rats feeding on turtle eggs and nestlings within the BNP are first time records. These observations are important as it might reveal an additional threat to the survival of eggs and nestlings affecting the process of recruitment of the turtles. Further monitoring of this threat is needed to assess the magnitude of the threat and to examine if additional measures are required to circumvent the attacks of these newly recorded predators.

SELECTIVITY ASPECTS ON MARINE DEBRIS INGESTION BY JUVENILES GREEN TURTLES (*CHELONIA MYDAS*) IN THE PARANÁ COAST, SOUTHERN BRAZIL

Tawane Yara Nunes and Camila Domit

Laboratório de Ecologia e Conservação, Centro de Estudos do Mar, Universidade Federal do Paraná, Pontal do Paraná, Paraná, Brazil

Marine debris is a major threat to marine life, causing direct mortality through entanglement and ingestion. The most impacted species are the sea turtles, particularly the green turtles (*C. mydas*), which is primarily herbivorous with high consumption of seagrass and algae, may leading to a greater likelihood to ingest plastics that resemble their natural food. The Paranaguá estuarine complex (CEP) in the Paraná coast, southern Brazil, comprises a port complex and intensely urbanised areas with deficient waste management. Conversely, that region is classified as a world heritage site and an important foraging ground for juveniles *C. mydas*. Between 2014 and 2015, 49 dead stranded *C. mydas* were collected and their digestive tract was removed to assess the marine debris ingestion. All the fragments of debris were quantified and classified by type: soft and rigid plastic, ribbons, nylon, straws, balloons, fishery debris, and 'others'; also by colours: black, white, transparent and coloured (except for balloons and fishery debris). Marine debris environmental availability was accessed by beach monitoring, along 5000 m of beachline on the CEP mouth, split into 5 linear transects (1000 x 2 m each), sampled at the same period of the turtles sampling. All fragments of debris, sized from the visual limit until 30 cm, were quantified and classified with the same parameters described above for ingested debris. To evaluate the biological factors with the ingestions rates, the turtle curvilinear carapace length (CCL) and total numbers of debris ingested was analyzed with a generalized linear model (GLM). Also, were used the Manly's ratio to estimate the debris selection for the entire sampled population. From the 49 green turtles, CCL varying between 29.8 and 57.0 cm (39.4 ±6.3), 41 had the entire digestive tract analyzed. Those ones with incomplete digestive tract were evaluated only for the frequency of occurrence (FO%) analysis. 93.9% of the turtles (n=46) had ingested debris; an amount of 4.745 items were ingested by 41 turtles (124.7 ±201.4). A negative correlation between CCL and total numbers of debris ingested ($p<0.001$) was observed. Transparent soft plastic was the most ingested category (27.0%) followed by soft white plastic (15.7%). For environment survey, 43,652 items of debris were counted, composed mostly of colored rigid and soft plastic (20.6% and 15.7% respectively). The proportion of debris categories were used as a measurement of environmental availability to calculate selectivity ratio. The selective ratio highlighted a strong selectivity for transparent nylon lines (97.5); however, an availability bias might be an underestimation of that item in the environment due to the method. The green turtles seemed to avoid colored straws (0.02). These results suggest younger turtles are more vulnerable to marine debris impacts and the ingestion rates and the characteristics of debris may variate according to their availability and the foraging behavior of juvenile green turtle. More effort is needed to identify the marine debris characteristics that are most attractive to the marine animals and also the potential origin of them to guide pollution mitigation actions and strategic plans to reduce marine debris impacts.

LEATHERBACK BYCATCH RAPID ASSESSMENT IN INTERNESTING AND FORAGING AREAS IN THE EASTERN PACIFIC*

Clara Ortiz Alvarez[1,2], Mariela Pajuelo[1,2], Mariano E. Abrego[2,3], Ana R. Barragan[2,4], Mariano Barrantes[2,5], Alejandro Cotto Sánchez[2,6], Luis G. Fonseca[2,5], Velkiss Gadea Espinal[2,6,7], Jeffrey Mangel[1,2,8], Juan M. Rguez-Baron[2,9,10], Pilar Santidrian Tomillo[2,5], Laura Sarti[2,11], Heriberto Santana[2], Myriam Prado[2], Bryan Wallace[2,12,13], Amanda Williard[9], Alan Zavala[2], and Joanna Alfaro-Shigueto[1,2,8,14]

[1]ProDelphinus, Miraflores, Perú
[2]Eastern Pacific Leatherback Conservation Network – LaúdOPO
[3]Dirección Nacional de Costas y Mares, Ministerio de Ambiente de Panamá, Ancón, Panamá
[4]Kutzari, Asociación para el Estudio y Conservación de las Tortugas Marinas, Mexico D.F, México
[5]Leatherback Trust, Playa Grande, Costa Rica
[6]Fauna & Flora International, Cambridge, UK
[7]Red Nicaragüense para la Conservación de Tortugas Marinas – RNCTM
[8]Centre for Ecology and Conservation, University of Exeter, Penryn, Cornwall, UK
[9]Department of Biology and Marine Biology, University of North Carolina, Wilmington, NC, USA
[10]JUSTSEA Foundation, Bogota, Colombia
[11]Programa Nacional para la Conservación de las Tortugas Marinas Dirección de Especies Prioritarias para la Conservación Comisión Nacional de Áreas Naturales Protegidas Ejercito Nacional 223, Col. Anahuac 1 Sección Del. Miguel Hidálgo Ciudad de México
[12]Conservation Science Partners, Inc, Fort Collins, CO, USA
[13]Nicholas School of the Environment, Duke University, NC, USA
[14]Facultad de Biología Marina, Universidad Científica del Sur, Lima, Perú

Sea turtle interactions with small-scale fishing operations are pervasive around the world, and likely have greater population-level effects than large-scale, industrial fisheries. However, obtaining even baseline information to compare bycatch effects within and among ports and countries can be extremely challenging due to logistical challenges associated with typical modes of bycatch monitoring and data collection. The East Pacific (EP) leatherback turtle nests along the coast of Mexico, Central, and South America, and ranges from waters off Mexico to central Chile, and westward to 130°W. While conservation efforts have focused on eliminating anthropogenic threats at most significant nesting beaches, the EP leatherback population remains low and continues to decrease towards regional extirpation. Fisheries bycatch remains the most serious threat to EP leatherbacks while at foraging grounds off South America; however, no comprehensive study has assessed its impact around nesting and internesting areas. Therefore, the aim of this study was to assess leatherback bycatch from artisanal fisheries in countries where these data were lacking. Local, in-country partners of the LAUD OPO network conducted a rapid bycatch assessment in Mexico, Nicaragua, and Costa Rica. Using direct survey methods, a total of 933 artisanal fishers were surveyed in 48 ports (Mexico: n=709 fishers, 37 ports; Nicaragua: n= 110 fishers, 6 ports; Costa Rica: n= 114 fishers, 5 ports), representing on average over 30% of the fishing fleet per port for Nicaragua and Costa Rica, and 6% per port for Mexico. Gillnets were the most frequently reported gear by Mexican (50%) and Nicaraguan (55%) fishers, while longlines were most commonly used in Costa Rica (51%). In all countries, over 60% of fishers reported sea turtle bycatch, and of these, only between 4% to 15% of fishers reported leatherback bycatch. Across countries, Mexico registered the highest number of leatherbacks bycaught, with an estimated 300 animals captured in the previous year. The estimated average leatherback catch per vessel during the past year was 1 for both Costa Rica (1 ± 0.0) and Nicaragua (1 ± 0.09) and 2.3 (± 0.57) for Mexico. Fishers from Mexico and Nicaragua reported leatherback bycatch almost year-round in gillnets or longlines, while in Costa Rica leatherback bycatch was reported in longlines and concentrated between September and

November, coinciding with the early months of the leatherback nesting season. In Mexico and Costa Rica, most fishers (65% and 75%, respectively) reported leatherbacks as bycaught in good condition while in Nicaragua only 18% of fishers reported leatherbacks bycaught in good condition. All fishers in Costa Rica reported releasing turtles alive and only 76% of fishers did so in Mexico and Nicaragua. Leatherback consumption and sale was reported by 3% and 6% of fishers in Mexico and Nicaragua, respectively. Overall, results of this regional collaboration showed that bycatch occurs near nesting areas, and thus it is a threat spread all along the distribution of the species in the eastern Pacific. Further analyses will incorporate data from Panama and Colombia and will attempt to identify variables that could be driving sea turtle bycatch in the areas surveyed. Interviews with fishers were a useful approach to obtain basic information about sea turtle bycatch more specifically about the EP leatherback population, providing a degree of quantification to additional sources of fishery bycatch and mortality, which can assist in the development of population models and species management.

SMALL-SCALE FISHERMEN & BYCATCH IN BIOKO ISLAND, EQUATORIAL GUINEA: WHAT ABOUT THE TURTLES?*

Aliki Panagopoulou[1,2], Frank V. Paladino[1,3], and Shaya Honarvar[3,4]

[1]*The Leatherback Trust, Fort Wayne, IN, USA*
[2]*Drexel University, Department of Biodiversity, Earth and Environmental Science, Philadelphia, PA, USA*
[3]*Purdue Fort Wayne University, Department of Biology, Fort Wayne, IN, USA*
[4]*Bioko Marine Turtle Program, Malabo, Equatorial Guinea*

Bioko Island in Equatorial Guinea hosts important nesting areas for leatherback (*Dermochelys coriacea*) and green (*Chelonia mydas*) turtles. The marine waters around the island host habitats for leatherback, green, olive ridley (*Lepidochelys olivacea*), hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*) turtles. Therefore, incidental captures in fisheries operating in the marine area surrounding Bioko may be a serious threat for resident turtles and nesting adults alike and may exacerbate an existing occurrence of turtle meat consumption in the area. The purpose of our study was to collect information on the little-studied small-scale fishermen of Bioko Island and their fishing practices, assess possible interactions with sea turtles end explore views and perceptions on sea turtles especially in relation to bycatch and consumption. Between September and December 2017, we visited 15 small-scale fishing ports around Bioko Island including the towns of Luba and Riaba and conducted 93 questionnaire-based interviews with small-scale fishermen. Our results show that Bioko small-scale fishermen fish for subsistence but also supply Equatoguinean markets. The fleet is characterized by the use of canoes called 'cayucos', ranging from 2 to 11 m, using oars or a small-powered outboard motor, carrying a crew of 1-7 people. Fishing generally occurs close to the shore and the dominant type of gear used is hook and line, gill nets and spear. Nearly all respondents report encountering all 5 turtle species known to frequent the waters surrounding Bioko, with approximately half of them stating that turtles have been captured in their gear. Turtles are not considered a major threat to respondents or the local fishery, however sharks and cetaceans are presented as exhibiting the most captures and causing most damages to gear. In addition, contamination as a result of the presence of marine debris and oil exploration are blamed for observed decreases both in sea turtle populations and fish stocks. Nearly a third of respondents stated that some fishermen in the community purposefully hunt for turtles, or that the turtles that are incidentally caught are subsequently consumed or sold in the local markets. Our study has provided some important information related to the small-scale fishing activity around Bioko Island and revealed that incidental capture of sea turtles in fishing gear may be a major conservation issue for local turtle populations. In addition, respondents have provided clues that consumption of turtle meat is a more frequent occurrence that previously thought. This, combined with the known poaching incidents involving nesting females for the purposes of trade and consumption, suggest that there is a need for action addressing this grave conservation issue.

EFFECTIVE OUTREACH TO THE GULF OF MEXICO SHRIMP FISHERY LEADS TO INCREASE IN TED COMPLIANCE AND REDUCTION IN INCIDENTAL CAPTURE OF SEA TURTLES*

Pamela Plotkin, Tony Reisinger, and Gary Graham

Texas Sea Grant at Texas A&M University, College Station, TX, USA

We provided comprehensive outreach and training to shrimp fishermen in the Gulf of Mexico from 2014 through 2017. During this project we worked one-on-one with shrimp fishermen on the docks and aboard their vessels to teach them how to correctly install, operate and maintain TEDs. We certified training for vessels that take part in Fisheries Improvement Programs (FIPs) to document that they were trained in the correct installation, operation and maintenance of TEDs. This training certification helped these vessels gain access to specific markets that require such information to assess sustainability of the catch. We also provided annual inspections of vessels and TEDs. We trained 1,665 fishermen aboard 557 vessels, inspected 1,352 TEDs and nets, and distributed 1,880 publications/outreach materials. This training increased awareness among the fishermen about how to properly install and operate TEDs, resulted in higher compliance rates fleet-wide and significantly reduced incidental capture of sea turtles. Training certifications were used by vessels participating in FIPs (N=344) to demonstrate they were trained and inspected and their catch qualified as sustainable. This part of our project gained momentum throughout the performance period as more buyers began participating. Key results from this project include the following: (1) There is a significant need for continued annual training of fishermen in the Gulf of Mexico shrimp fishery because of the very high turnover rate of deck hands (2) the majority of deck hands we trained either had never received formal training to learn how to install, operate and maintain a TED, or had not received this training in recent years (3) following training, fishermen were able to articulate how correct installation, operation and maintenance of TEDS reduce impacts to sea turtles and other non-target species, increase shrimp capture, and result in compliant fishing gear (4) Most TED deficiencies encountered were minor (5) Some of the TEDs constructed and sold by net shops to fishermen are not compliant and there is no quality control (6) If TED training is sustained at high levels, occurs annually and is done by trained professionals who are trusted by the fishermen, compliance with federal TED regulations will increase and sea turtle incidental capture and mortality will decrease.

COMPARISON OF ILLEGAL EGG HARVEST AND PREDATION RATES OF NESTS AT TWO ECOLOGICALLY SEPARATED OLIVE RIDLEY TURTLE NESTING BEACHES ON THE SOUTHERN NICOYA PENINSULA, COSTA RICA

Janie Reavis[1], Carmen Mejías-Balsalobre[2], Isabel Naranjo[2], Randall Arauz[3,4], Daniela Rojas-Cañizales[2], and Jesse Senko[1]

[1]*Arizona State University, Tempe, AZ, USA*
[2]*CREMA, Rescue Center for Endangered Marine Species, Costa Rica*
[3]*Fins Attached Marine Research and Conservation, Colorado Springs, CO, USA*
[4]*Migramar, Olema, CA, USA*

Human consumption of marine turtle eggs, meat, and other products is considered to be a major threat to sea turtle populations worldwide. Declining populations are often attributed to anthropogenic pressures; however, depredation by natural or feral species such as raccoons, crabs, and dogs are often unknown. A popular tool for the conservation of marine turtle eggs is hatcheries, but their protection is limited by factors such as carrying capacity and timing or location of nests. The Rescue Center for Endangered Marine Species (CREMA) runs four sea turtle conservation projects on the nesting beaches of the Southern Nicoya Peninsula in Costa Rica, where the predominant nesting activity is from Olive Ridley turtles (*Lepidochelys olivacea*), followed by sporadic Green (*Chelonia mydas*), Leatherback (*Dermochelys coriacea*), and Hawksbill turtles (*Eretmochelys imbricata*). Two of these nesting projects are based in Costa de Oro and San Miguel, which are adjacent beaches divided by an estuary. Both projects use a hatchery where nests are usually relocated; however, when the hatchery is not available, nests are either relocated or left in situ at the beach. The aim of this study is to: 1) compare human consumption and depredation rates of nests relocated and left in situ; and 2) determine the primary drivers mediating hatching rates on these two adjacent nesting beaches with differing human populations. We reviewed data collected from 2012 to 2018 of nests relocated and left in situ at both nesting sites, and these data represent nesting conditions prior to relocation to a hatchery. We found that the nesting beach at Costa de Oro exhibits high rates of human harvest, which increases later in the nesting season, while San Miguel exhibits comparatively low egg harvest but much higher depredation, also increasing later in the nesting season. For example, during the 2017 nesting season, depredation rates in San Miguel rose from 6% in July to approximately 31% in November while human harvest in Costa de Oro increased from 9% in July to 24% in December. These are preliminary results that will soon be a part of a larger analysis of all nesting data from 2012 to 2018. Our results demonstrate that different pressures impact hatching success in the Southern Nicoya Peninsula along with natural threats, possibly due to contrasting community values and human populations. San Miguel has been protecting nests for over 20 years, whereas the Costa de Oro project only began in 2012. It also important to consider that depredation on the San Miguel nesting beach may be increased by human pressure such as in the case of domesticated animals, especially when the human population in San Miguel is consistently higher than in Costa de Oro. Persistence of depredation and human egg harvest alongside conservation efforts exhibit the prevalence of these pressures and suggest increased pressure if measures such as nightly patrols and hatchery protection were not utilized. We suggest a continuation of hatchery and patrol-based conservation efforts as well as community outreach to attempt to merge cultural values with sea turtle conservation.

SIXTEEN YEARS OF STRANDINGS MONITORING IN AN IMPORTANT FEEDING AND DEVELOPMENT AREA FOR SEA TURTLES IN URUGUAY

Marina Belen Reyes[1,2], Natalia S. Teryda[1,3], Candela Buteler[1], Daniel González-Paredes[1,4], Florencia David[1,2], María Dolores Guitard[1], Alejandro Fallabrino[1], Andres Estrades[1], and Gabriela M. Vélez-Rubio[1,5]

[1]ONG Karumbé, Investigación y Conservación de tortugas marinas, Montevideo, Uruguay
[2]Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina
[3]School of Natural Resourses and Environment, University of Florida, Gainesville, FL, USA
[4]College of Science and Engineering, James Cook University, Townsville (QLD), Australia
[5]Centro Universitario Regional del Este (CURE), Universidad de la República, Uruguay

Long-term stranding analysis represents a useful tool for habitat use studies by providing an estimation of the species distribution. However, this kind of analysis should be complemented with other studies due to possible biases. Previous stranding studies have shown that the Uruguayan coastal waters are an important feeding ground for mainly three sea turtle species, *Chelonia mydas*, *Caretta caretta* and *Dermochelys coriacea*. Therefore, the aim of this study is to characterize sea turtle stranding events occurred along part of the coast of Department of Rocha (Uruguay) between 2002 and 2018. Stranding events were analyzed during 16 years between the localities of Barra del Chuy (limit with Brazil) and Punta del Diablo (ca. 50 km). Data came from two data sources: [1] reports provided to the Marine Turtle Stranding Network ran by Karumbe NGO; [2] data from beach surveys conducted by Karumbe's technicians during the summer months (four months per year). A stranding was considered as any turtle, or it remains, dead or alive that washed ashore. For each individual, date, location, species and decomposition state were recorded. Additionally, CCL was measured, and when possible, a necropsy was performed to determinate the cause of death/stranding. Alive individuals were transported to Karumbe's rehabilitation center for treatment. For the period 2002-2018, a total of 1346 stranded turtles were recorded (annual mean±SD=79.1±43.2, range 24–160) from the stranding network and beach surveys. Almost for all the years the most frequent species was the green turtle (n=948, 70%), followed by loggerhead turtle (n=349, 26%) and leatherback turtle (n=40; 3%). Sporadic strandings of hawksbill turtle (n=5) and olive ridley (n=4) were registered. This result is consistent with previous studies including all the Uruguayan coast. All green turtles were considered as juveniles with mean curve carapace length of 39.54 ± 7.08 cm (mean CCL ± SD, n=948). Loggerhead turtle [71.10 ± 13.21 cm (n=439)] and leatherback turtles [132.54 ± 8.92 cm (n=40)] registered were considered as late juvenile and adults. In regards to the state of the stranded turtles, it was found that 72% of the reports (n=969) were dead stranded turtles in different stages of decomposition, while 38% were reported alive (n=379). For green turtles, 56% (n=545) were found alive or freshly dead, indicating a high use of the Uruguayan coastal waters by juvenile individuals of this species. Although in most cases (74.38%, n=897) the cause of stranding for green turtles could not be determined, the main causes of stranding were determined as interaction with marine debris (8.37%, n=101) and interaction with fisheries (7.63%, n=92). Long-term stranding analysis in feeding areas is essential for the study of juvenile turtle regional stocks and their threats. Also, it is imperative to highlight the importance of the community's involvement and collaboration, which represents a huge contribution with data collection and, at the same time, creates conservation awareness around the sea turtle species inhabiting Uruguayan waters.

FISHERIES BYCATCH ASSESMENT FOR SEA TURTLES OFF THE COAST OF COLOMBIA AND PANAMA

Juan M. Rguez-Baron[1,2], Mariano E. Abrego[3],Ana K. Gomez[2],Emiliano Zambrano[4], and Amanda S. Williard[1]

[1]*Department of Biology and Marine Biology, University of North Carolina, Wilmington, NC, USA*
[2]*JUSTSEA Foundation, Bogota, Colombia*
[3]*Departamento de Conservacion de Recursos Costeros y Marinos, Direccion de Costas y Mares, Ministerio de Ambiente de Panama*
[4]*E.A.T. Asesorias Pesqueras, Colombia*

Fisheries bycatch is considered as a major driver in declines of several sea turtle populations. Those unintentional catches are product of a combination of fisheries and biological factors, such as, fishing effort, gear, and distribution, with the life history of sea turtles (e.g., late maturity, long life span) and life-cycle traits (e.g., distinct ontogenetic habitats, separate breeding and feeding grounds). Although in the last decades several initiatives have been developed for understanding the features of bycatch in order to minimize its impacts, there still are some challenges for working to, for instance, direct observation of bycatch normally is <5% of total fishing effort, and rarely occurs in small-scale fisheries. This is especially critical for developing countries, where the governance and fisheries management are poor. Colombia and Panama are considered data-deficient regions in terms of bycatch risks for marine megafauna, for that reason the action plans for leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*) sea turtles recommended the expansion of port-based sea turtle bycatch assessments. From this framework, in 2016 we started a scalable project in order to generate the information for evaluating the scale and range of fishing effort, and the nature and frequency of fishing interactions and their potential effects on sea turtles' conservation. The methods we used were as follow, 1) we conducted comprehensive bycatch assessment surveys at multiple ports in Colombia and Panama, 2) through citizen science conducted by fishers, we collected factual bycatch data from six fishing ports on a year-round period, and 3) on-board fisheries observers were deployed in areas with high potential for sea turtle interactions, as identified through previously conducted port-side surveys of fishermen.

USING DRONES TO INVESTIGATE THE BEHAVIOURAL RESPONSES OF GREEN SEA TURTLES TO BOAT TRAFFIC: CONSIDERATIONS FOR BOAT-STRIKES AND PREDATOR AVOIDANCE*

Nathan J. Robinson, Bill Bigelow, Jack Cuffley, Candance Fields, Alex Smith, and Ana Miguel Blanco

Cape Eleuthera Institute, Rock Sound, Eleuthera, The Bahamas

Boat strikes are a well-known threat to sea turtle populations worldwide. Even though much has been learned about boat strikes by examining injuries on dead or stranded turtles, there is a distinct lack of empirical data on how free-swimming turtles respond to nearby boat traffic. Consequently, it is not well understood how individual turtles differ in their behavioural responses to passing boats and how this influences their susceptibility to boat strikes. To address this knowledge gap, we used drones to record how juvenile green turtles *Chelonia mydas* in the coastal waters of Eleuthera, The Bahamas responded to being approached by boat. Several shallow (>2m) sites around Eleuthera were opportunistically surveyed for green turtles using a drone (DJI Phantom 4 Pro). Once a turtle was spotted, the drone was flown directly above the turtle and maintained at an altitude of 25 m. The drone would remain above the turtle for a minimum of 1 min. After this, the turtle was approached by boat at a speed of ~8 km/h. When the turtle made its initial flight response away from the boat, we continued to pursue the turtle by boat for a minimum of 4 min. After this turtle, the turtle's movement speed had often slowed down significantly and so it was now possible for snorkelers to enter the water and attempt to capture the turtle using the modified 'rodeo' technique that is typical for in-water capture of juvenile turtles. Once the turtle was captured, it was tagged using metal flipper tags and its carapace length was measured. We analysed the video footage from the drone post-hence to determine: (1) the distance from the boat at which the turtle first elicited a behavioural response, (2) the maximum movement speed during its flight response, and (3) the time required for the turtle to return to its pre-disturbance movement speed. We determined each of these factors by converting the drone footage into individual photographs, each 5 sec apart and then overlaying these images on one another. From the composite image, it was possible to calculate the distance moved by the turtle per 5 sec interval as well as the distance from the boat at which the turtle begun its flight response. The boat was used for scale. From our preliminary analyses, it appears that there are important differences in how sea turtles respond to boat traffic based on their size. Smaller turtles appear to elicit a flight response to passing boats at greater distances and swim away much faster, albeit for shorter periods of time, than larger turtles. In constrast, the more subdued response exhibited by larger turtles in response to passing boat traffic could mean that larger individuals are more likely to be subject to boat strikes. This finding highlights the importance of 'turtle-friendly' boating laws, especially in areas with sub-adult or adult turtles.

THE GULF OF VENEZUELA: A CRUCIAL HABITAT FOR IMMATURE HAWKSBILL TURTLES IN THE SOUTHERN CARIBBEAN, NEW EVIDENCES

Maria Jose Petit Rodriguez[1,2], Daniela Rojas-Cañizales[1,3], María Gabriela Sandoval Ferrer[1,2], Jordano Palmar[1], Martín Oquendo[1], Nínive Espinoza[1], Natalie Wildermann[1,4,5], Mark Hamann[6], and Héctor Barrios-Garrido[1,2,4,5,6]

[1]Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV)
[2]Laboratorio de Ecología General. La Universidad del Zulia (LUZ). Venezuela
[3]Rescue Center for Endangered Marine Species (CREMA)
[4]Marine Turtle Research, Ecology and Conservation Group, Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL, USA
[5]Centro de Modelado Científico (CMC). La Universidad del Zulia (LUZ) Venezuela
[6]TropWATER – Centre for Tropical Water and Aquatic Ecosystem Research; College of Marine and Environmental Sciences, James Cook University, Townsville, Australia

Hawksbill turtle (*Eretmochelys imbricata*) is considered worldwide as a critically endangered species. Its presence in the waters of the southern Caribbean, and especially in the Gulf of Venezuela (GV), is associated with local reef areas since these ecosystems are considered their significant feeding zone. In the GV, hawksbill turtle is the second most frequent sea turtle species. To assess their spatio-temporal distribution and frequency by size (juvenile and adult individuals), the available stranding data on the species (Curved Carapace Length-CCL; and GPS location) in the study area were compiled and analyzed (2005-2017). Following previous authors, the GV was divided into 3 zones (Lower, Middle, and Upper Guajira) to assess population attributes of interest and its spatio-temporal distribution. 109 records were counted, of which 23 could not be categorized (high weathering or incomplete shells), of these, 75.2% were registered as immatures and the rest as adult-size animals (based in the available data for the Caribbean Basin). Hawksbill turtle's presence was evident throughout the year (two peaks in rainy season). There were small differences in the relative frequency throughout the three zones of immature and adult-size individuals; however, these differences were not statistically significant (Chi-square test). Nonetheless, immature animals were more frequent registered in the Lower and Middle Guajira (sandy bottoms and seagrass beds), and adult-size individuals were more frequently observed in the Upper zone (abundant in coral patches and marine sponges). The largest number of individuals corresponds to sizes with CCL between 31 and 60cm. In view of the current worldwide state of hawksbill turtle's populations, juvenile individuals are considered a global priority hence, information based on population dynamics and habitat use will inform effective conservation strategies and efforts for the population stocks of the hawksbill turtle in the southern Caribbean and the GV taking into account its illegal take and use by local communities is yet to be assessed.

LATEST OVERVIEW OF THE MARINE TURTLES STRANDINGS AT SOUTHERN GULF OF VENEZUELA: BIG PROBLEMS, URGENT SOLUTIONS

Maria Alejandra Rodriguez[1,2], Daniela Rojas-Cañizales[1,2,3], Miguel Vásquez-Matusalen[1], María José Petit-Rodríguez[1,2], Nínive Espinoza[1], Natalie Wildermann[1,2,4,5], and Héctor Barrios-Garrido[1,2,4,5,6]

[1]*Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV)*
[2]*Laboratorio de Ecología General. La Universidad del Zulia (LUZ), Venezuela*
[3]*Rescue Center for Endangered Marine Species (CREMA), Costa Rica*
[4]*Centro de Modelado Científico (CMC) La Universidad del Zulia (LUZ), Venezuela*
[5]*Marine Turtle Research, Ecology and Conservation Group, Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL, USA*
[6]*TropWATER – Centre for Tropical Water and Aquatic Ecosystem Research; College of Marine and Environmental Sciences, James Cook University, Townsville, Australia*

In the last decade, stranding marine turtles are getting more common. Factors such as diseases; boat strikes, marine debris ingestion, and by-catch are the main causes of the increase of stranding records. It is challenging to document this problem in Venezuela; the difficult access, the economic crisis and the scarcity of personnel have led to a lack of information about the real situation on the beaches. In Southern Gulf of Venezuela (GV) five species of marine turtles converged in the feeding grounds, Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Loggerhead (*Caretta caretta*), Leatherback (*Dermochelys coriacea*) and Olive Ridley (*Lepidochelys olivacea*) turtles. The aim of this study is to present the latest records of stranded marine turtles in Southern GV. From 2012 to 2015 we conducted censuses in Zapara Island and Quisiro beach, to record the stranding marine turtles. Marine turtle remains were identified and information of each record was registered including biometric measurements (Curve Carapace Length CCL, as priority), possible cause of death, and the state of decomposition of the carcasses from 0 (alive) to 6 (only bones). A total of 26 stranding marine turtles were documented in Zapara Island (n=13, 50%), and Quisiro beach (n=13, 50%). All five species were found; the most common were the Leatherback turtles (n=15, 57.7%), followed by Hawskbill (n=4, 14.5%), Green (n=3, 11.5%), Loggerhead (n=2, 6.7%) and Olive Ridley (n=2, 6.7%). Although in both beaches was recorded the same number of marine turtles strandings the total amount for each species was different. Leatherbacks were the most frequent species in Quisiro beach (n=9, 69.2%), followed by Hawksbill (n=3, 23.0%) and Green turtles (n=1, 7.7%), while Isla Zapara reported 6 (46.1%), 1(7.7%) and 2 (7.7%) respectively. However, Loggerheads (n=2, 15.4%) and Olive Ridleys (n=2, 15.4%) were only documented in Isla Zapara. Based on the CCL measurements, most of the animals were immature. According to the state of decomposition of stranding turtles found, three were fresh or recently dead (category 2), and the rest were in an advanced state of decomposition (categories ranging between 3 and 6). The stranding turtles usually were missing the head or the flippers and presented injuries in their carapace. The concentration of stranding marine turtles in the southern GV is likely to be related to the strong local currents that occur in this area of the GV. The five species of stranding turtles documented on the present study matches with the historical distribution of marine turtles in the area. This study constitutes the latest assessment of this threat on the Southern GV, the lack of knowledge on this topic since 2015 is disquieting considering the current situation of Venezuela and the potential pressures that feeding grounds maybe suffering by overfishing and IUU (Illegal, Unreported, and Unregulated) fishing practices linked to smuggling of aquatic bushmeat. A more complete and updated assessment is needed; however, the logistics are still challenging mainly due to the current economic crisis (reflected on its hyperinflation rate) of the country.

DEMOGRAPHICS OF SEA TURTLES BYCAUGHT IN THE RECREATIONAL HOOK AND LINE FISHERY IN VIRGINIA, USA*

Sarah A. Rose, Erin B. Bates, and Susan G. Barco

Virginia Aquarium, Virginia Beach, VA, USA

In recent years, reports of sea turtles “hooked” by recreational anglers, primarily at fishing piers, have increased drastically in Virginia. From 2008-2012, an average of three turtles were reported “hooked” by recreational anglers. In 2013, 18 interactions were reported, with seven (39%), all loggerhead sea turtles, collected for exam and rehabilitation. Of these seven, 86% (n=6) contained secondary hooks and 71% (n=5) exhibited secondary conditions. In 2014, we began consistent data collection and initiated the Virginia Pier Partner Program (VPPP), an outreach campaign that emphasized the reporting and safe retrieval of hooked turtles, to better understand and address interactions. With these VPPP efforts, 250 interactions have been reported since 2014, 92% (n=229) were reported at fishing piers. As part of VPPP data collection, anglers were interviewed after reporting an interaction with a sea turtle, regardless of whether the animal was collected for exam. Interviews gauged the fishing habits of anglers, including bait and gear type, target species, how the turtle was recovered onto the pier, and how anglers knew to report the animal. For turtles that were recovered, data on hook type, the nature of hook interaction (ingested, “fair” hooked, or externally, “foul” hooked), health parameters, radiographs, and bloodwork were collected. Of the 250 recreational gear interactions reported from 2014 to October 2018, 170 turtles were recovered for exam. The number of turtles presenting with secondary conditions decreased within this study period. Kemp’s ridley sea turtles comprised the majority (86.5%) of animals recovered, with 147 admitted for exam. Nineteen loggerheads were recovered (11.2%), and four green sea turtles were encountered during the study period (2.4%). All recovered turtles were juveniles. Secondary hooks occurred in 14.1% of turtles, with 10.2% (n=15) in Kemp’s ridleys and 47.3% (n=9) in loggerheads, including two loggerheads that contained tertiary hooks. This difference between species is significant (p-value = 0.00001459), using Pearson’s Chi-squared test. The number of fair versus foul hooking varied between the groups, with fair hooks confirmed in 73.2% of Kemp’s ridleys and 64.1% in loggerheads, though the difference was not significant (p-value = 0.1826). Bait type was also documented and analyzed for all reported interactions from 2014-2017. The main bait types reported for fair hooked turtles (where it was assumed the turtle purposely ingested bait) were squid (45%), cut fish (37%), and shrimp (8%). Preliminary data from surveyed pier anglers suggests that the most common bait used at fishing piers weren’t consistent with those used when interactions occurred. Six bait types represented 94% of the bait described by pier anglers, including: squid (28%), cut fish (20%), bloodworms (17%), shrimp (14%), artificial “flavored” bait (10%), and live fish (6%). The disparity between these groups suggests that turtles may target specific bait when depredating from fishing gear, raising the possibility that anglers who switch bait to a less-preferred option may reduce their likelihood of turtle interactions. The majority of turtles reported since 2014 were otherwise healthy apart from trauma associated with the recent gear interaction, as evidenced by the low number of secondary conditions upon time of admit, blood work analysis and body condition. Additionally, the apparent preference of specific types of bait pursued by the fair-hooked animals may be taken into consideration to mitigate interactions.

LEATHERBACK SEA TURTLE STRANDINGS IN THE GREATER ATLANTIC REGION (MAINE THROUGH VIRGINIA) OF THE UNITED STATES

Kate Sampson

NOAA Fisheries

Stranded and incidentally captured leatherback sea turtles, *Dermochelys coriacea*, are documented at higher levels in the Greater Atlantic Region (Maine through Virginia) than in any other area of the United States. Stranded turtles are documented by the Sea Turtle Stranding and Salvage Network (STSSN), made up of dedicated non-profit organizations, and state and federal agencies. Entangled turtles are responded to by the Sea Turtle Disentanglement Network, which involves many of the same STSSN organizations that have received special training to safely disentangle and document sea turtle entanglements. Leatherback sea turtles are in our region from May through November and, unfortunately, during their residency they overlap with high levels of fishing and vessel activity. In the ten-year period of 2008-2017, the two networks documented a total of 677 leatherbacks. The highest number of strandings and incidental captures was in Massachusetts (348, 51.4%), where leatherback distribution overlaps with pot gear fisheries and end line entanglements are common. Cause of stranding could be identified for 62.2% of the cases (421 turtles). In some events (256, 37.8%), the Networks were unable to identify a cause of stranding. These cases were typically not thoroughly examined due to state of decomposition, stranding location, or other limiting circumstance. Of the turtles with known cause of stranding, 273 (64.8%) were identified as fishing gear entanglement, the highest of any other documented cause. Of these, 249 involved the end line of pot gear fisheries. Lobster pot gear was identified most frequently (79 cases), followed by conch pot gear (17 cases). Entanglement in pound nets/weirs, primarily in Virginia, were also documented in 19 cases. Leatherbacks entangled in fishing gear or other line were most often reported alive (79.5%) and many of these were disentangled and released on site. However, injuries from these incidents can be significant and include abrasions, constriction injuries, necrosis, or even partial amputation of flippers. Watercraft interactions were identified in 111 (16.4%) strandings. Most often these cases involved clear propeller or skeg slices, but blunt force trauma was also documented. The highest number of documented watercraft interactions was in Massachusetts. The Networks continue to partner with NOAA Fisheries to document more information in these cases. Understanding the distribution of threats in our region is the first step towards mitigation and recovery of the species, whether it be through outreach or regulation.

NEW FINDING OF ENTANGLEMENT IN NESTING LOGGERHEAD (*CARETTA CARETTA*) FEMALES IN BOA VISTA ISLAND (CAPE VERDE)

M.E. Medina Suárez[1], J. Pinós Crosas[1], and A. Liria Loza[1,2]

[1]*Cabo Verde Natura 2000, Boa Vista Island, Cape Verde*
[2]*University of Las Palmas de Gran Canaria, Gran Canaria, Spain*

The total annual global production of plastics grew from 1.5 million t to 299 million t between 1950 and 2015. Plastic items have become the principal constituent of marine debris, mainly deriving from human activities, such as fishing activities. High concentrations of floating plastic are transported across the globe by winds and oceanic currents and can accumulate in convergence zones or gyres, as well as exposed coastlines. For some species, plastics could present a major threat through ingestion, entanglement, the degradation of key habitats, and wider ecosystem effects. The marine turtles, whose complex life histories and highly mobile behavior can be particularly vulnerable to the impacts of plastic pollution. Marine turtle entanglement in marine debris has been described in the recent years and has been analyzed but is mainly focused on stranded animals or in water observations. Currently, most observations of entanglement in nesting females are anecdotal, but observational monitoring programs could be developed for the many conservation projects operating globally on turtle nesting beaches. Analyze any variation in entanglement rates among species and life stages could be important to better understand vulnerability, particularly for small or isolated populations. Standardized protocols for data collection would facilitate comparisons across regions, studies and over time. The Cape Verde loggerhead rookery started to be monitored in 1998 with the discovery of the first turtle sightings founded in Boa Vista Island by L.F. Lopez-Jurado. Daily census and nesting females monitoring have been conducted each nesting season from 1998 to date by the NGO Cabo Verde Natura 2000 in the most important nesting beaches, located in southeastern Boa Vista Island. Marine turtle entanglement has been observed on few cases of juveniles stranded in several islands (Boa Vista, Sal, Maio and Sao Vicente). But, as in other areas, entanglement on nesting females has been observed sporadically, mainly produced by debris derived from fisheries activities. Nevertheless, during 2018 nesting season, four cases of entanglement has been observed in only 20km of beaches. Different materials are causing entanglement, 3 were caused by nets derived from fisheries industries and 1 were caused by plastic items derived anthropogenic and industrial uses.

HOW MUCH IS TOO MUCH? A QUANTITATIVE ANALYSIS LINKING SEA TURTLE MORTALITY AND PLASTIC DEBRIS INGESTION*

Chris Wilcox[1], Melody Puckridge[1], Qamar Schuyler[1,2], Kathy Townsend[3], and Britta Denise Hardesty[1]

[1]*Oceans and Atmosphere, Commonwealth Scientific and Industrial Research Organisation, Hobart, Tasmania, Australia*
[2]*University of Queensland Moreton Bay Research Station, Dunwich, North Stradbroke Island, Queensland, Australia*
[3]*University of the Sunshine Coast, Fraser Coast, University of Queensland Moreton Bay Research Station, School of Biological Sciences, University of Queensland*

Plastic in the marine environment is a growing environmental issue. Sea turtles are at significant risk of ingesting plastic debris at all stages of their lifecycle with potentially lethal consequences. We tested the relationship between the amount of plastic a turtle has ingested and the likelihood of death, treating animals that died of known causes unrelated to plastic ingestion as a statistical control group. We utilized two datasets; one based on necropsies of 246 sea turtles and a second using 706 records extracted from a national strandings database. Animals dying of known causes unrelated to plastic ingestion had less plastic in their gut than those that died of either indeterminate causes or due to plastic ingestion directly (e.g., via gut impaction and perforation). We found a 50% probability of mortality once an animal had 14 pieces of plastic in its gut. Our results provide the critical link between recent estimates of plastic ingestion and the population effects of this environmental threat.

GLOBAL TRAFFICKING OF MARINE TURTLES*

Jesse Senko[1,2], Janie Reavis[1], Maria del Mar Mancha-Cisneros[3], Irene Kelly[4], John Wang[4], Frances Humber[5], Andrew T. Smith[1], Annette C. Broderick[6,7], Brendan J. Godley[6,7], and Bryan Wallace[8]

[1]*School of Life Sciences, Arizona State University, Tempe, AZ, USA*
[2]*School for the Future of Innovation in Society, Arizona State University, Tempe, AZ, USA*
[3]*Nicholas School of the Environment, Duke University Marine Lab, Beaufort, NC, USA*
[4]*NOAA Fisheries, Pacific Islands Regional office, Honolulu, HI, USA*
[5]*Blue Ventures Conservation, London N7 9DP, UK*
[6]*Marine Turtle Research Group, Centre for Ecology and Conservation, University of Exeter, Penryn, Cornwall, UK*
[7]*College of Life and Environmental Sciences, University of Exeter, Cornwall Campus, Penryn UK*
[8]*Conservation Science Partners, Inc., Fort Collins, CO, USA*

Illegal trafficking of wildlife is the third most valuable illicit global market after drugs and firearms. Harvest of marine turtle meat and products – both legal and illegal – is known to be a threat to populations in coastal areas worldwide, but the global magnitude and extent of trafficking in marine turtle products remains unquantified. Here we review primary and grey literature as well as archived media reports and surveys of in-country experts to provide the first global assessment of marine turtle trafficking. We characterize and evaluate the global magnitude and extent of trafficking, including the scale and species breakdown at country level, relative impacts to regional management units (RMUs), data sources and research gaps, market drivers, and known or suspected centers of supply and demand as well as trafficking routes.

SEA TURTLE POACHING HOTSPOTS IN THE GULF OF VENEZUELA: MERGING SCIENTIFIC AND INDIGENOUS ECOLOGICAL KNOWLEDGE*

Kelly Soluri[1], Maria Gabriela Montiel-Villalobos[2,3], Daniela Rojas-Cañizales[4,5], Natalie Wildermann[1,2,3], Mariana M.P.B. Fuentes[1], Mark Hamann[6], and Hector Barrios-Garrido[1,2,3,6,7]

[1]*Marine Turtle Research, Ecology and Conservation Group, Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL, USA*
[2]*Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV), Maracaibo, Zulia, Venezuela*
[3]*Laboratorio de Ecología y Genética de Poblaciones, Centro de Ecología, Instituto Venezolano de Investigaciones Científicas (IVIC), Caracas, DF, Venezuela*
[4]*Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV), Maracaibo, Zulia, Venezuela*
[5]*Rescue Center for Endangered Marine Species (CREMA), San Francisco de Coyote, Guanacaste, Costa Rica*
[6]*TropWATER – Centre for Tropical Water and Aquatic Ecosystem Research; College of Marine and Environmental Sciences, James Cook University, Townsville, Queensland, Australia*
[7]*Laboratorio de Ecología General. Centro de Modelado Científico (CMC). La Universidad del Zulia (LUZ), Maracaibo, Zulia, Venezuela*

The practice of sea turtle poaching is prevalent in the Wayuu indigenous communities of the Guajira Peninsula which borders the Gulf of Venezuela (GV) and the Caribbean. For generations, Wayuu sea turtle poachers have used sea bottoms such as coral reefs and seagrass meadows for fishing in order to capture sea turtles. Previous authors defined this area as a "Highest Extraction Zone (HEZ)"; however, herein we compiled and merged 211 data points along linear transects with observations carried out southwards in the HEZ to identify critical areas for sea turtle protection in the Gulf of Venezuela. In these areas, seagrass meadows contained *Thalassia testudines*, *Siringodium filiforme*, and *Halodule wrightii*, which are known to be a part of a green sea turtle habitat. The stony coral reefs found in the GV also host many sponges (e.g., *Chondrilla caribensis*) which attract spongivores such as hawksbill turtles. Separate studies have been done on the population structure of hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) turtles and their habitats but have not been combined. GPS points and data plots were collected of different known sea turtle habitats, turtle strandings, and sightings using scientific patrols in artisanal ports. Additionally, using informal interviews and direct observation from the fishermen of the nearby communities, we identified places where turtle nets are set all year-round in the HEZ and outside of it, and merged these with biological data from the nets placed on the sea bottom. Using ArcGIS software, the ecological and traditional data was layered to show the hot spots of poaching activity in the Gulf of Venezuela and distribution of marine turtle sightings to prioritize certain high-risk areas for conservation. Our interviewees confirmed that they selected species specific sites; for example, southern sites are used to harvest immature green and hawksbill turtles, mainly for local and traditional use (consumption, medicine, etc.); whereas northern areas are used to capture mature green turtles and immature and adult hawksbill turtles (these larger animals being used mainly for illegal commerce). When key areas for conservation are singled out, perhaps it will make the efforts against illegal poaching more efficient. The unusual combination of extensive available foraging habitat, high index relative abundance, the presence of larger size classes, along with continued turtle fishing pressure, highlights the importance of the GV both as a foraging ground for immature individuals of *C. mydas* and *E. imbricata* in the Caribbean, and as a location of interest for future monitoring.

ENVIRONMENTAL IMPACTS ON LEATHERBACK SEA TURTLE HEALTH: USING A ONE HEALTH APPROACH TO STUDY METAL POLLUTION IN WILDLIFE*

Rachel M. Speer[1], Catherine F. Wise[2], Sandra S. Wise[1], Mark Martin Bras[3], Mike Barandiaran[4], Erick Bermúdez[4], Lirio Márquez-D'Acunti[3], and John Pierce Wise, Sr.[1]

[1]*University of Louisville, Louisville, KY, USA*
[2]*North Carolina State University, Raleigh, North Carolina* [3]*Vieques Conservation and Historical Trust, Vieques, Puerto Rico*
[4]*U.S. Fish and Wildlife Service, Vieques, Puerto Rico*

The concept of 'one' environmental health posits that humans, animals, and the ecosystem share a common environment and therefore, what affects the health of one impacts the health of all. While toxicological impacts on human health are readily investigated, toxicological-impact studies in wildlife and the ecosystem lag far behind. We have applied the 'One Environmental Health' approach in metal toxicology using leatherback sea turtles (*Dermochelys coriacea*) as a target study species. Leatherback sea turtles are highly endangered and experience many human derived threats including habitat degradation, entanglement in fishing gear, and pollution of their environment. Thus, we study leatherbacks to understand the threat of metal pollution to them, to monitor the health of the oceans, and to better understand human health. Vieques, Puerto Rico is a high nesting location for leatherback sea turtles providing excellent study opportunities and the ability to involve the local community in an educational scientific research program. Metals such as hexavalent chromium [Cr(VI)] are known to have many adverse health effects including immune system dysfunction, decreased reproductive success, and the development of cancers. Additionally, Cr(VI) is a known global marine environment pollutant and studies report Cr levels in sea turtle tissues and other marine species including whales. In this study we have employed several methods to evaluate leatherback health in the context of metals toxicology: 1) We collected tissue samples across 5 years to measure metal levels including Cr(VI); 2) We characterized the karyotypes and baseline chromosome damage levels in cell lines from multiple leatherback individuals to monitor the population; and 3) We established primary leatherback cell lines to measure Cr(VI) induced cytotoxicity, genotoxicity, and the DNA repair response and compared those outcomes to the same endpoints in human cells. We found leatherbacks are at risk to exposure to metals in the environment and have established baseline toxicological standards for this species. Additionally, we found Cr(VI) was cytotoxic and genotoxic to leatherback lung cells and these results were similar to those in human lung cells.

SEA TURTLE BYCATCH TRENDS IN THE U.S. ATLANTIC PELAGIC LONGLINE FISHERY

Lesley W. Stokes and Lance P. Garrison

National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL, USA

Incidental capture in commercial fisheries has been identified as a major threat to sea turtles worldwide. The National Marine Fisheries Service (NMFS) operates the Pelagic Observer Program (POP) to collect catch and bycatch data from U.S. commercial fisheries. From 2010-2016, observers monitored an average of 12.4% (range 8.5 – 16.8%) of the fleet's fishing effort, collecting data on gear characteristics, target catch, and protected species interactions. Total bycatch of sea turtles in the longline fishery is estimated annually using data from the observer program and a mandatory fishery logbook system (FLS). Estimated interaction levels fluctuate with reported fishing effort, but leatherback and loggerhead interactions have declined since historically high levels. Leatherback take levels peaked in 2004 following a sharp increase since 1998, but a sharp decrease in leatherback bycatch rates began in 2005 after new regulations were implemented. Loggerhead interaction levels peaked in the mid-1990's and have declined since 1998, following a cyclic pattern of general increase over a three-to-four-year period, followed by a sharp decline. There has been a decrease in leatherback bycatch levels since 2004, but not loggerheads, which follow a more cyclic pattern aligned with fishery effort levels. Sea turtle interactions are relatively rare events given the number of strata (i.e., species, season, area), and further research into appropriate analytical tools for these data is warranted. Investigating trends in spatial and temporal bycatch patterns as well as fleet fishing characteristics may contribute to the development of finer scale management actions. However, studying historical bycatch rate trends alone is not enough to determine whether the impact of the fishery on a species is increasing, decreasing, or stable. Understanding sea turtle population abundance and distribution patterns is essential to putting bycatch levels into context when considering the impact of fisheries on these endangered and threatened species.

HIGH-USE AREAS, SEASONAL MOVEMENTS OF SEA TURTLE AND FISHERIES INTERACTION IN SOUTHWESTERN ATLANTIC OCEAN

Laura Prosdocimi[1] and Natalia S. Teryda[2]

[1]Secretaría de Agroindustria, Paseo Colón 982 (1063), Ciudad Autónoma de Buenos Aires, Argentina
[2]School of Natural Resources and Environment, University of Florida, Gainesville, FL, USA

The Rio de La Plata area, defined as the Warm Temperate Southwestern Atlantic (WTSA) province and its adjacent international waters - comprising part of the Argentinean and Uruguayan exclusive economic zones (EEZs) - is a highly important fishing area in the Southwestern Atlantic Ocean. In this the area, bottom trawling is the dominant fishery, mainly targeting white croaker (*Micropogonias furnieri*) and hake (*Merluccius hubbsi*). Within the same area, there are three sea turtle species (*Chelonia mydas, Caretta caretta* and *Dermochelys coriacea*) that interact with this fishery. These species belong to different life cycle stages and come from different nesting beaches in the Atlantic Ocean. Individuals forage in these temperate coastal waters from the end of spring to the beginning of fall when they start migrating northward to warm waters in Brazil. This migration makes the turtles vulnerable to bycatch by the commercial fishing fleet along the way. In the past decade, many satellite-tracking studies of different sea turtle species in the Atlantic Ocean have been published, and each of these studies have given an essential, yet partial, description of habitat use. These studies highlighted the importance of the Rio de La Plata Estuary as a key foraging ground for sea turtles in the WTSA and the need for considering it as central focus of attention for conservation efforts. We present an integrative analysis of the spatio-temporal distribution and habitat use of sea turtles in the Rio de La Plata Estuary. Spatio-temporal data was retrieved from an exhaustive literature search for the area. From peer reviewed publications information such as turtle species, the year of the study and the movement presented by the turtles were recorded. This information was combined with data of trawling fishing effort distribution from the Argentinean Secretary of Agroindustry database across the same time period. Records of nine *C. mydas*, six *C. caretta* and three *D. coriacea* turtles were found in peer reviewed publications comprising the time period of 2006-2013. These animals were monitored with electronic tags with the goal of following their movement after being released in the vicinity of their capture sites. Turtles used the Brazilian, Uruguayan and Argentinean EEZs, presenting seasonal movements along the coast. Individuals migrated towards Brazil during colder months (May-August), while during warmer months (October-November) they migrated southward to Argentina and Uruguay. Data suggests that the Rio de la Plata Estuary is a highly frequented area by different sea turtle species, which overlapped with trawling fisheries operations, representing a high impact risk for the turtles. This is a unique opportunity to identify the areas and seasons of highest turtle susceptibility to bycatch. It also provides much-needed preliminary guidance on the design and implementation of potential bycatch mitigation measures at an oceanic scale. Although turtles and fisheries show highly diverse distributions, we highlighted areas of high susceptibility to bycatch that are worthy of further research and mitigation efforts. Minimizing bycatch, or the unintended capture of non-target species during fisheries operations, is a key component of sustainable fisheries management that maintains marine biodiversity.

INVESTIGATING THE DYNAMICS OF EGG POACHING OF OLIVE RIDLEY TURTLES (LEPIDOCHELYS OLIVACEA) IN PLAYA COROZALITO

Julie Twitchell[1], Carmen Mejías-Balsalobre[1], Isabel Naranjo[1], Randall Arauz[2,3], and Daniela Rojas-Cañizales[1]

[1]*CREMA, Rescue Center for Endangered Marine Species, Costa Rica*
[2]*Fins Attached Marine Research and Conservation, Colorado Springs, CO, USA*
[3]*Migramar, Olema, CA, USA*

Although made illegal in Costa Rica in 1996, with the Ostional National Wildlife Refuge as an exception, the poaching of sea turtle eggs is still an issue that affects many nesting beaches throughout the country. This includes Corozalito beach located on the Southern Nicoya Peninsula, where the Rescue Center for Endangered Marine Species (CREMA) runs a marine turtle conservation project. In Corozalito beach sea turtles nest solitarily and in arribada, both of which are subject to egg poaching. However, it is extremely difficult to record poaching during an arribada due to the massive number of nests and the lack of police enforcement. The present study focuses only on solitary nests. The aim of this study is to explore how poaching has changed for solitary Olive Ridley nests over the seasons 2012 to 2018 on Corozalito beach, and to determine if there are any significant differences between poaching frequencies in sectors and zones of the beach. This study also aims to get a more in-depth view the problem of the poaching by interviewing two key community members. Corozalito beach is 800m long and it is subdivided in 12.5m sectors (1A, 1B, 1C, 2, …15). Nesting activity occurs throughout the entire beach, although the main activity and poaching seem bigger in specific sectors. Night patrols and morning censuses are conducted in Corozalito to document the nesting activity and to collect data. The state of the nest is recorded (A: Anido/Nested, D: Depredado/Depredated, S: Saqueado/Poached) as well as its location (zone and sector). Interviews were semi-structured, consisting of open-ended questions regarding the history of poaching in Corozalito and the subjects' personal views on the issue. Poaching frequencies were analyzed and preliminary results suggest that significantly more poaching occurs in sector 5A, which is on the North side of the beach, close to the entrance and near thick vegetation. Overall, 0.65% of nests were poached in zone 1 (near tide line), 73.02% of nests were poached in zone 2 (between tide and vegetation), and 26.33% were poached in zone 3 (in vegetation). Poaching differences between years and months are still being analyzed. The easy access from the road and the thick vegetation nearby providing cover are possible reasons why sector 5A has such a high poaching rate. In speaking with locals, both agreed that more police presence and general beach vigilance would help decrease poaching rates. However, the locals had differing opinions about the people involved in the poaching (Locals or-Non-locals), and the appropriate actions to take to combat poaching, such as privatizing the beach. The results on frequency of poaching by areas of the beach presented in this study could be used by CREMA to relocate nests to sectors and zones less affected by poaching. The interviews made it clear that there isn't one simple solution to address poaching in Corozalito, and there are conflicting opinions on the best methods. Nonetheless, locals agreed that continuing to educate children about conservation and having larger police presence are both important efforts to eradicate poaching.

LEATHERBACK POST-INTERACTION MORTALITY IN NORTHEASTERN UNITED STATES POT/TRAP FISHING GEAR

Carrie Upite, Kimberly Murray, Brian Stacy, Lesley W. Stokes, and Sara Weeks

National Marine Fisheries Service

Post-interaction mortality (PIM) refers to the death of sea turtles following live release from fishing gear and is attributed to the delayed effects of physiological disturbances or traumatic injuries resulting from capture. The National Marine Fisheries Service (NMFS) recently developed national criteria to assess PIM for turtles bycaught in trawl, net, and pot/trap fisheries, building upon criteria previously developed for regional fisheries. These criteria are based on the degree of resulting behavioral abnormalities and injury observed in bycaught sea turtles. The Northeast US Sea Turtle Disentanglement Network responds to public reports of entangled sea turtles, collects information on the nature of the turtle entanglement, injuries and behavior, and provides the data to NMFS. The NMFS Northeast Sea Turtle Injury Workgroup used these data to evaluate likelihood of PIM based on the national criteria as applied to 217 turtles reported entangled in fishing gear from 2012-2017. Most of the interactions involved leatherbacks (n=201) entangled in vertical lines of pot/trap gear. We applied the PIM criteria to calculate a 5-year mortality rate for this gear type. This is the first time post-interaction mortality for turtles in vertical fishing lines has been determined. The results can be used to better assess lethal and non-lethal interactions in federal fisheries.

AN ALARMING INCREASE IN THE ILLEGAL TAKE OF SEA TURTLES ON BIOKO ISLAND, EQUATORIAL GUINEA

Callie A. Veelenturf[1], Elizabeth M. Sinclair[1,2], Frank V. Paladino[1,2], and Shaya Honarvar[1,2]

[1]*Bioko Marine Turtle Program, Malabo, Equatorial Guinea*
[2]*Purdue University, Ft. Wayne, IN, USA*

Bioko Island hosts the second largest nesting aggregations for leatherback and green sea turtles in West Africa, and historically, estimates of green turtle take on the island's southern nesting beaches were as high as 200-300 turtles per night in the 1940s. During the 1990s green and hawksbill turtles still were appearing in local meat markets in numbers as high as 100 turtles per night. Decreasing population numbers along with increasing conservation efforts had decreased this turtle take rate to around 50 individuals per year in the early 2000s through 2013. Until recently, Bioko's beaches were spared the increase in coastal development seen around the globe, due to its lack of road availability, boat access, and rugged shoreline. In November 2014, however, construction of the first paved road to the nesting beaches from the second largest city on the island was completed, bringing with it an expected increase in poaching of turtle eggs and adult nesting females. The quick and simple transport method has already been taken advantage of by both turtle poachers and bushmeat hunters who have begun to set up hunting camps along the five sea turtle nesting beaches (Beaches A – E). Between the years 2007 - 2014, only 3 leatherback poaching events were reported on Beach D, the main leatherback nesting beach, but within the 2014/15 season alone at least 12 leatherback sea turtles were poached on this beach. During the 2017/18 nesting season, a total of 15 leatherbacks were poached on Beach D, an increase from the previous 4 years, and a dramatic increase from the entire 2007-2014-year period. These numbers do not include the more commercially preferred species, green sea turtles, which are also being taken annually. On Beach C alone during the 2017/18 season, a total of 102 carapaces of olive ridley (10), green (50) and leatherback (42) sea turtles were found in the tree line.

Poaching events are most common at the beginning of the nesting season (October), as conservation groups are just beginning to establish their yearly presence and passive poaching protection efforts, and during the end of December and beginning of January, during the holiday season. As expected, poaching events tend to be more common closer to beach access points. Enforcement of current national laws (law 8/1988 and 183/87) that protect the 19 kilometers of turtle nesting beach is needed if reduction of this increasing poaching threat is to be reduced. Identified trends in poaching events have been provided to the government of Equatorial Guinea for better understanding the vulnerability of resident turtle populations to anthropogenic encroachment, which is important in planning for continued development within the scientific reserve.

RECREATIONAL SCALLOP HARVEST AND MARINE TURTLES: FRIENDS OR FOES?*

Natalie Wildermann[1], Christopher Sasso[2], Christian Gredzens[1], and Mariana M.P.B. Fuentes[1]

[1]Marine Turtle Research, Ecology and Conservation Group, Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL, USA
[2]NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL, USA

The impact of fisheries on marine megafauna has been widely identified. However, a major proportion of studies focus on commercial fisheries, frequently overlooking the effect that smaller local recreational fisheries might have on marine populations. This is particularly important for marine turtles in near-shore habitats which overlap with recreational fisheries. Here we assessed the effect of recreational scallop fisheries on the distribution and behavior of foraging marine turtles in the coastal waters of the upper Eastern Gulf of Mexico. Before and during the scallop season we quantified the density and overlap of marine turtles and vessels sighted, and satellite tracked a subset of turtles (n = 4; 2 green turtles *Chelonia mydas*, 1 Kemp's ridley turtle (*Lepidochelys kempii*), and 1 loggerhead turtle (*Caretta caretta*) to assess potential changes in their distribution and behavior. The relative distribution of marine turtles sighted during the scallop season overlapped with 48% of the area most frequently used by harvesters, and marine turtle hotspots shifted between the seasons. In addition, during the scallop season the size of home ranges of individual turtles appear to decrease, and turtles displayed frequent changes in the travel speed and directionality. We hypothesize that such changes are likely related to the distribution and movement of vessels and the abundant presence of people in the water. Our study highlights the importance of considering recreational fisheries and their local effect on marine megafauna populations to inform future adaptive management practices; however, further studies are needed to quantify the direct and indirect impacts of the recreational fisheries and assess the actual risk of associated activities to marine turtle populations.

FUTURE OF SEA TURTLE CONSERVATION

EFFECTIVE CONSERVATION THROUGH PARTNERSHIP WITH PRECIOUS PLASTIC INITIATIVES*

Sabine Berendse

Sea Turtle Conservation Curacao

Sea Turtle Conservation Curacao has cleaned over 80,000 gallons of marine debris from potential nesting beaches on Curacao and Klein Curacao. In 2017 they started a partnership with LIMPI recycling, an initiative that uses the open source blueprints of Precious Plastic to build machines that transform waste plastic and marine debris into new products. Initially it was used to produce sea turtle related merchandise. We sold over 3000 products in a year and this opened our eyes to the potential of waste plastic as raw material. Since plastic pollution is a huge threat to sea turtles, we believe something needs to be done about it. And the best way to do so is to make sure that less plastic ends up in the ocean. By rethinking plastic from waste to valuable material and using it as such we have the potential to repurpose 35,000 kg on a monthly basis, locally. That will prevent plastic pollution and it will also generate some income to fund the other activities of Sea Turtle Conservation Curacao. This model is scalable and replicable and it might be interesting for other sea turtle conservation organizations.

SEA TURTLE FACIAL SCUTES EVOLUTION AT FIRST STAGES OF LIFE

Alejandra Carvallo

Marine Savers and Four Seasons Resorts, Maldives

The purpose of this project is to record the growth of the hatchlings on a weekly basis, from the moment they are accepted in our rehabilitation center up to their release. Twice a week, close up pictures of the sides of the head and the carapace are taken in order to record the evolution or transformation of the scales and scutes during growth and assess how they change over time. A stand for a DSLR camera was specially designed and attached to a plexiglass sheet with a measuring tape glued over it, so that way we can place the turtle at the same spot and distance every time, giving us the length measurement of each individual throughout the year. At the end of the collection of data, normally between 15 and 18 months, the photograph series obtained will be uploaded in a program called "Photomorph", which morphs one picture into the next one, creating a video that will display how the scales and scutes evolve with time. This will provide us with information on the stage of development. The scales don't change significantly, so they can be used to identify the turtles in the future when they are encountered and photographed in the wild once they have been released. We have designed a code to measure the size of the scutes to determine the change throughout growth.

3D PRINTING - PROSTHETICS FLIPPERS

Alejandra Carvallo

Marine Savers and Four Seasons Resorts, Maldives

With increased research and development, scientists are now able to fit animals with deformities or limb amputations with prosthetics that allow them to live normal lives. The lack of data is a problem in different parts of the world. There are few researchers studying animal prostheses and not enough published studies to be sure if, or when, animals will benefit from prosthetic limbs. Individuals with prosthetics are also unable to be released. Fitting an individual with prosthetics will affect the individual's behavior and will involve some adaptation with some muscles needing to get used to the new setup. The structure of each individual's muscles and skeleton will affect the success of prostheses. The size of the stump and the ability to move it will also require different ways to attach the prosthetic. Other issues may arise with communication as the animal cannot tell you if the prosthetic suits properly or if the change feels better. All the data needs to be backed up by observations and behavioral assessments. Sea turtle prosthetics has been open to discussion in different parts of the world, and some individuals have been suited with them successfully.

WHY DO WE (STILL) DO THIS?*

Jack Frazier

National Museum of Natural History, Smithsonian Institution, Washington, DC, USA

Marine turtleologists show remarkable depth and breadth of investigation including isotopes, trace elements, molecules, bacteria, eggs, hatchlings, giant leatherbacks, populations, ecosystems, weather, climate, into space with solar radiation, the magnetosphere, and beyond. Temporal considerations run from the Triassic (~240 Ma), Jurassic, Cretaceous, Paleogene, Neogene, Quaternary, Holocene, Stone Age, Bronze Age, Iron Age, the Anthropocene, and into the future. Socio-political interactions span from meek, marginalized children, to fisher communities, the fishing industry, commercial enterprises from producers to marketers, on to government offices and intergovernmental actors and institutions, and yet further to millionaire entrepreneurs. Personal attitudes reveal extraordinary levels of commitment, dedication, devotion, enthusiasm, innovation, knowledge, passion, … Beyond the astonishing attitudes and positions are remarkable actions: publications of numerous books and hundreds of scientific articles, spawning scores of students every year, prizes, honors, enormous grants, and on … During recent years, numerous multi-author initiatives have identified global priorities for marine turtle research, conservation, and management; assessments of those proposals and how to measure success; inspiring narratives of success stories; dispiriting reviews of failures and looming threats; and other attempts to evaluate diverse accounts and histories. These initiatives are dominated by researchers, versed in the latest technological advances, adept at capturing financial and political resources, and publishing their studies in top-tier journals. On occasion a token "social scientist" may be included in the mix, giving a nod to the realization that "science" and "conservation" are human activities, carried out within a social matrix, and – ultimately – designed to influence human attitudes and activities. Yet, professionals whose study animal is *Homo sapiens*, those expressly trained and experienced to investigate, design, and conduct objective evaluations of human endeavors – although they may not know what end of a turtle goes forward – are simply not included, nor are they even considered. Even with the best possible multi/trans-disciplinary team, evaluators face daunting challenges to assess marine turtle research and conservation – how to confront: animals with intrinsically complex life cycles, at many levels; inherently dynamic, unstable, and unpredictable systems – human and non-human, with resultant uncertainty, conflicting "scientific" explanations, and limits to predictability; differing perceptions of "reality", particularly in the age of "post-truth"; anti-intellectualism and arrogant ignorance; fundamental communication exigencies with diverse societies and diverse sectors of societies, involving diverse cultures, languages, communication traditions, responsiveness to change, etc.; even basic levels of ethics and morality in the overall venture. "Modern" marine turtles (Chelonioidea) have existed for at least 110 Ma. During the succeeding Eras, Periods, Epochs, Ages, millennia, and centuries, scores of species of these turtles have evolved and survived, in a world that has experienced hundreds (often thousands) of: meteor impacts, polarity reversals, major volcanic events, tectonic uplift and subsidence, global warming events, ice ages, and other profound changes to the planet, its oceans, and shores. Yet, marine turtles survived all this – long before Homo sapiens existed, and could study and conserve them. We must ask, again: "Why do we do this?" And, seek answers from others – outside the world of turtles.

THE GLOBAL MALE SEA TURTLE INITIATIVE: ADDING MALES TO THE CONSERVATION EQUATION

Marco Garcia-Cruz[1,2,3,4], Cathi L. Campbell[1,2], Karen A. Bjorndal[2], Luis Cardona[3], Cynthia J. Lagueux[1,2], Kathryn M. Rodríguez-Clark[5], Margarita Lampo[1,4], Celsi Señaris[1,4], Hannah B. Vander Zanden[1,2], Mariana M.P.B. Fuentes[6], Carlos Carreras[7], Pedro Vernet[1], and Alan B. Bolten[1,2]

[1]ProOcean Marine Research, Conservation and Innovation, Avinguda Can Monmany, 5. 08197. Sant Cugat del Valles, Barcelona, Spain
[2]Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, PO Box 118525, Gainesville, Florida, 32611, USA
[3]IRBio y Department of Evolutionary Biology, Ecology and Environmental Science, University of Barcelona, Barcelona, Spain
[4]Centro de Ecología, Instituto Venezolano de Investigaciones Científicas, Apdo. 20632, Caracas 1020-A, Venezuela
[5]Animal Care Sciences, Smithsonian National Zoological Park and Conservation Biology Institute, MRC 5507 Washington D.C., 20013-7012, USA
[6]Department of Earth Ocean and Atmospheric Science, Florida State University. Tallahassee, Florida, USA
[7]Department of Genetics, Microbiology and Statistics and IRBio, University of Barcelona, Av. Diagonal 643, 08028 Barcelona, Spain

Most of our knowledge of the biology, ecology, and conservation needs of sea turtles has been obtained from studies of adult females on nesting beaches, and to a lesser extent from observations of juveniles in foraging and developmental habitats. These studies have principally sought to understand natal homing and nest site fidelity, migratory movements, nesting trends, somatic growth, and survival rates. Much less effort has been invested in understanding male sea turtle biology and ecology, and the importance of male turtles in management and conservation. Since male turtles rarely come ashore, they are seldom seen by beach-bound researchers. Researchers studying in-water aggregations of adult turtles face numerous challenges, resulting in a greater scarcity of knowledge about male sea turtles than other segments of sea turtle populations. It is critically important that we increase our understanding of male sea turtle biology and ecology. For example, climate change is expected to decrease the production of males in some populations due to temperature-dependent sex determination, and understanding the role of male sea turtles in population viability will be crucial to identify appropriate mitigation strategies. The proportion of males to females needed to maintain population viability was one of the key “Unsolved Mysteries of Sea Turtles” determined by an expert working group at the IUCN Marine Turtle Specialist Group’s Burning Issues Workshop in 2006 (see SWOT Report Vol. 2), and remains unsolved. Furthermore, studying adult male sea turtles in important foraging and mating areas across the globe is vital to better understand sea turtle mating strategies, contributions to genetic stocks, operational sex ratios, population dynamics, critical habitats, and habitat needs. Using existing data, our initial focus will be to create a global distribution map of courtship, mating, feeding, and basking sites for each sea turtle species, and to identify links to nesting populations where known. We will also infer some aspects of the reproductive male population in the Caribbean using genetic analysis, and thus estimate effective operational sex ratios and characterize male mating patterns. In addition, we will explore male foraging and reproductive behavior using satellite tracking. Management strategies and actions to conserve sea turtle populations in the future will need to address the roles of male turtles more effectively and to consider how the impacts of regional climatic cycles, primary threats, and conditions in foraging areas apply to both females and males. To ensure that these concerns are addressed for sea turtle populations across their range, we have created “The Global Male Sea Turtle Initiative”, to promote the biological and ecological study of male sea turtles and support current efforts. We invite colleagues from around the world to join this effort. For more information please visit: http://www.pro-ocean.org.

WARMING SEAS INCREASE COLD-STUNNING EVENTS FOR KEMP’S RIDLEY SEA TURTLES IN THE NORTHWEST ATLANTIC

Lucas Griffin[1], Curtice Griffin[1], John Finn[1], Robert Prescott[2], Mark Faherty[2], Brett Still[3], and Andy Danylchuk[1]

[1]University of Massachusetts, Amherst, Massachusetts, United States of America
[2]Massachusetts Audubon Society, Wellfleet Bay Wildlife Sanctuary, South Wellfleet, Massachusetts, United States of America
[3]University of Rhode Island, Kingston, Rhode Island, United States of America

Since the 1970s, the magnitude of turtle cold-stun strandings have increased dramatically within the northwestern Atlantic. Here, we examine oceanic, atmospheric, and biological factors that may affect the increasing trend of cold-stunned Kemp’s ridleys in Cape Cod Bay, Massachusetts, United States of America. Using machine learning and Bayesian inference modeling techniques, we demonstrate higher cold-stunning years occur when the Gulf of Maine has warmer sea surface temperatures in the late summer and late fall. Surprisingly, hatchling success, a proxy for population abundance, was not identified as an important factor. Further, using our Bayesian count model and forecasted sea surface temperature projections, we predict more than 2,300 Kemp’s ridley turtles may cold-stun annually by 2031 as sea surface temperatures continue to increase within the Gulf of Maine. We suggest warmer sea surface temperatures may have modified the northerly distribution of Kemp’s ridleys and act as an ecological bridge between the Gulf Stream and nearshore waters. While cold-stunning may account for a minor proportion of juvenile mortality, we recommend continuing to rehabilitate cold-stunned individuals to maintain population resiliency for this critically endangered species in the face of a changing climate.

EFFECTS OF FUTURE SEA LEVEL RISE ON COASTAL NESTING HABITAT

Betsy von Holle[1], Jennifer L. Irish[2], Annette Spivy[3], John F. Weishampel[1], Anne Meylan[4], Matthew H. Godfrey[5], and Mark Dodd[6]

[1]*University of Central Florida, Orlando, FL, USA*
[2]*Virginia Tech, Blacksburg, VA, USA*
[3]*University of Maryland, College Park, MD, USA*
[4]*Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL, USA*
[5]*North Carolina Wildlife Resources Commission, Beaufort, NC, USA*
[6]*Georgia Department of Natural Resources, Brunswick, GA, USA*

Sea level rise (SLR) and disturbances from increased storm activity are expected to diminish coastal ecosystems available to nesting species by removing habitat and inundating nests during incubation. We updated the United States Geological Survey's (USGS) Coastal Vulnerability Index, which provides a qualitative and relative assessment of a coastal area's vulnerability to erosion and shoreline retreat as a function of SLR and other factors, for the South Atlantic Bight. We considered a eustatic SLR projection of 14 cm by 2030. We linked long-term survey data for three sea turtle species, three shorebird species, and five seabird species to future coastal erosion vulnerability to SLR to understand effects of future SLR on nesting habitats. Over 2,000 km (43%) of the South Atlantic Bight coastline is projected to have an increase in coastal erosion vulnerability by the 2030s, with respect to its present vulnerability. Future vulnerability of SLR-induced erosion along the South Atlantic Bight is spatially variable, and the eleven coastal study species also varied in their use of coastal habitats with high future coastal vulnerability to SLR. By 2030, forty-seven percent (586 km) of all beaches surveyed for sea turtle nesting across the study region (1,250 km) will have increased vulnerability to erosion, as compared to SLR rates in 2000. This broad-scale study predicts the level of susceptibility of our study species to erosion from future SLR, which is the first step in managing coastal species for the changing environmental conditions associated with climate change and SLR.

HATCHING SUCCESS AND INCUBATION DURATIONS OF HAWKSBILL TURTLES, *ERETMOCHELYS IMBRICATA*, IN AN EXTREME ENVIRONMENT

Jassim Al Khayat

Qatar University, Doha, Qatar

Relatively little work has investigated the nesting success of hawksbill turtles (*Eretmochelys imbricata*) in the Arabian Gulf. Moreover, recent work has shown that hawksbills in the region display a reduced fecundity compared to their tropical counterparts. However, it is still not known whether hatching success in the region is comparable to tropical areas. The current research reports the hatching success and incubation durations on a long-term conservation program in northeast Qatar. From 2010 to 2017 nesting site surveys were conducted to determine the presence of clutches, clutch sizes, nesting season lengths, and incubation durations. Clutches were excavated post-hatching emergence to determine hatching success. A total of 235 nests were confirmed, mean incubation period and hatching success were 52.8 days (±5.4) and 76.0% (±21.4) respectively. Meteorological data analysis showed air temperatures in Qatar to increase on average 15.3°C (±1.4), ranging from 23.4°C (±1.1) from the first clutch being laid to 38.7°C (±0.8) when

the last clutches hatched. The region is an extreme environment and as the species' reproductive success is associated with temperature, research in the region is of significant interest to conservationists.

A GLOBAL SNAPSHOT OF LOGGERHEAD TURTLES: SUCCESSES AND CHALLENGES

Jacques-Olivier Laloë[1], Jacquie Cozens[2], Berta Renom[3], Albert Taxonera[3], and Graeme Hays[1]

[1]*Centre for Integrative Ecology, Deakin University, Geelong, Australia*
[2]*SOS Tartarugas, Santa Maria, Sal, Republic of Cape Verde*
[3]*Project Biodiversity, Santa Maria, Sal, Republic of Cape Verde*

Most major sea turtle nesting sites around the world are now well-studied, with conservation organisations operating globally throughout nesting seasons. Not only do such conservation and monitoring efforts help protect turtles directly at their nesting site, they are also essential to assessing the conservation status of individual populations. In order to assess the global conservation status of different sea turtle species, datasets from individual field sites are needed. Here we highlight the importance of making abundance data freely available to improve conservation management and underline important conservation challenges that lay ahead. We present a 10-year (2008-2017) dataset of nesting activities for the loggerhead sea turtle on the island of Sal, part of the Cape Verde islands in the Atlantic. Foot patrols recorded 21,938 nests and we estimated that the annual number of nests on Sal increased from 506 to 7,771 over a decade. We report a 15-fold increase of nest numbers over a period of 10 years and an annual growth rate of 25% per year. This is among the highest growth rates reported for a rookery worldwide. To place this population within the global context, we review the published information for loggerhead populations around the world. This provides a global snapshot of the status of loggerhead turtles. We highlight some of the success stories from across the globe but also underline the conservation challenges found in many parts of the world, including turtle bycatch, coastal development, light pollution, plastic pollution, sea level rise and warming incubation temperatures. This study celebrates the highly successful collaborative efforts of the sea turtle conservation community, emphasizes the value of long-term monitoring efforts, and highlight important conservation challenges.

INFORMING RESEARCH PRIORITIES FOR IMMATURE SEA TURTLES THROUGH EXPERT ELICITATION

Natalie Wildermann[1], Christian Gredzens[1], Larisa Avens[2], Hector Barrios-Garrido[1,3], Ian Bell[4], Janice Blumenthal[5], Alan B. Bolten[6], Joanne Braun McNeill[2], Paolo Casale[7], Maikon Di Domenico[8], Camila Domit[9], Sheryan P. Epperly[10], Matthew H. Godfrey[11,12,13], Brendan J. Godley[14], Victoria González Carman[15,16], Mark Hamann[17], Kristen M. Hart[18], Takashi Ishihara[19,20], Kate L. Mansfield[21], Tasha L. Metz[22], Jeffrey D. Miller[23], Nicolas J. Pilcher[24], Mark A. Read[25], Christopher Sasso[10], Jeffrey A. Seminoff[26], Erin E. Seney[20], Amanda Williard[27], Jesús Tomás[28], Gabriela M. Vélez-Rubio[29,30], Matthew Ware[1], Jessica L. Williams[31], Jeanette Wyneken[32], and Mariana M.P.B. Fuentes[1]

[1]*Marine Turtle Research, Ecology and Conservation Group, Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL 32306, USA*
[2]*NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Beaufort, NC 28516, USA*
[3]*Centro de Modelado Científico (CMC), La Universidad del Zulia (LUZ), Av. Universidad, Sector Grano de Oro. Ciudad Universitaria, Bloque A-2, Planta Baja, Maracaibo 4005, Venezuela*
[4]*Aquatic Species Program, Conservation and Biodiversity Operations Branch, Queensland Department of Environment and Science, Brisbane, QLD 4102, Australia*
[5]*Cayman Islands Department of Environment, KY1-1002 Grand Cayman*
[6]*Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, Gainesville, FL 32611, USA*
[7]*Ethology Unit, Dept. of Biology, University of Pisa, Pisa 56126, Italy*
[8]*Center for Marine Studies, Federal University of Paraná, Pontal do Paraná, Paraná 83255-000, Brazil*
[9]*Laboratório de Ecologia e Conservação, Marine Studies Centre, Federal University of Paraná, Pontal do Paraná, Paraná 83255-000, Brazil*
[10]*NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL 33149, USA*
[11]*North Carolina Wildlife Resources Commission, Beaufort, NC 28516, USA*
[12]*Duke University Marine Lab, Nicholas School of the Environment, Duke University, Beaufort, NC 28516, USA*
[13]*Department of Clinical Sciences, College of Veterinary Medicine, North Carolina State University, Raleigh, NC 27607, USA*
[14]*Marine Turtle Research Group, Centre for Ecology and Conservation, School of Biosciences, University of Exeter, Cornwall Campus, Penryn TR10 9EZ, UK*
[15]*Instituto de Investigaciones Marinas y Costeras (CONICET – UNMdP), Mar del Plata 7600, Provincia de Buenos Aires, Argentina*
[16]*Instituto de Investigación y Desarrollo Pesquero (INIDEP), Mar del Plata 7600, Provincia de Buenos Aires, Argentina*
[17]*College of Science and Engineering, James Cook University, Townsville, QLD 4811, Australia*
[18]*US Geological Survey, Wetland and Aquatic Research Center, 3321 College Avenue, Davie, FL 33314, USA*
[19]*Suma Aqualife Park, Kobe, Hyogo 654-0049, Japan*
[20]*Sea Turtle Association of Japan, Hirakata, Osaka 573-0163, Japan*
[21]*Marine Turtle Research Group, Department of Biology, University of Central Florida, Orlando, FL 32816, USA*
[22]*Department of Marine Biology, Texas A&M University at Galveston, Galveston, TX 77554, USA*
[23]*Biological Research and Education Consultants, Missoula, MT 59801, USA*
[24]*Marine Research Foundation, Kota Kinabalu, Sabah 88450, Malaysia*

[25]*Great Barrier Reef Marine Park Authority, Townsville, QLD 4810, Australia*
[26]*NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, CA 92037, USA*
[27]*Department of Biology and Marine Biology, University of North Carolina Wilmington, Wilmington, NC 28403, USA*
[28]*Marine Zoology Unit, Cavanilles Institute of Biodiversity and Evolutionary Biology, University of Valencia, Valencia 46071, Spain*
[29]*Karumbé NGO, Montevideo 11600, Uruguay*
[30]*Centro Universitario Regional del Este (CURE), Universidad de la República, Rocha 27000, Uruguay*
[31]*Tartarugas para o Amanhã, Praia do Tofo, Inhambane Province, Mozambique*
[32]*Biological Sciences, Florida Atlantic University, Boca Raton, FL 33431, USA*

Although sea turtles have received substantial focus worldwide, research on the immature life stages is still relatively limited. The latter is of particular importance, given that a large proportion of sea turtle populations comprises immature individuals. We set out to identify knowledge gaps and identify the main barriers hindering research in this field. We analyzed the perceptions of sea turtle experts through an online survey which gathered their opinions on the current state of affairs on immature sea turtle research, including species and regions in need of further study, priority research questions, and barriers that have interfered with the advancement of research. Our gap analysis indicates that studies on immature leatherback Dermochelys coriacea and hawksbill Eretmochelys imbricata turtles are lacking, as are studies on all species based in the Indian, South Pacific, and South Atlantic Oceans. Experts also perceived that studies in population ecology, namely on survivorship and demography, and habitat use/behavior, are needed to advance the state of knowledge on immature sea turtles. Our survey findings indicate the need for more inter-disciplinary research, collaborative efforts (e.g. data-sharing, joint field activities), and improved communication among researchers, funding bodies, stakeholders, and decision-makers.

GENETICS AND GENOMICS

UNFOLDING MIGRATORY MARINE SPECIES: THE CASE STUDY OF THE REINTRODUCED GREEN TURTLES OF THE CAYMAN ISLANDS

Anna Barbanti[1], Maria Turmo[1], Janice Blumenthal[2], Jack Boyle[3], Annette C. Broderick[3], Lucy Collyer[2], Gina Ebanks-Petrie[2], Brendan J. Godley[3], Walter Mustin[4], Marta Pascual[1], and Carlos Carreras[1]

[1]*Department of Genetics, Microbiology and Statistics and IRBio, Universitat de Barcelona, Av. Diagonal 643, 08028 Barcelona, Spain*
[2]*Department of Environment, PO Box 10202, Grand Cayman KY1-1002 Cayman Islands*
[3]*Centre for Ecology and Conservation, College of Life and Environmental Sciences, University of Exeter, Penryn Campus, Penryn, TR10 9FE, UK*
[4]*Cayman Turtle Center, 786 NW Point Rd, West Bay, Cayman Islands*

The green turtle (*Chelonia mydas*) is an endangered species characterised by a long-life cycle and long migrations. In the Cayman Islands, this species was considered extinct in the 1970s. Recent surveys have detected a recovery of Cayman Islands green turtle nesting population on both Grand Cayman and Little Cayman Islands, after the intervention of a long-term reintroduction program started in 1968 by the Cayman Turtle Farm (CTF). A recent study on wild Cayman females showed that most of them are descendants of the CTF, but still there is no updated information regarding the number of female and male breeders, individual contribution to the reproduction, time between nesting events, or connectivity between the two different islands. In this study, we used 13 microsatellites markers to analyse 320 hatchlings (one per nest) and 57 adult females (sampled between 2013 and 2015) breeding in both Little and Grand Cayman Islands. Using parentage analysis we reconstructed the number of breeders contributing to our sampled hatchlings finding 119 females and 115 males, without a significantly different sex ratio among the three years. Most females of this population lay between 1 and 3 nests but we found individuals laying up to 9 nests in one season. These results were combined with biological data available, such as number of eggs per nest and their viability. Testing the mobility of adult individuals between Little Cayman and Grand Cayman, we found that some female and male individuals contributed to nests laid in both islands. These individuals moved between the two islands within the same nesting season and also between two different nesting seasons. However, the two populations remain genetically significantly different. Relatedness analysis showed that almost all hatchlings from Little and Grand Cayman are related to the farm. Nevertheless, the Pairwise F_{ST} revealed that both Little and Grand Cayman were significantly genetically different from the farm. This means that the detected movements between the three groups is not enough to cause homogenisation of allele frequencies. This study shows that molecular markers are a powerful tool to collect relevant biological information on marine species characterised by long migratory routes and complex life cycles.

THE MEDITERRANEAN LOGGERHEAD GENOMICS: LESSONS FROM THE POPCOMICS PROJECT

Anna Barbanti[1], Hector Torrado[2], Enrique Macpherson[2], Creu Palacin[1], Xavier Turon[2], Marta Pascual[1], and Carlos Carreras[1]

[1]*Department of Genetics, Microbiology and Statistics and IRBio, Universitat de Barcelona, Barcelona, Spain*
[2]*Center for Advanced Studies of Blanes (CEAB-CSIC). Blanes, Girona, Spain*

The possibility to apply high-throughput sequencing technologies on non-model organisms has opened new research opportunities that have yet to be explored in marine turtles. In this context, we aim to reassess the genetic structuring of Mediterranean loggerhead populations with high number of loci, and to assess genetic structuring driven by local adaptation through the analysis of outlier markers. This initiative is included within the 'Marine Biodiversity and Genomics: from Populations to Communities (PopCOmics)' project (popcomicsproject.blogspot.com), which aims to address relevant research challenges in marine species with genomic tools. This project already includes similar studies in other marine species that have yielded important results to be taken into account when applying genomics not only to Mediterranean loggerhead turtles but also to other future marine turtle genomic projects. A pilot study using 2bRAD on the fish *Diplodus puntazzo* and *Caretta caretta* showed the importance of minimum values of depth per locus in order to have reliable results. Therefore, it reflects a trade-off between the target number of locus and the number of samples we can pool, and has to be taken into account to optimize the economic cost of the project. The genome size of the target species can be used as a proxy to assess the expected number of loci under a saturation scenario and selective base ligation can be used to reduce the number of loci without losing power to detect genetic differentiation. Furthermore, a study with different species of the fish genus *Symphodus* has shown that the inclusion of samples of non-target species will result in dramatic drops on loci numbers, related to the proportion of non-target samples and the phylogenetic distance to the target species. Thus, reductions on the number of loci and high missingness values in a given sample can be used to detect nuisance non-target species samples to be removed from the analyses to improve the results. This same procedure can uncover instances of cryptic speciation. Once the dataset is clean, the analysis of outlier loci can provide patterns of genetic structuring potentially driven by selective pressures that can be different from those found with classical genetic studies or with neutral markers, as shown in the Adriatic populations of *Symphodus tinca*. These analyses are particularly interesting when different levels of structuring can be found, and a hierarchical approach could be necessary to unfold the selection drivers that shape the genetic structuring at each level. For instance, populations of the sea urchin *Paracentrotus lividus* are greatly influenced by the salinity gradient along its Atlanto-Mediterranean distribution, but when the Mediterranean populations are analysed independently from the Atlantic, new outlier loci emerged involving cell cycle and DNA repair that were not previously detected. A similar hierarchical analysis is probably going to be needed in marine turtles, as they typically present different levels of genetic structuring, from management units (MUs) to regional management units (RMUs). As a result of all the technical results provided by the PopCOmics project, a cost-efficient and reliable genomic project can be designed for the Mediterranean loggerhead turtles that would potentially yield novel insights into its biology that could be taken into account in management and conservation plans.

UNDERSTANDING BREEDING SEX RATIOS IN THE DECLINING EASTERN PACIFIC LEATHERBACK POPULATION; INSIGHTS FROM MEXICO

Ana R. Barragan[1], Laura Sarti[2], Mayra Martinez[1], Kelly Stewart[3], Amy Frey[4], Erin LaCasella[4], Lisa M. Komoroske[5], and Peter H. Dutton[4]

[1]*Kutzari AC, Mexico*
[2]*Dirección de Especies Prioritarias, CONANP, Mexico*
[3]*The Ocean Foundation, Washington, DC 20036*
[4]*Southwest Fisheries Science Center, La Jolla, CA 92037*
[5]*University of Massachusetts at Amherst, MA*

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 (SSAP) 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 FIRST DATABASE OF DNA SEQUENCES OF COI GENE FOR MEXICAN SEA TURTLES

Fátima Yedith Camacho-Sánchez[1], Hervey Rodríguez-González[2], Alan Zavala[3], José A. Narváez-Zapata[4], Hugo H. Acosta-Acosta[5], Catherine Hart[6], and Miguel Angel Reyes-López[1]

[1]*Conservation Medicine lab. Centro de Biotecnología Genómica, IPN*
[2]*Depto.de Acuacultura, CIIDIR Sin., IPN*
[3]*Lab. de Vida Silvestre, CIIDIR Sin., IPN*
[4]*Centro de Biotecnología Genómica, IPN*
[5]*CONANP, Mexico*
[6]*Grupo Tortuguero de las Californias, Baja California Sur, MEX. Investigación y Capacitaciones Ambientales y Sociales A.C.*

The diversity at gene, species, and ecosystem levels of the biosphere, is defined like biodiversity. Study of biodiversity is integrated in various territories of science like taxonomy, molecular biology, biogeography, ecology, evolution, genetics, and conservation biology. Traditional taxonomy is important for identification, conservation, and sustainable use of biodiversity. There are some difficulties to studying biodiversity using only taxonomic ways like a low number of taxonomists. Exist one marker, the cytochrome c oxidase subunit I gene (COI), offers solutions to quickly distinguish among species, providing information on species diversification and molecular evolution. To Mexico the study, knowledge and conservation of its great biodiversity of species is very important, it derives many of these species are vulnerable, endangered or critically endangered, one of those species is sea turtle. Sea turtles have inhabited the Earth for over 100 Myr, are threatened worldwide, there is a need for modern conservation measures, using molecular tools such as would be DNA barcoding. Six out of 7 worldwide sea turtles nest in Mexico, all of them are grouped in two known families, Dermochelyidae (*Dermochelys coriacea*) and Cheloniidae (*L. kempii*, *L. olivacea*, *C. caretta*, *E. imbricata*, *C. mydas*). The objective of the work was to analyze the reported and generated sequences from COI gene, comparing genetic variability among Worldwide and Mexico sea turtles. One hundred and fifty-six sea turtle sequences were compared in total, 143 were download from BOLD and 13 sequences obtained *in vitro* were compared; afterwards, those ones assigned to similar groups and transformed into FASTA format, then a nucleotide alignment was made by Clustal W to obtain haplotype networks by Network 5 and finally a Neighbor joining tree was constructed by MEGA 7 with 10,000 replicates, using nucleotide substitution model of K2p. Thirty-five haplotypes were separated in different networks for each species, due to the variation between nucleotides and to 670 mutations found in total for all the sequences. The average distance was 8.2% and the average distance between the families Dermochelyidae and Cheloniidae was 8.1%. The average distance between Cheloniidae was 6.6%. The COI fragment is variable in marine turtle taxa. The nucleotide sequences reported in BOLD for *L. kempii* (kemp's ridley) was compared with 3 sequence obtained *in vitro*, both were 100% aligned and clustered in the same haplotype. In general, haplotypes were not shared interspecifically in all samples analyzed. The DNA barcode based on the COI gene identifies each species of sea turtle and is a useful tool for determining intra and inter species variability of the world's sea turtles.

GENOMIC-ERA APPROACHES TO COMBATTING MARINE TURTLE FIBROPAPILLOMATOSIS AND POPULATION DETECTION

David J. Duffy[1,2], Kelsey Yetsko[2], Liam Whitmore[1], Jessica Farrell[2,3], Christine Schnitzler[2,3], Rachel Thomas[2], Catherine Eastman[2], Devon Rollinson[2], Lorraine Karpinski[4], Bette Zirkelbach[4], Whitney Crowder[5], Elizabeth Murchison[6], Máire Lawlor[6], Brooke Burkhalter[2], and Mark Q. Martindale[2]

[1]*Department of Biological Sciences, University of Limerick, Limerick, V94 T9PX, Ireland*
[2]*The Whitney Laboratory for Marine Bioscience, Sea Turtle Hospital, University of Florida, St. Augustine, FL 32080, USA*
[3]*Department of Biology, University of Florida, Gainesville, FL 32611, USA*
[4]*The Turtle Hospital, 2396 Overseas Highway, Marathon, FL 33050, USA*
[5]*Gumbo Limbo Nature Center, 1801 North Ocean Blvd. Boca Raton, FL 33432, USA*
[6]*Transmissible Cancer Group, Department of Veterinary Medicine, University of Cambridge, Cambridge CB3 0ES, UK*

Next-generation sequencing technologies are the vanguard of an 'omics revolution that is driving biological investigation towards ever more data-intensive approaches, and altering every facet of modern biology and medicine. Marine turtles as a group have historically been underrepresented in terms of genomic resources, despite their global and ecological importance. This puts sea turtles at a considerable disadvantage in terms of the numerous threats and challenges facing these enigmatic species. Therefore, we are harnessing genomic approaches to address immediate challenges in sea turtle conservation, while simultaneously building genomic resources for the sea turtle community. Primarily, our Fibropapillomatosis Genomic

Initiative is employing transcriptomics and genomics to: elucidate the underlying host and viral mechanisms of fibropapillomatosis (FP) tumours; determine novel therapeutic treatments for FP; identify blood-based biomarkers predictive of rehabilitation outcome; and answer fundamental questions about the biology of this chelonid-specific disease epidemic. We recently revealed that fibropapillomatosis tumours share common genomic drivers with human cancers, particularly basal cell carcinoma skin cancer, and that human anti-cancer drugs are effective in preventing post-surgical FP tumour regrowth. We since extended our FP transcriptomic profiling to a wide range of tumour types to determine more effective therapeutic treatments to reduce rehabilitation burdens on facilities and individual turtles. Importantly, we are profiling internal FP tumours as currently no treatments exist. Patients presenting with internal tumours are euthanized regardless of tumour size/burden. We also showed a suspected driver of FP tumours, Chelonid herpesvirus 5 (ChHV5), is transcriptionally inactive (latent) in established tumours, and can now confirm that ChHV5 is also largely latent in early-stage, post-surgical regrowth, and internal tumours, calling into question how and when ChHV5 drives tumour development. We are also employing genomics to answer fundamental questions about FP, e.g., the relationship between an individual's various tumours, and the correlation between ChHV5 viral load, viral transcription and viral shedding. We investigated whether FP is a transmissible cancer (a clonal cancer that can be transmitted from animal to animal, distinct from cancers caused by infectious agents). Importantly, we are also employing tumour genomics to better elucidate the environmental co-trigger(s) driving FP development in *Chelonia mydas*. Additionally, we developed environmental DNA-based assays (qPCR- and deep sequencing-based) for sea turtle species and their ChHV5 pathogen detection from sea water, for improved in situ population and pathogen monitoring. Finally, we are generating multi-species genomic resources for the sea turtle research community, and to investigate whether there is a genomic basis for the variation in FP susceptibility between sea turtle species. While FP has been reported in all seven marine turtle species, it has only reached epizootic (epidemic) proportions in juvenile *C. mydas*. The adoption of genomic technologies promises great advancements to sea turtle conservation and research, with topics as diverse as population biology and monitoring, evolutionary histories, and conservation medicine poised to benefit from genomic insights. Genomics and precision wildlife medicine are already rapidly enhancing our understanding of the enigmatic marine turtle disease, fibropapillomatosis, and paving the way to improved treatment and management strategies to maximise rehabilitation outcomes and conservation gains.

SCALING UP GENOMIC TOOLS FOR MASS TAGGING STUDIES

Peter H. Dutton

NOAA Southwest Fisheries Science Center, La Jolla, CA 92037

Recent advances in genomic technologies have provided opportunities to apply genetic approaches to inform wildlife conservation in novel ways. For sea turtles, genetic tools show promise for addressing persistent gaps in knowledge on population vital rates such as age to maturity, survival, sex ratios, mating systems, patterns of dispersal and recruitment, demographic structure, and estimation of other quantitative genetic parameters. Expanded arrays of multiple nuclear markers (SNPs and microsatellites) being developed for sea turtles and new high throughput laboratory technologies provide a basis for cost-effective genetic "tags" for use in Capture-Mark-Recapture (CMR) studies. Advances in genotyping that allow thousands of individuals to be genotyped at a very large number of single nucleotide polymorphisms (SNPs) permit parentage and kinship inference to be pursued on a large scale, providing new capacity to pursue intergenerational "tagging", despite absence of knowledge of pedigrees that typically characterize wild sea turtle populations. I will present new case studies to illustrate how advances in genomics are being applied to mass tagging experiments and discuss current challenges and future potential for incorporating genetic tagging into sea turtle population assessment and conservation.

POPULATION STRUCTURE OF OLIVE RIDLEY SEA TURTLES (*LEPIDOCHELYS OLIVACEA*) IN GHANA, WEST AFRICA

Alexis Ferrera[1], Angela Formia[2,3], Claudio Ciofi[3], Chiara Natali[3], Andrews Agyekumhene[4], and Phil Allman[1]

[1]Florida Gulf Coast University, Fort Myers, Florida, USA
[2]Wildlife Conservation Society, Marine Program, BP 7847, Libreville, Gabon
[3]Department of Biology, University of Florence, 50019 Sesto Fiorentino (FI), Italy
[4]Wildlife Division, Ghana Forestry Commission, Winneba, Ghana

Sea turtles are known to migrate across ocean basins to reach foraging and breeding grounds, but still exhibit significant population structure on the nesting beaches. Although five species of sea turtles nest in West Africa, the genetic structure of many species in this region has not been adequately explored. We investigated the diversity of mitochondrial (control region) and nuclear (microsatellites) DNA for Olive Ridley sea turtle samples collected from two coastal communities in Ghana during three nesting seasons: 2006, 2015 and 2016. The control region of mtDNA was successfully sequenced for 45 samples (17 from Ada Foah, 28 from Mankoadze). Analysis revealed six variable positions defining five haplotypes, of which one is previously undescribed (Lo91). Haplotype analysis indicates one substitution between ocean basins: a shared haplotype with the Western Atlantic population, but no shared haplotypes with Australia. This is indicative of population expansion from a small ancestral population and supports the scenario of colonization of the Atlantic Ocean via founder effect. Eleven microsatellite loci were used to analyze two years of samples (2015 and 2016) from the same location. This comparison revealed the two nesting cohorts are not genetically distinct and are therefore considered a single population (F_{IS}=0.085, P=0.703; F_{ST}=0.025, P=0.286). This population was compared to six females from Ada Foah across seven loci. Comparison indicated the two locations are less related than expected under a model of random chance, show signs of outbreeding and comprise moderate variation between two potential subpopulations (F_{IS} =-0.160, P=1.00; F_{ST}=0.104, P=0.002). Pending further investigation, conservation strategies should consider nesting cohorts between years as single populations while regarding nesting sites as separate populations for conservation efforts. This study addresses a lack of basic information in this region regarding genetic variability of Olive Ridley's and is the first of its kind to address this knowledge gap by providing a refined understanding of population structure of Olive Ridleys in Ghana. A full understanding of the population structure at varying spatial scales is vital for long-term viability and further research is required to fully understand these connections.

GENOTYPING IN THOUSANDS BY SEQUENCING (GT-SEQ): A PRACTICAL GENOMICS APPROACH FOR SEA TURTLE CAPTURE-MARK-RECAPTURE STUDIES

Amy Frey[1], Peter H. Dutton[1], Kelly Stewart[2], Lisa M. Komoroske[3], and Phillip A. Morin[1]

[1]*NOAA Southwest Fisheries Science Center, La Jolla, CA, USA*
[2]*The Ocean Foundation, Washington, DC, USA*
[3]*University of Massachusetts at Amherst, MA*

Genetic fingerprinting (genotyping) provides a means to identify individuals and serves as a reliable tag for long-term Capture-Mark-Recapture (CMR) studies. While genotyping has been used increasingly for demographic studies such as paternal genotype reconstruction to census males and estimate breeding sex ratios, these studies have been based on the use of microsatellites and so have been limited to hundreds (as opposed to thousands) of samples. Genotyping error, reproducibility across laboratories and even machines, the relatively labor-intensive protocols, and the computational burden of kinship analysis render microsatellites less attractive than SNPs when large numbers of individuals need to be analyzed. Our goal was to develop a system that provides a practical and effective genetic tool for using genotyping as a tag for CMR studies and a cost-effective alternative to microsatellites for large-scale marine turtle conservation genetic studies. Next-generation sequencing (NGS) technologies now make it possible to both identify and genotype thousands to millions of Single Nucleotide Polymorphisms (SNP) directly from sequence data. While whole genome sequencing has yet to be applied for sea turtles, advances in reduced representation approaches, such as RAD-Seq and RAD-Capture, allow for SNP discovery and design of primers that target informative SNP loci that are applicable to population genetic and demographic studies. We used leatherback sequences from a recent RAD-Capture study to design primers targeting regions with informative SNPs to develop a practical, cost effective, accurate and reliable way to genotype tens of thousands of individuals using GT-Seq. The GT-seq method uses multiplexed PCR products from a relatively small panel (50-500) of targeted SNPs for thousands of individuals on a single High Throughput Sequencing (HTS) lane. The method involves two simple multiplex PCR reactions, the first amplifying targeted SNP loci, and the second adding two unique DNA tags to enable the multiplexing of thousands of individuals. This is followed by a normalization step to ensure that plates of individuals (n=96) are pooled in equal concentrations. All 96 individuals on a plate are then combined, bead-purified to remove any unwanted PCR artifacts, and quantified with qPCR before the plates are pooled and the library is sequenced. We optimized a panel of 136 SNPs and have genotyped just over 2,400 leatherback hatchlings and nesters sampled from St. Croix, US Virgin Islands. Data analysis is underway for the hatchlings sampled in 2009 as part of a long-term CMR study to determine age at first reproduction in leatherbacks nesting. This provides a method to move from manual analysis with traditional markers to a next-generation sequencing approach incorporating multiplexing and high-throughput processing to reduce cost and increase efficiency.

PROGRESS AND FUTURE DIRECTIONS OF eDNA APPROACHES FOR POPULATION ASSESSMENT OF SEA TURTLES

Kirsten J. Harper[1], Kelly D. Goodwin[2], Lynsey R. Harper[3], Erin LaCasella[4], Amy Frey[4], and Peter H. Dutton[4]

[1]The Cooperative Institute for Marine and Atmospheric Studies, University of Miami, stationed at Southwest Fisheries Science Center, La Jolla, California 92037, USA
[2]Ocean Chemistry and Ecosystems Division, Atlantic Oceanographic and Meteorological Laboratory, National Oceanic and Atmospheric Administration, stationed at Southwest Fisheries Science Center, La Jolla, California 92037, USA
[3]School of Environmental Sciences, University of Hull, Hull, HU6 7RX, UK
[4]Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, La Jolla, California 92037, USA

Environmental DNA (eDNA) analysis is a rapid, non-invasive method for species detection and distribution assessment using DNA released into the surrounding environment by an organism. eDNA analysis is recognised as a powerful tool for detecting endangered or rare species in a range of ecosystems. Although the number of studies using eDNA analysis in marine systems is continually increasing, there are no published studies investigating the use of eDNA analysis to detect sea turtles in natural conditions. We examined the use of eDNA analysis as a tool for detecting the Pacific green turtle, *Chelonia mydas*, in San Diego Bay, California, USA. We identified two predesigned primer pairs that amplify DNA fragments of differing lengths (488 bp and 254 bp) in *C. mydas*, and compared the efficacy of each for detecting *C. mydas* eDNA in water samples taken from a tank at SeaWorld, San Diego, and at three sub-sites within San Diego Bay. Additionally, water samples from San Diego Bay were taken at two depths, 0.5 m and 2.5 m below surface, and the detection rate compared for each primer pair. *C. mydas* eDNA was successfully detected in all water samples collected from SeaWorld using both primer pairs; however, a density effect was observed in relation to movement of *C. mydas* individuals within the tank. The concentration of *C. mydas* eDNA was higher in the area of the tank frequented more often. For water samples taken from San Diego Bay, both primer pairs performed comparably at all three sub-sites for samples taken at 0.5 m below surface. However, the shorter fragment primer pair had a greater detection rate when samples were taken at 2.5 m below surface. *C. mydas* eDNA was detected at all three subsites when using the shorter fragment primer pair, whereas *C. mydas* eDNA was detected at only one subsite when using the longer fragment primer pair. Our results suggest that refinement of sampling methodology to better reflect the life history of *C. mydas* and further optimisation of the eDNA assay, specifically primer design, are required before the method can be implemented on a large-scale basis. Nevertheless, eDNA analysis represents a promising tool to detect and monitor *C. mydas* in the open ocean.

MARINE TURTLE CONSERVATION GENOMICS

Lisa M. Komoroske

University of Massachusetts at Amherst, MA

Marine turtles migrate across long distances, exhibit complex life histories, and occupy habitats that are difficult to observe. These factors present substantial challenges to understanding fundamental aspects of their biology or assessing human impacts. Early development of genetic tools made important contributions

to understanding marine turtle population and evolutionary biology, such as providing evidence of regional natal homing by breeding adults, establishing connectivity between rookeries and foraging habitats, and determining phylogeography and broad scale stock structure for most marine turtle species. Recent innovations in molecular technologies, statistical methods, and creative application of genetic tools have significantly built upon this knowledge to address key questions in marine turtle biology and conservation management. Here, I will introduce the latest major advances and potential of marine turtle genomic applications, which continues to be an expanding 'umbrella' discipline. Importantly, technological advances allow us to ask new questions both through new data types and analyses, and through the capacity to 'scale-up' studies to include thousands of samples in a time and cost effective manner. Some of these advances include: improved resolution and large-scale syntheses of population connectivity and phylogeography, application of environmental DNA to reveal habitat utilization, use of whole genomes to reconstruct demographic histories and explore adaptive variation, transcriptomics to understand physiological and evolutionary processes, and the capacity of rapid, multiplexed genotyping to estimate key demographic rates, provide insight into reproductive strategies and behavior, and assess differential human impacts among populations. I will also discuss remaining challenges and exciting emerging capabilities, many of which will be highlighted by the talks throughout this special session.

MULTIPLE PATERNITY OF HAWKSBILL TURTLES (ERETMOCHEYS IMBRICATA) AT BUCK ISLAND REEF NATIONAL MONUMENT, ST CROIX, U.S. VIRGIN ISLANDS

Erin LaCasella[1], Kelly Stewart[2], Clayton Pollock[3], Zandy Hillis-Starr[3], Amy Frey[1], and Peter H. Dutton[1]

[1]Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic Atmospheric Administration, 8901 La Jolla Shores Drive, La Jolla, CA 92037
[2]The Ocean Foundation, 1320 19th St. NW, Washington DC 20036
[3]National Park Service Christiansted NHS/Buck Island Reef NM/Salt River Bay NHP & EP, 2100 Church Street, #100, Christiansted, St. Croix, Virgin Islands 00821

Buck Island is an uninhabited island located just off the northeast coast of St. Croix (U.S. Virgin Islands). Established as a National Monument, Buck Island has been managed and protected by the National Park Service for over 40 years and is an important coral ecosystem inhabited by hundreds of marine species. The islands' pristine beaches are important nesting grounds for multiple species of birds and marine turtles which are monitored throughout their nesting seasons. Hawksbill turtles (*Eretmochelys imbricata*) have been monitored on Buck Island since 1988, this location is an important hawksbill index beach in the Caribbean. Female turtles are much more widely studied since they come to shore to nest, in contrast to male turtles which are rarely seen. Various mating systems (such as polyandry and polygyny) are known to exist in marine turtle populations and understanding the life history of these endangered species is important to assess their threats and for better conservation and management practices. In this study we use genetic analyses of nuclear DNA to determine the level of multiple paternity, identify males through genetic identity and to count the numbers of males versus females to evaluate the breeding sex ratio of this important population. Hawksbill tissue samples were collected from 22 females and 652 hatchlings, representing 22 nests, during the nesting season in 2015. Genomic DNA was extracted from each female and hatching sample. The DNA was amplified and genotyped using six polymorphic microsatellite markers. Genotypes for each individual were scored in GeneMapper 5.0 and using the program GERUD1.0, we were able to reconstruct genotypes for the fathers using genotype profiles from the females and hatchlings. Early results indicate single paternity in 16 nests (89%) and multiple paternity in 2 nests (11%). For the 18 females currently assessed, we have identified 19 males which essentially indicates a 1:1 operational sex ratio for this breeding population. Our results also show evidence of polygyny (males mating with multiple females) and polyandry (females mating with multiple males). Our results demonstrate the importance of identifying mating systems for these endangered species to assess the threats they face. This is the first time these questions have been evaluated for this critically endangered population.

EVOLUTIONARY DYNAMICS AND DISEASE ASSOCIATIONS OF IMMUNE GENES IN NEARSHORE JUVENILE GREEN AND LOGGERHEAD SEA TURTLES

Katherine R. Martin, Kate L. Mansfield, and Anna E. Savage

Department of Biology, University of Central Florida, Orlando, FL

The Major Histocompatibility Complex (MHC) is a critical component of the acquired immune system in vertebrates. Genetic variation in MHC genes is often predictive of disease resistance in immune-challenged organisms. Using genomic tools, it has become increasingly possible to assess the level of immunogenetic variation in populations affected by infectious disease. However, such tools have yet to be fully leveraged to answer standing questions in sea turtle biology. This is especially so with respect to the evolution of sea turtle immune systems and the prevalence of the infectious tumor disease, fibropapillomatosis (FP). Using next generation sequencing techniques, we sequenced multiple classical MHC class I gene copies from 244 juvenile green turtles (*Chelonia mydas*) and 72 juvenile loggerheads (*Caretta caretta*) with and without FP, collected from the Indian River Lagoon (IRL) in Florida, USA. We also quantified chelonid fibropapilloma-associated herpesvirus (CFPHV) infections using quantitative PCR. We conducted genealogical analyses to assess evolutionary relationships among MHC alleles within and between each species, and converted these alleles to functional supertypes, which allows us to compare only those MHC alleles that differ in antigen binding functionality. Using generalized linear models, we inferred whether significant associations exist between MHC supertypes, the occurrence of FP, and presence of CFPHV infections. We also evaluated the molecular evolution of class I alleles across lineages and amino acids to determine the role of positive selection in shaping turtle immune diversity over time. Preliminarily, our results suggest that MHC allelic diversity in green turtles and loggerheads is much greater than previously thought. Additionally, previous work by our lab has illustrated that the genetic diversity of CFPHV alone is not enough to predict FP incidence in juvenile green and loggerhead sea turtles in the IRL. However, we found that at least six MHC alleles are significantly associated with FP incidence. Thus, immunogenetic diversity may be a more reliable indicator of FP resistance and susceptibility in threatened sea turtle populations. Finally, our study is the first to characterize MHC class I gene diversity in green turtles, and contributes to a better understanding of population-level immunogenetic diversity in this threatened species that has been acutely affected by FP.

GENOMICS AND SEA TURTLE EVOLUTION: GENOME LEVELS OF VARIATION AND HOMOLOGY ACROSS FIVE SEA TURTLE SPECIES REVEALED BY A REDUCED REPRESENTATION METHOD

Camila Mazzoni[1,2], Maximilian Driller[2,3], and Sibelle Torres Vilaca[4]

[1]*Leibniz Institute for Zoo and Wildlife Research (IZW), Berlin, Germany*
[2]*Berlin Center for Genomics in Biodiversity Research (BeGenDiv), Berlin, Germany*
[3]*Free University Berlin (FU-Berlin), Berlin, Germany*
[4]*Trent University, Ontario, Canada*

Turtle genomes have probably gone through a deceleration of evolutionary rates. All sea turtles have the same chromosome number and are expected to have high levels of homology and large conserved syntenic blocks and relatively low divergence in DNA sequences. High conservation at the genomic level allied to deep phylogenetic splits place sea turtles as a particularly interesting and potentially unique model of evolution. However, no formal analysis of the genomic content and levels of nucleotide variability has been performed across different sea turtle species to this date. The new genomic era has opened up new opportunities for studying non-model organisms, but yet only one genome – in a draft state – is currently available for sea turtles. Reduced representation methods, such as RAD-Seq, are inexpensive ways of exploring genome-level features of different species. Without a proper reference genome, this method needs a thorough and robust analytical pipeline to generate unambiguous variation. Here, we have used a carefully developed bioinformatic pipeline customized to sea turtle genome features and were able to compare the genome content of five different sea turtle species in regard to homology, nucleotide variability and divergence levels. Nucleotide conservation across species was found as expected based on the sea turtle phylogeny. On the one hand, our results confirm the earlier expectations that sea turtle genome content is highly conserved and that levels of variability are generally low. On the other hand, our analysis brings new insights regarding where relevant variation in the genome could be unique for the different species. Finally, this study reinforces the importance of investing in complete and high-quality genomes as the only proper way to identify the major differences across different sea turtle species, especially regarding the more variable and repetitive parts of the genome.

OPTIMIZING NEXT GENERATION DNA METABARCODING METHODS TO CHARACTERIZE SEA TURTLE DIET

Christine Sarkis[1], Erin E. Seney[2], Karen Holloway-Adkins[3], MacKenzie Tackett[2], and Anna Forsman[1]

[1]*University of Central Florida, Genomics and Bioinformatics Cluster, Department of Biology, Orlando, FL*
[2]*University of Central Florida, Marine Turtle Research Group, Department of Biology*
[3]*KSC Ecological Program, Kennedy Space Center*

Sea turtle diet composition varies among species, life stages, and localities and can include both plants and animal prey items. A range of techniques are used to characterize sea turtle diets, including visual and microscopic examination of lavage, gut content, and fecal samples. Visual identification of macroalgae and other small food items can be particularly challenging for herbivorous green turtles (*Chelonia mydas*) and for gut contents from dead stranded individuals, which are often degraded due to decomposition. With the

advent of next generation sequencing, it is now possible to identify diet sample components based on genes that are conserved across taxa but that vary in nucleotide sequence (DNA metabarcoding). Our objectives were to (1) identify primer sets that would facilitate efficient library preparation and maximize the number of prey taxa detected through Illumina sequencing, and (2) validate the use of DNA metabarcoding techniques for characterizing green sea turtle diet through comparisons with a subset of visual identification data. We optimized DNA extraction and amplification protocols and metabarcoding primer pairs using 39 diet samples collected from green turtles that stranded on the West Coast of Florida (USA) during 2010-2015. We tested multiple primer combinations targeting plant- and metazoan-specific genomic regions, including trnL and CO1. The trnL gene is found in chloroplast DNA and the trnLc/trnLh primer combination that we tested is plant-specific. We found a range of annealing temperatures that produce successful amplification with this primer pair. However, the same sample produced different sets of amplicons at 52°C and 58°C. To explore whether these amplicons match the trnL region or result from non-specific priming, we sequenced libraries from six diet samples prepared at both temperatures. We also tested CO1 primer pairs, which targets the Cytochrome C Oxidase I gene of mitochondrial DNA. Specifically, we compared the use of standard and degenerate reverse primers in combination with the same forward primer. A degenerate primer should allow for detection of more prey taxa in the sea turtle diet. However, PCR reactions using the degenerate primer variant were not effective with our diet samples, whereas the standard version successfully produced PCR product. Finally, we considered primer concentration. We found that high primer concentration resulted in excess primer and adapter dimers, which reduce the data output of DNA sequencing. Sequencing results from our pilot samples will assist in selecting the best primer combinations and PCR conditions for optimal DNA metabarcoding of green turtle diet samples. The results from this study will provide critical baseline data and protocols to inform our ongoing studies of diet in the context of life history, ecology, and disease dynamics of green turtles and other sea turtle species.

IMPROVED RESOLUTION OF STOCK STRUCTURE AND MIGRATORY CONNECTIVITY IN GREATER CARIBBEAN GREEN TURTLES THROUGH MITOGENOMIC SEQUENCING

Brian Shamblin[1], Karen A. Bjorndal[2], Alan B. Bolten[2], Peter H. Dutton[3], Kristen M. Hart[4], Blair Witherington[5,6], Dean A. Bagley[7], Kate L. Mansfield[7], Donna J. Shaver[8], Robert F. Hardy[5], Shigetomo Hirama[5], Michael J. Bresette[6], Zandy Hillis-Starr[9], Eugenia Naro-Maciel[1o], Llewellyn M. Ehrhart[7], Ian Lundgren[9], Luis Jaime Peña[11], and Campbell J. Nairn[1]

[1]*University of Georgia, Athens, GA*
[2]*University of Florida, Gainesville, FL*
[3]*NOAA-NMFS Southwest Fisheries Science Center, La Jolla, CA*
[4]*United States Geological Survey, Fort Lauderdale, FL*
[5]*Florida Fish and Wildlife Research Institute, Melbourne Beach, FL*
[6]*Inwater Research Group, Jensen Beach, FL*
[7]*University of Central Florida, Orlando, FL*
[8]*Padre Island National Seashore, Corpus Christi, TX*
[9]*Buck Island Reef National Monument, Christiansted, St. Croix, Virgin Islands*
[10]*City University of New York, New York, NY*
[11]*Gladys Porter Zoo, Brownsville, TX*

Nonetheless, the slow rate of mitochondrial evolution and the dispersal capability of marine turtles has often led to extensive sharing of common control region haplotypes, limiting the resolution of population structure and mixed stock analyses. In some cases, nuclear markers have provided further resolution on the scale of female philopatry. However, opportunities for nuclear gene flow, even in the presence of strong female philopatry (and perhaps even male philopatry), can reduce the effectiveness of nuclear markers in characterizing the scale of female natal site fidelity and dispersal. Three common 490 base pair control region haplotypes dominate the profiles of green turtle nesting populations in the Greater Caribbean region: CM-A5 in eastern rookeries, CM-A1 in northern rookeries, and CM-A3 at Tortuguero, Costa Rica and the northern rookeries. Additional mitochondrial markers have proven useful in clarifying cases of ambiguous demographic structure and population origins of surface-pelagic and neritic aggregations. Application of the mtSTR subdivided CM-A5 into 15 different variants, revealing strong stock structure between Aves Island and United States Virgin Island rookeries separated by approximately 250 km. Mitogenomic sequencing of CM-A5 turtles detected four single nucleotide polymorphisms (mtSNPs), defining four haplotypes that were also strongly structured among rookeries. The combination of mtSTR and mtSNP data resolved a total of 22 distinct haplotypes, with only a single haplotype shared between Tortuguero and the eastern rookeries. Control region haplotype frequencies for the rookeries of Tamaulipas/Veracruz, Mexico and central eastern Florida were not significantly different due to sharing of CM-A1 and CM-A3 at similar frequencies. However, mitogenomic sequencing of the CM-A1 females detected a single mtSNP that was diagnostic of each lineage. Subsequent sequencing of the mtSNP in CM-A1 neritic juveniles foraging in Texas and surface-pelagic juveniles captured in the northern Gulf of Mexico off Louisiana and the Florida panhandle excluded Florida contributions and demonstrated that the Tamaulipas/Veracruz management unit was the largest contributor to both aggregations. CM-A3 is the most ubiquitous haplotype in the region, representing 90% of the Tortuguero females and dominating the rookery profiles in southern Florida and many of the Cuban and Mexican rookeries. Inference of population structure among rookeries on the Atlantic coast of Florida and in the Florida Keys was limited by widespread sharing of CM-A3 at high frequencies. These females yielded 10 mtSTR haplotypes that were strongly structured among four management units and demonstrated demographic independence of the insular populations of the Dry Tortugas and Marquesas Keys, 75 km apart. Tortuguero CM-A3 mtSTR frequencies were significantly different from all Florida management units except the Marquesas Keys. Where both mtSNP and mtSTR data are available, it appears that neither fully captures all of the variation, suggesting that mitogenomic sequencing is worthwhile to address unresolved cases of significant mtSTR sharing among rookeries.

COMMUNITY STRUCTURE OF CHELONIA MYDAS AT FORAGING SITES IN THE PENINSULA OF BAJA CALIFORNIA

Miriam Castro-Uribe[1,2], Sergio Francisco Flores Ramírez [1], Agnese Mancini [2], Karen Oceguera[2], and Jesús Lucero-Romero

[1]Laboratorio de Ecología Molecular y Conservación de la Universidad Autónoma de Baja California Sur, Carretera al Sur, Km 5.5 Col. El Mezquitito, La Paz, Baja California Sur Fax: 6121238800
[2]Grupo Tortuguero de las Californias, Calle Ficus 108 Colonia Azaleas, C.P. 23098 La Paz, Baja California Sur

Marine coastal ecosystems at both sides of the Baja California Peninsula (BCP), Mexico, comprise a bevy of highly productive zones, characterized by the prevalence of upwelling events, that generate optimal habitat conditions for diverse and abundant communities of sea turtles, which mostly growth and maturate in such sites. In the area, knowledge on the geographic provenance, relative abundance and stage of maturation, of Eastern Pacific green turtles (*Chelonia mydas*), is very important to propose and implement measures, aimed to conserve this endangered population segment, given the threats imposed by poaching and bycatch. Potentially, turtles (*Cm*) that feed in coastal waters off BCS, can arrive from 4 main nesting areas in the Eastern Pacific: Hawaii, Revillagigedo, Michoacán and Galápagos, which have been characterized as genetically distinct. Therefore, we hypothesized that migration distance between the turtles' birth sites and feeding areas, in addition to habitat selection mediated by the turtles' requirements, will result in differences in size composition and haplotype frequencies (indicative of provenance), among the species' feeding and maturation sites. To test these hypotheses, we collaborated with Grupo Tortuguero de las Californias to collect skin biopsies from dead stranded individuals (2006, 2012 and 2018, n = 290) and morphometric data (CCL and CCW, 2001-2018, n = 5961) from C. mydas individuals at the species' main aggregation sites, such as: Laguna Ojo de Libre (LOL), Punta Abreojos (PAO), San Ignacio Lagoon (LSI), El Cardón (ELC), Puerto López Mateos (PLM) and Magdalena Bay (BMA). Using standard phenol-chloroform extraction methods, we obtained total genomic DNA from each biopsy. Obtained DNA was used to amplify 550 bp of the mtDNA control region of each individual, and elucidated haplotypes were assigned to their provenance rookeries via Bayesian analysis using Mixtock-R software. The analysis revealed that the contribution of each rookery to the PBC community changes temporarily. Mainly, the contribution of the rookeries of Hawaii and Galapagos. These contributed very few individuals to the areas of feeding and growth in 2006, but many in 2012. Notably, Revillagigedo exhibits a constant contribution over the years to the coastal waters of the PBC. This is particularly important, since this small population and one of the most genetically diverse, contributed almost 50% of the turtles that died between 2000 and 2012 in the PBC. In summary, despite being made up of turtles from the same populations, the percentage of contribution of each site defines a possible Regional Conservation Unit, while the differences in time allow us to differentiate between those migratory routes that persist and those that seem to be lost in time, or a dynamic process that ends up changing the structure of the communities. On the other hand, we performed nonparametric Kruskall-Wallis and Nemenyi tests to evaluate if the turtles showed a differential distribution between sites (14), areas (11), regions (2) and years (18), depending on their morphometry (CCL, CCW and weight). Regarding differences in large-scale sizes, significant differences were found on both sides of the PBC, at a meso scale between some areas LOL-PAO, PLM-BMA there is segregation of sizes despite their closeness, and even at micro-scale sites differences in size can be observed such as ELC-LSI, which confirms that the turtles segregate between different feeding and growth sites in the PBC, according to their provenance population and their maturity stage.

FIRST EVIDENCE OF MULTIPLE PATERNITY FOR LOGGERHEAD TURTLES FROM BRAZIL

Laís Amorim[1], Jacob Lasala[2], Ana Carolina Mariano Barcelos[1], Arturo B. Martinelli[1], Lucas Vila-Verde[3], João Luiz Guedes da Fonseca[1], and Sarah Maria Vargas[1]

[1]*UFES (Universidade Federal do Espírito Santo), Brazil*
[2]*Florida Atlantic University, Boca Raton, FL*
[3]*Fundação Pró-TAMAR, Brazil*

Many aspects of marine turtle biology are very difficult to evaluate because they are highly migratory animals and the lack of information can harm conservation efforts. Characterization of a marine turtle's mating system is essential for their conservation, since male reproduction patterns and paternal contributions to nests can directly affect the genetic diversity of populations. No paternity tests have been performed for Brazilian marine turtles so far. The aim of this study was to test the hypothesis of multiple paternity for loggerheads turtle's nests from Povoação beach, near Doce River mouth, Espírito Santo State, in southeastern Brazil. We have analyzed samples from 15 females and 10-20 hatchlings of their nests obtained during one nesting season (2017/2018). We have amplified five polymorphic microsatellites markers for all individuals sampled and, using the program CONOLY, found that 46.6% of clutches sampled had multiple fathers with an average of 1.66 fathers per nest (1-3 fathers found). We also found no evidence of polygyny because no individual fathers contributed for more than one nest in the season analyzed. This is the first study showing polyandry for marine turtles from Brazil and other studies should be done to understand if it is an isolated aspect of loggerheads turtles from Brazil or it is a common pattern. Other studies around the world have shown multiple paternity for loggerheads turtles. The pattern variation found for individual studies could be related to offspring sex ratios produced by sand temperature (TSD) in distinct nesting places, the philopatric behavior of male’s individuals and female’s migrations patterns that enable a variety of matings during migration routes. More studies involving other close by loggerheads Brazilian populations and using the same set of molecular markers must be done to understand if individual males can be contributing to different breeding populations and if the amount of multiple paternity will contrast for different locations and distinctive sand temperature. The results of this work are also showing that the genetic diversity of Povoação Beach is being underestimated by using only mitochondrial molecular markers and that multiple males are contributing to increase the levels of genetic diversity for the second largest nesting population of loggerheads turtles from Brazil.

IN WATER BIOLOGY

COSTA RICA'S SOUTHERN NICOYA PENINSULA: A CRITICAL HOTSPOT FOR THE CONSERVATION OF THE EASTERN PACIFIC HAWKSBILL TURTLE (ERETMOCHELYS IMBRICATA)

Daniel Arauz-Naranjo[1], Elpis J. Chávez[1], Daniela Rojas-Cañizales[1], Carmen Mejías-Balsalobre[1], and Randall Arauz[2]

[1]Rescue Center for Endangered Marine Species, Barva, Heredia, Costa Rica
[2]Fins Attached, Colorado Springs, Colorado, United States

Hawksbill sea turtles (*Eretmochelys imbricata*) are particularly threatened in the Pacific Ocean. One of the principal reasons for its decline is the collection of its elaborately coloured keratinous shell for fabrication of items like rings and pendants as well as being caught as by-catch by gillnets and trawling nets. In the Eastern Pacific (EP), this species was once considered common, however, it is now considered the rarest marine turtle in the region almost reaching regional extirpation. Data on nesting and foraging activity of this species are scarce in the EP, in Costa Rica few foraging grounds alongside the pacific coast have been identified and studies of home range and habitat use with acoustic telemetry have only been performed in one site (Punta Coyote). Starting in 2017, The Rescue Center for Endangered Marine Species (CREMA) has been monitoring a hawksbill population that feeds and grows inside and around the waters of Cabo Blanco Absolute Natural Reserve in Costa Rica's southern Nicoya Peninsula. Using a special sea turtle net and diving techniques, hawksbills have been captured in-water during monthly field expeditions where individuals are measured, weighed, tagged, and released. To track the movements of the animals, sea turtles have been tagged with acoustic transmitters, and 4 acoustic receivers have been deployed in suspected foraging grounds to record the date and time of each "hit" emitted by the acoustic transmitters. To date, 24 different individuals have been captured a total number of 36 times. Of all the captures, 3 were made by free diving, and 3 were captured using SCUBA equipment. 30 turtles were caught using the net, with a catch per unit of effort (CPUE) of 0.56 turtles per hour. The size of the turtles ranged from 35cm to 72.7 cm with weights ranging from 3.45 kg to 41.2 kg. Even though none of the sea turtles reached the reported average nesting size for the area, 3 turtles had evidently developed as males. So far, 12 individuals have been tagged with VEMCO V16 acoustic transmitters. With data from the receivers still being processed, preliminary data shows that this population presents very high site fidelity. Recent studies suggest that hawksbills in the EP exhibit a higher degree of fidelity to their natal area than other species. With restricted or nonexistent migrations, specifically how far hawksbills disperse from rookeries to foraging grounds is still an uncertainty. Specifically, studies on habitat use and movements of juvenile hawksbill sea turtles in the EP would greatly increase much needed understanding to successfully address management questions in the area. Essentially, the survival of young hawksbills and the protection of foraging grounds can have a significant effect upon population growth. I would like to thank The Zoological Society of London's EDGE team, as well as the Photo ARK of National Geographic for providing the main funding for this project. Tags were provided by the New England Aquarium, Lincoln School, and Ocean Tracking Network. Finally, I would like to thank the whole research team of the Rescue Center for Endangered Marine Species for making this project happen.

AVOIDING ATTACK: LEATHERBACK SEA TURTLE (DERMOCHELYS CORIACEA) INTERNESTING MOVEMENTS CIRCUMVENT SHARK ATTACKS

Ayaka Asada[1], Scott Eckert[2], and Randall Davis[1]

[1]*Texas A & M University at Galveston, Texas, USA*
[2]*Principia College, Illinois, USA*

From April to June, female leatherback sea turtles nesting at Sandy Point on St, Croix, USVI lay multiple clutches of eggs separated by ~10 days at sea (i.e., internesting interval) during which they may travel 500-700 km and range up to 150 km offshore. Why do females range so far offshore rather than remaining in waters near the nesting beach? Three hypotheses have been proposed to explain this behavior: a) foraging, b) thermoregulation and c) threat avoidance from sharks and/or aggressive male leatherbacks. We deployed video and data recorders (VDRs) on nine females nesting during May of 2016, 2017 and 2018. The instruments were mounted on the carapace and positioned to image the top of the head to record feeding events. Up to 27 hours of video was recorded for each turtle below a depth of 10 m and continuous data on depth, speed, compass bearing, pitch, roll and water temperature were recorded every second. Five VDRs were recovered with complete data during one internesting period. Of the 3,615 dives below a depth of 1 m, only 0.6% involved feeding on pelagic salps (*Salpa* spp.) and jellyfish such as Atlantic sea nettle (*Chrysaora quinquecirrha*). Therefore, feeding appeared to be opportunistic and rare. Average recorded water temperature (all depths) while at sea was 24°C, and the turtles spent less than 10% of the time in water below a temperature of 22°C. Hence, active behavioral thermoregulation is unlikely as a reason to move offshore. Instead, we propose that avoiding or minimizing shark attack is a primary reason for leatherbacks to move offshore during the interesting interval. We recorded one hundred periods of defensive behavior (average duration = 2.7 min) with the turtles inverting and rotating. This defensive behavior increased fourfold when within 5 km of St. Croix. We infer that this behavior was in response to shark attack. During this study, 50% of the nine instruments deployed were damaged or removed from the turtles. Most of the damage occurred as the turtles approached Sandy Point, and two females disappeared completely (based on the time and date when the satellite and radio transmitters were lost) within 5 km of St. Croix. Rake marks consistent with shark teeth occurred on the VDRs as well as on the carapace around the instrument. Many of the turtles nesting at Sandy Point had fresh wounds or old scares consistent with shark attack, possibly from tiger sharks (*Galeocerdo cuvier*). One recent study showed that 75% of the nesting population during one season had fresh injuries. Our results support the hypothesis that female leatherbacks move offshore during the internesting interval to avoid or reduce the likelihood of shark attack.

INTERACTIONS BETWEEN GREEN TURTLES AND THALASSODENDRON HABITATS REVEALED BY LONG VIDEO RECORDINGS

Katia Ballorain[1], Laure Montchamp[2], Claire Jean[3], and Mayeul Dalleau[1]

[1]*Centre d'Etude et de Découverte des Tortues Marines (CEDTM), Réunion Island*
[2]*AFB*
[3]*Kelonia, Réunion Island*

The Western Indian Ocean (WIO) region is one of the world's most species-rich areas for seagrass, which provide forage for the green turtle (*Chelonia mydas*) and feeding habitat for hawksbill turtles (*Eretmochelys imbricata*). In particular, *Thalassodendron ciliatum*, a large and robust climax seagrass species, is a common Indo-Pacific species, but historically has not been considered a favored element in the diet of the herbivorous green turtles. While mixed-species and intertidal seagrass meadows are known primary as feeding grounds for green turtles, we do not know how monospecific *Thalassodendron* meadows are used. Supported by a newly EU funded project to reinforce seagrass conservation in the WIO, the interactions between sea turtles and *Thalassodendron* are studied in the Marine Nature Park of Glorieuses Archipelago, in the northern Mozambique Channel, where extensive meadows occur up to 30 m depth. Among 10 juvenile green turtles equipped with a Fastloc GPS from 36 to 461 days in 2015-2016, three of them are regularly located in the *Thalassodendron* meadows. Thanks to the latest advances in underwater camera technologies, sea turtle behaviors, habitat use and fine scale movements can be studied through an array of new possibilities. Long video recordings (230 hours of footage) from turtle-borne cameras (up to 15.5 hours long videos per deployment) and remote 360° underwater cameras (up to 6 hours long videos per deployment) are used in 2018 to complete Fastloc GPS information and isotopic analysis (n=60 juveniles) to reveal the functional role of *Thalassodendron* habitats for sea turtles. Our study proposes an integrated approach to assess the ecology of juvenile sea turtles foraging in remote habitats and results provide valuable insights into sea turtle behavioral ecology, diets and habitats selectivity. The value of *Thalassodendron* meadows as a suitable habitat for the green turtle is highlighted, and enhances our knowledge of the ecosystem services that this poorly documented yet abundant seagrass species provides for sea turtles. In the framework of the same project, a Western Indian Ocean Seagrass Network is being set up and aims to facilitate regional cooperation on seagrass-turtle interaction researches.

FORAGING ECOLOGY OF HAWKSBILLS IN ROATÁN, HONDURAS: INSIGHTS FROM IN-WATER OBSERVATIONS AND STABLE ISOTOPE ANALYSIS

Dustin S. Baumbach[1,2], Marsha K. Wright[1,2], Jeffrey A. Seminoff[3], Garrett Lemons[3], Klaus Rützler[4], Brian Wysor[5], Gary W. Saunders[6], Dennys Estevez[7], Lidia Salinas[8], and Stephen G. Dunbar[1,2,8]

[1]*Marine Research Group, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, CA 92350*
[2]*Protective Turtle Ecology Center for Training, Outreach, and Research, Inc. (ProTECTOR, Inc.), Loma Linda, CA 92350*
[3]*NOAA-National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, CA 92037,*
[4]*Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560*
[5]*Department of Biology, Marine Biology and Environmental Science, Roger Williams University, Bristol, RI 02809*
[6]*Centre for Environmental & Molecular Algal Research, Department of Biology, University of New Brunswick, Fredericton, NB E3B 6E1*
[7]*School of Public Health, Research Consulting Group, Loma Linda University, Loma Linda, CA 92350,*
[8]*Protective Turtle Ecology Center for Training, Outreach, and Research, Inc.–Honduras (ProTECTOR, Inc.–Honduras), Tegucigalpa, Honduras*

The hawksbill sea turtle (*Eretmochelys imbricata*) is listed in the IUCN Red List as critically endangered worldwide, yet much is still unknown about this species. Recent work worldwide has shown that hawksbill diet intake is variable depending on the habitat in which they reside (mangroves or coral reef). To understand more about how to protect hawksbills, researchers have focused on identifying their foraging ecology and habitat use in these areas. Still, few data are available about these aspects for hawksbills in the western Caribbean, despite consistent populations throughout the region. We describe the foraging ecology of juvenile hawksbill turtles at a tropical coral reef system in the western Caribbean Sea: the Sandy Bay

West End Marine Reserve (SBWEMR), Roatán, Honduras. We conducted focal follows for 31 hawksbill turtles using SCUBA, and recorded all ingested items along with the amount of time individuals spent feeding on each item. Observed prey species were collected and identified to lowest taxonomic unit by sponge and algae specialists. Hawksbills were then hand-captured and brought to a laboratory facility where we collected blood and skin samples, and applied flipper tags. Stable-carbon and -nitrogen isotope values were measured for each blood fraction (red blood cells and plasma) and habitat samples. Due to a longer turnover time, RBC data provide retrospective dietary information over a longer timeframe (weeks to months), compared to plasma which provides more recent information (days to weeks). We conducted linear regressions on time of day vs. food type for in-water observations, and generated Bayesian mixing models for stable isotope data using MixSIAR. We identified hawksbill prey items as the sponge, *Geodia neptuni* and the red alga, *Kallymenia liminghii*. Regression models revealed that, during the 5 hours of recorded hawksbill observations, turtles spent significantly more time foraging on *G. neptuni* in the morning (mean = 233.69 min with 95% CI: 158.64, 344.25; $p = 0.0242$) and late-morning (mean = 585.78 min with 95% CI: 215.47, 1592.52; $p \leq 0.001$) than in mid-morning (mean = 170.47 min with 95% CI: 101.12, 287.40; $p = 0.4174$) and afternoon (mean = 214.56 with 95% CI: 140.96, 326.60; $p = 0.1073$). Plasma data from Bayesian stable isotope mixing models revealed that *G. neptuni* constituted more than half of hawksbill diets (mean = 0.517 ± 0.045 SD), followed by *K. liminghii* (mean = 0.348 ± 0.048 SD). Similarly, red blood cell data revealed *G. neptuni* as the main prey item (mean = 0.669 ± 0.040 SD) followed by *K. liminghii* (mean = 0.238 ± 0.036 SD). The similarity in results for plasma and RBC mixing models suggests that hawksbill diet remains consistent through time. To our knowledge, this is the first-ever SIA study of hawksbills in the western Caribbean, and the first to identify *K. liminghii* in the diet of Caribbean hawksbills. Future studies should investigate this prey item further to determine its benefit to hawksbills.
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HOOKED ON PIERS: AN INCREASE IN JUVENILE GREEN SEA TURTLES CAPTURED INCIDENTALLY ALONG SOUTHEAST FLORIDA RECREATIONAL FISHING PIERS

Caitlin Bovery[1], Whitney Crowder[1], Cody Mott[2], and Jeff Guertin[2]

[1]*Gumbo Limbo Nature Center, Florida, USA*
[2]*Inwater Research Group, Florida, USA*

Sea turtles display habitat site fidelity that varies across life stages. After spending their early years foraging in an oceanic drift community, juvenile green sea turtles (*Chelonia mydas*) recruit to inshore shallow waters at approximately 2-5 years of age where they remain until they mature. Because of the proximity of many nearshore habitats to piers or inlets, sea turtles often strand in these areas due to human interactions. Gumbo Limbo Nature Center's Sea Turtle Rehabilitation Facility (GLNC) has been treating injured sea turtles since 2010. Recently, GLNC recorded an increase in the number of juvenile green sea turtles treated due to injuries sustained from incidental capture on local piers in Southeast Florida. Additionally, GLNC staff have noted a decrease in the frequency of dead strandings reported to Gumbo Limbo Nature Center in proximity to the same piers. One possible explanation for the recent increase in incidental captures of juvenile green sea turtles is the implementation of the Responsible Pier Initiative (RPI) at the Deerfield Beach International Fishing Pier in July 2015. Originally developed by the Loggerhead Marinelife Center in Juno Beach, Florida, USA, the RPI has since been incorporated at fishing piers throughout the southeast United States. The program installed educational signage and a rescue net on the pier to facilitate the rescue

and reporting of incidentally captured sea turtles on piers. Since launching this community outreach program in 2015 at the Deerfield Pier, GLNC has seen a 683% increase in live strandings due to interactions with recreational fishing gear on local piers. Of those live strandings, 22% have been previously captured on a recreational fishing pier, including one case study that was recaptured three times in under two years on the same pier. The frequency of sea turtle interactions with fishing piers presents a unique opportunity to gain new insights into how juvenile green sea turtles utilize these waters and what level of site fidelity they may display towards these foraging grounds. In 2018, Inwater Research Group and Gumbo Limbo Nature Center began a collaborative acoustic telemetry study of wild caught and pier-hooked juvenile green sea turtles in nearshore and intracoastal waters surrounding the Deerfield Pier. An array of acoustic receivers was placed in these waters, and acoustic transmitters were deployed on wild-caught juvenile green sea turtles and rehabilitated juvenile green sea turtles that were hooked at the Deerfield Pier. Preliminary data from acoustic telemetry indicate strong fidelity within the study area. Additionally, anecdotal evidence of local divers sighting acoustic tagged turtles and one instance of an acoustically tagged rehabilitated sea turtle being recaptured at the pier four times within the last year confirms the residence of turtles in the area. As interactions between sea turtles and recreational fishing gear continue to rise, further understanding of the site fidelity and habitat use of these nearshore sea turtle inhabitants could prove crucial to their management as a protected species, specifically regarding rehabilitation programs, pier management, and implementation of community outreach programs. Acknowledgements: The authors would like to acknowledge all of the volunteers and staff who dedicate countless hours to the Gumbo Limbo Sea Turtle Rehabilitation Facility. We also thank the Inwater Research Group and Friends of Gumbo Limbo for funding this project and their constant support of sea turtle conservation and rehabilitation at Gumbo Limbo Nature Center. All work was authorized under Florida Fish & Wildlife Conservation Commission Marine Turtle Permit #084.

EPIBIONTS OF HAWKSBILL SEA TURTLES IN SOUTHEAST FLORIDA

Liberty Boyd[1] and Lawrence Wood[2,3]

[1]*Florida International University, Florida USA*
[2]*Florida Hawksbill Project, Florida, USA*
[3]*National Save The Sea Turtle Foundation, Florida, USA*

Sea turtles, like all marine vertebrates, can host considerable populations of epibionts, externally-attached symbiotic organisms on the skin and shell. These organisms can form facultative, obligate, and sometimes endemic commensal relationships with sea turtles, whose outer surface provides an insular, mobile substrate for their colonization and dispersal. Juvenile hawksbill turtles, Eretmochelys imbricata, living off Florida's east coast can develop epibiotic growth on the head, body tissue, plastron, and carapace. For this study, photographs of 213 individual hawksbill turtle carapaces (including re-captures) from SE Florida were analyzed to document colonization patterns, relative abundance, and ecology of macroscopic commensals, including sea turtle barnacles (*Chelonibia* spp.) and fire coral (*Millepora* spp.). ImageJ was used to quantify the percent coverage, spatial dispersal, and growth rate of these organisms on the carapace. Preliminary results show that although overall epibiotic abundance increased significantly with turtle size, it was not uniformly dispersed. The primary turtle barnacle, *Chelonibia* spp., showed clumping behavior at preferred settlement sites at or near the apex of the carapace, while *Millepora* spp. preferred settlement sites on the lower carapace, specifically the posterior scutes. Hawksbill epibionts may reflect turtle movement and dispersal and can serve as a model for studying successional processes of epibiotic colonization. I would like to give special thanks to Dr. Larry Wood of the Florida Hawksbill Project for providing me with the photographs and capture data for this project. I would also like to thank the Florida Hawksbill Project, the

National Save the Sea Turtle Foundation, and Kyalami Charters for providing the means and funding to go diving off Jupiter, Florida to capture turtles and collect data.

APPARENT DIGESTIBILITY OF MARINE MACROALGAE AND FISH IN JUVENILE GREEN TURTLES

Patricia Campos and Luis Cardona

Department of Evolutionary Biology, Ecology and Environmental Science and IRBio, University of Barcelona, Barcelona, Spain

Determining both the nutrient requirements of a species and its digestive strategy is critical to gain a full understanding of its nutrition. Herbivores consume foods that are often low in many essential nutrients and high in structural constituents, which may result into reduced digestibility. The assessment of the digestibility coefficient is thus essential for measuring the daily ration and the daily energy intake. These coefficients are also useful for understanding resource partitioning by different species of herbivores that graze/browse in the same area. Juvenile neritic green turtles (*Chelonia mydas*) acquire a microbiota rich in polysaccharide fermenting bacteria quickly after settlement in neritic habitats, but may behave as omnivores for an elapsed time. The apparent digestibility of seagrasses is high, but little is known about the digestibility macroalgae, which dominate the diet of green turtles in most areas. For that reason, we investigated the digestibility and calculated the intake passage time (IPT) of the red algae (*Pterocladiela capilacea*), the brown macroalgae *Sargassum* sp. and the fish *Cynoscion leiarchus*. The digestibility experiment was conducted in captivity at the facilities of Projeto Tamar at Ubatuba, Brazil, and involved green turtles ranging from 48.0 to 63.0 cm in curved carapace length. Faces and food samples were collected and analysed to evaluate the proximate chemical composition (water, carbohydrate, protein, lipid and ash), the energy density and the apparent digestibility of each diet. External markers (plastic beads) were added to each diet to calculate IPT, which was 20.6±3.8 days (mean± SD). Diets differed largely in nutrient contents and energy density, as well as in apparent digestibility. Results indicated that the apparent digestibility of the *Pterocladiela capilacea* and fish diets were similar (93.9% and 98.9% respectively) and significantly higher than that of the *Sargassum* sp. diet (75.8%). Those differences arose partially from the higher apparent digestibility of fibre from *Pterocladiela capilacea* as compared to that from *Sargassum* sp. (95.2% and 84.0% respectively). The overall evidence indicates that foraging on *Pterocladiela capilacea* is more profitable than foraging on *Sargassum* sp., which may explain the prevalence of red algae in the diet of green turtles off Brazil. Furthermore, evidence indicates that red algae diets are similar to animal diets as far as digestibility is considered, although a higher daily intake is necessary to acquire the same energy intake, due to a lower energy density. Acknowledgements: This research was funded by CNPq- Conselho Nacional de Desenvolvimento Científico eTecnológico – Brasil (ASM grant 235186/2014-7). We are thankful to the team of the Projeto Tamar - Brazil, for helping with the field work.

EFFECT OF TIDAL SURFACE CURRENTS ON THE OFFSHORE HATCHLINGS DISPERSION. A COMPARATIVE STUDY AMONG GREEN AND HAWKSBILL TURTLES ON CHAGAR HUTANG TURTLE SANCTUARY, PULAU REDANG, MALAYSIA

Javier Oñate Casado

[1]Sea Turtle Research Unit (SEATRU), Universiti Malaysia Terengganu, Kuala Terengganu, Terengganu, Malaysia
[2]School of Biological Sciences, The University of Queensland, Australia

Sea turtle hatchlings emerge from underground nests at night and rapidly crawl to the sea to swim offshore. Once in the water, hatchling might experience high predation rates while in shallow water before reaching deeper water where both encounters with predators and mortality rates likely decline. Behavioral studies have described different swimming strategies used by hatchlings to counter near-shore predation. Dispersal away from nearshore to open ocean is also likely to be influenced by coastal and oceanographic conditions. This study, performed at Pulau Redang (Malaysia), compared predation rates of green turtle hatchlings (*Chelonia mydas*) and hawksbill turtle hatchlings (*Eretmochelys imbricata*) as they disperse from the same beach (Chagar Hutang Bay) under the same environmental conditions. The possible influence of tidal and wind-induced surface currents on this dispersal process were also assessed. An Acoustic Doppler Current Profiler was used to measure surface currents, and direct observations of hatchlings swimming off-shore were taken from a kayak using GPS loggers to track hatchling swimming paths. Green turtle hatchlings swam faster and more directly offshore than hawksbill hatchlings. Despite this difference in dispersal behaviors, there was no difference in predation rate found between green and hawksbill hatchlings, with most predation events occurring within 150 meters of shore indicating that predators are more abundant in shallower areas of the bay where coralline-rocky areas predominate. Straight-line distance from shore was positively correlated with surface current speeds for green turtle hatchlings suggesting some reliance on surface currents in assisting off-shore migration of this species. Surface current speed varied among moon phases, being quicker under waxing moon conditions. The findings of this study provide a better understanding of how both hatchling species differ when they migrate off-shore in natural conditions and how dispersal is affected by predation, moon phase and physical oceanographic conditions in Chagar Hutang Turtle Sanctuary. Acknowledgements: I would first like to thank to my supervisors and SEATRU for funding this project. I am profoundly thankful to my supervisor Uzair for giving me the opportunity of working with sea turtles in such a charming place like Chagar Hutang. A special big thank you to my supervisor David for his extremely quick feedbacks and corrections as well as for teaching me how to deal with hard and stressful moments during fieldwork. Special mention to the Erasmus Mundus Masters Programme TROPIMUNDO for the thesis grant for fieldwork.

TIME AFTER TIME: EVALUATING MARINE TURTLE SIGHTING DATA USING TIME-TO-DETECTION MODELS

Ryan Chabot, Ryan C. Welsh, Cody Mott, Jeff Guertin, Steven T. Weege, Blair Witherington, Jonathan C. Gorham, and Michael J. Bresette

Inwater Research Group, Florida, USA

The focus of most in-water marine turtle research falls into two categories: capture of individuals and visual counts of individuals as part of a population survey (e.g., sighting transects) without capture. Capturing

turtles allows for measurement, sample collection, and health assessments, but often limits sample sizes because of large investments of time and resources per animal. In contrast, visual counts can provide population-level information at larger geographic scales, but with tradeoffs that include minimal information gathered at the individual level. Time-to-detection analyses are a group of statistical models that rely primarily on how long it takes for an individual to reach an "event" (e.g., seed germination, animal detection, etc.) to understand how the probability of an event occurring varies through time. Haphazard, Unmarked, Nonlinear Transects (HUNTs) are a valuable tool for marine turtle research, particularly in the pursuit of individuals for active capture. The duration of HUNTs before sighting an individual can also be used as time-to-detection data. Distance sampling is a technique used to provide robust estimates of wildlife abundance and associated covariates. However, stringent model assumptions frequently restrict study designs to those excluding animal capture. Although important potential covariates (e.g., water temperature, size class, etc.) are collected during these HUNTs, their structure frequently violates the assumptions of distance sampling. Combining these covariates with HUNT duration information at the individual level may help elucidate how covariates at the population level can affect time-to-detection. In this study, we used Cox proportional hazards models (a class of time-to-detection models) to evaluate the relationship between covariates and time-to-sighting data collected across three marine turtle species. In total, 746 HUNTs were conducted in the nearshore waters between Crystal River and Homosassa Springs, Florida, USA between 2012-2018. Three categorical (study area section, cloud cover, and wave height) and two continuous (water temperature and tide level) variables were included as covariates. We employed a model selection framework across species and size classes, using AICc values to determine the most informative model(s) for each. For n = 32 loggerheads (*Caretta caretta*), time-to-detection was significantly longer in one study section in comparison to the other three. Detection remained similar across different cloud covers in calm seas but changed in a non-linear pattern at higher wave heights. For juvenile Kemp's ridleys (*Lepidochelys kempii*) (n = 108), time-to-detection across water temperature regimes shifted in a non-linear manner with increasing cloud cover. With subadult ridleys (n = 55), time-to-detection generally grew longer with increasing wave height. Individuals were also detected more quickly at lower tides versus higher tides. For n = 551 juvenile green turtles (*Chelonia mydas*), differences in time-to-detection were driven by a complex interaction of tide and temperature among study area sections. The most informative models for loggerheads and both Kemp's ridley size classes contained variables linked to both observability (e.g., cloud cover) and behavior (e.g., starting temperature), whereas the best model for juvenile green turtles contained only variables that, in this case, are associated primarily with behavior. These differences may be driven, in part, by the fact that green turtles often flee more rapidly during vessel approach than the other two species. This rapid flight response makes them more conspicuous, increasing the likelihood that green turtles will be observed regardless of environmental conditions. To our knowledge, this is the first use of these types of time-to-detection models in a marine turtle study. Although not meant as a replacement for more robust population survey frameworks, this methodology may be useful to assess important population-scale covariates while still conducting active capture of individuals, and could inform the creation of more robust distance sampling study designs.

COMPARING STABLE ISOTOPE SIGNATURES TO DIET SNAPSHOTS IN JUVENILE GREEN TURTLES

Taylor Collins, Chris Long, Erin E. Seney, and Kate L. Mansfield

UCF Marine Turtle Research Group, Florida, USA

Stable isotope analysis (SIA) is a tool often used to investigate foraging ecology by producing broad-scale data on what and where an animal has been eating. Therefore, SIA can provide valuable information about foraging habits of migratory marine species that are more difficult to observe, including sea turtles.

Sexually immature sea turtles do not follow the consistent breeding to foraging habitat migration patterns of adult turtles. Therefore, it is largely unknown where juvenile sea turtles have been and what their foraging ecology was before a sample was taken, a key missing piece of information that often limits the utility of stable isotope techniques in this life stage. However, if current diet is known, we can assess its correlation with stable isotope signatures. Our goal was to leverage our concurrent diet and stable isotope data for juvenile green turtles to enhance our ability to use stable isotopes to draw general conclusions about their foraging ecology. Juvenile green turtles (*Chelonia mydas*) are found foraging in the Indian River Lagoon (IRL), a large estuarine habitat along the eastern coast of Florida, USA. We collected 87 pairs of esophageal lavage and skin samples from green turtles captured in the IRL during 2017 and 2018. Esophageal lavage provides diet samples that are a snapshot of current diet, while SIA of skin samples utilizes a longer integration of foraging ecology over 4-6 months. We used molecular techniques and next-generation sequencing to identify specific food items in the diet of sampled turtles and compared them to their carbon and nitrogen stable isotope signatures. In so doing, we determined the association between turtles' diet and their stable isotope signatures. If diet is correlated with stable isotope signatures, we can assume foraging ecology has stayed relatively constant over the previous months. However, if stable isotope signatures are not highly correlated with current diet, it could mean the turtles have changed their diet and/or habitat over the previous 4-6 months. Either result further informs the use of stable isotopes in juvenile green turtles in the IRL and may help future studies better examine habitat use and foraging ecology, allowing for more robust research on the impact of habitat characteristics on turtle health and distributions. Funding sources: This project was funded in part by a grant awarded from the Sea Turtle Grants Program. The Sea Turtle Grants Program is funded from proceeds from the sale of the Florida Sea Turtle License Plate. Learn more at http://www.helpingseaturtles.org.

STABLE ISOTOPE ANALYSIS OF SOUTHWESTERN ATLANTIC LEATHERBACK TURTLES (DERMOCHELYS CORIACEA): HABITAT USE AND FEMALE-OFFSPRING RELATIONSHIPS

Liliana Poggio Colman[1], João C. A. Thomé[2], Cecília Baptistotte[2], Annette C. Broderick[1], Julia C. Haywood[1], Ana C. Marcondes[3], Evandro A. de Martini[2], Thaís Pires[3], Flávia A. Ribeiro[3], Lucas Vila-Verde[3], Matthew J. Witt[4,5], and Brendan J. Godley[1,4]

[1]*Centre for Ecology and Conservation, University of Exeter, Cornwall, UK*
[2]*Centro TAMAR-ICMBio, Vitória, ES, Brazil*
[3]*Fundação Pró-Tamar, Vitória, ES, Brazil*
[4]*Environment and Sustainability Institute, University of Exeter, Cornwall, UK*
[5]*Biosciences, University of Exeter, Exeter, UK*

In the Southwestern Atlantic Ocean, leatherback turtles (*Dermochelys coriacea)* nest mainly on the coast of Espírito Santo, eastern Brazil (between latitudes 19°49'S and 19°20'S). This subpopulation is classified as Critically Endangered by the International Union of Conservation of Nature (IUCN), mainly due to its small population size and restricted geographical distribution. In order to investigate the marine habitat-use of nesting leatherback turtles and individuals washed ashore along the Brazilian coast, we performed stable isotopes analysis (SIA) of carbon (13C) and nitrogen (15N) on skin tissue of 61 leatherback turtles (2012-2017). A k-means cluster analysis revealed that nesting females segregate into at least two distinct groups based on their isotope values. Further evidence from satellite tracking suggests differences in their choice of foraging habitats (oceanic vs. more coastal). The overlap in stable isotope signatures between individuals washed ashore and the nesting population suggests that some could have been sharing foraging areas; or pertain to the Critically Endangered Brazilian nesting population. We also determined the stable isotope ratios of offspring tissues (egg yolk and hatchlings) from 16 assigned females (2015-2016). Egg-yolk and hatchling isotope values are correlated with nesting females for both 13C and 15N, indicating that offspring tissue is a valuable proxy for assessing isotope data in leatherback turtles when female tissues are not available. Linear mixed-effects models showed that time in days did not affect 13C or 15N in egg yolk or hatchlings in successive clutches. Further research combining SIA and tracking is needed to better understand habitat use and better determine the location of the feeding areas, contributing to the design and implementation of public policies for the effective conservation of this species in the Southwestern Atlantic Ocean.

INTEGRATING UAV IMAGERY AND BENTHIC SURVEYS TO STUDY DYNAMICS OF GREEN TURTLE GRAZING PLOTS

Nerine Constant, Alan B. Bolten, and Karen A. Bjorndal

Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, Gainesville, FL, USA

Green turtles (*Chelonia mydas*) are specialized grazers that maintain grazing plots by repeatedly cropping areas of seagrass. By creating and maintaining grazing plots, they affect the structure and function of seagrass ecosystems, and green turtles will play an increasingly important role as population recovery continues in response to long-term conservation efforts. Given the value of seagrass ecosystem services, there is growing interest in understanding the effects of green turtle grazing on their foraging habitat. Studies of green turtle foraging ecology have documented grazing plots ranging in area from less than 1 m^2 to over 100 m^2 and maintained for more than one or two years. However, little is known about how grazing plots change over time, which would provide insight into the scale of these effects. To study how green turtles establish, expand, and abandon grazing plots, we combined benthic survey data and imagery captured using a DJI Phantom 4 Advanced quadcopter at two naturally grazed seagrass meadows on the east coast of Eleuthera, The Bahamas. Both meadows are shallow (<4 m in depth), dominated by turtle grass (*Thalassia testudinum*), and grazed by juvenile green turtles. From June to September 2018, we captured images of grazing plots from an altitude of 10 m at one- to two-week intervals, flight conditions permitting. From the imagery, we obtained grazing plot area, perimeter, and dimensions and assessed change in these metrics over the monitoring period. To better understand spatial distribution of grazing intensity within plots, we conducted benthic transects for seagrass density and structural characteristics across 5 plots. To complement benthic surveys and confirm foraging patterns, we captured imagery opportunistically from higher altitudes (>30 m), which allowed us to quantify the spatial distribution of green turtles in grazing plots without disturbing their foraging behavior. Integrating unmanned aerial vehicle (UAV) imagery with benthic survey data provided a novel approach to monitor change in grazed areas, and our results will contribute to the limited knowledge of grazing plot dynamics. Acknowledgements: This project was funded by the PADI Foundation, the American Society of Ichthyologists and Herpetologists through the Helen T. and Frederick M. Gaige Fund, and the Archie Carr Center for Sea Turtle Research through the Disney Conservation Fund and the Jeff and Monette Fitzsimmons Fund. The authors thank Annabelle Brooks, Nathan Robinson, and the staff of the Cape Eleuthera Institute for their kind support and Eve Moore and Robert Johnson for their invaluable assistance during field work.

IDENTIFYING BEHAVIORAL BIASES CAUSED BY SATELLITE TAGS USING GEOMAGNETIC NAVIGATION MODELING

Sabrina Corbin[1], Andrew Herrmann[1], Noah Valloch[1], Susan Piacenza[1], Joseph Piacenza[2], and Brian Taylor[3]

[1]Department of Biology, University of West Florida, Florida, USA
[2]Department of Mechanical Engineering, University of West Florida, Florida, USA
[3]Department of Biology, University of North Carolina at Chapel Hill, North Carolina, USA

Sea turtles embark on long distance migrations to foraging grounds and nesting beaches, using multiple navigational modalities of magnetic, olfactory and visual cues. Satellite-linked platform terminal transmitters (PTTs) yield critical information about sea turtle movements in the ocean, their habitat usage, and migratory times. However, PTTs induce drag which may impact their swimming velocity, which could translate into phenological disruption of foraging and reproduction. It is unknown to what extent PTTs influence swimming behavior due to additional energy required to overcome the tag's drag, and if data derived from PTTs on sea turtles are representative of non-tagged individuals. And, what are the likely long-run consequences on sea turtle migratory pathways? This research aims to build on existing agent-based models for understanding sea turtle geomagnetic navigation, by incorporating the hydrodynamic drag imposed by the PTT into the model. This will help to better understand sea turtle swimming behavior at different stages of development, ranging from neonate to adulthood, and will provide insight into the relationship between swimming velocity and energy consumption as turtles navigate to waypoints. In order to do this, a computational energy balance will be incorporated into our simulation that describes the relationship between the oxygen and caloric consumption of a sea turtle and the external forces impacting swimming speed such as drag from the turtle, drag from the tag, and drag from the current. To parameterize the model, we will use hydrodynamic drag values imposed by state-of-the-art PTTs on 3D printed sea turtle models obtained through wind tunnel testing [California State University - Fullerton]. The 3D printed turtle models were created by 3D scanning 14 post-mortem sea turtles from Florida of four species: *Chelonia mydas, Eretmochelys imbricata, Lepidochelys kempsii,* and *Caretta caretta.* In the geomagnetic navigational simulations, we will model turtles with and without PTTs and compare swimming velocities and caloric consumption in the two groups. We will also investigate navigational timing and determine differences in patterns for tagged and untagged turtles. This work will be useful to improve our understanding of likely consequences of PTTs on turtle swimming behaviors, and to determine how PTTs might bias our understanding of sea turtle migratory movements. We predict that our final results will show that PTTs of any size create a substantial change in swimming behavior which affects how and when the turtles will reach the waypoints.

SATELLITE TRACKING MALE SEA TURTLES TAGGED IN DRY TORTUGAS NATIONAL PARK, FL

Andrew G. Crowder[1], Michael S. Cherkiss[2], Brian J. Smith[1], David C. Roche[2], Mathew Denton[2], and Kristen M. Hart[2]

[1]*Cherokee Nation Technologies, Contracted to the U.S. Geological Survey, Davie, FL, USA*
[2]*Wetland and Aquatic Research Center, U.S. Geological Survey, Davie, FL, USA*

Many sea turtle tracking and ecological studies have focused on females due to ease of access to individuals on the beach during a nesting event. Nesting occurs on a predictable seasonal cycle (every 10-14 days), with an interval of 2 to 5 years between nesting seasons, depending on the species. Through satellite telemetry, researchers have discovered patterns of migratory behavior of these long-lived imperiled marine reptiles. Male sea turtles, in contrast, have been understudied and as a result their behavioral ecology remains largely unknown. A better understanding of male movement patterns and space-use would inform our understanding of population dynamics, gene flow, and the threats these males face. In our long-term (2008-2018) capture-mark-recapture (CMR) and satellite tagging research in the Dry Tortugas National Park (DRTO) within the Florida Keys National Marine Sanctuary, we regularly capture sub-adult and adult male green (Chelonia mydas) and loggerhead (Caretta caretta) sea turtles. Here we report on satellite tracks and movements of 23 males (20 green turtles, 3 loggerheads) tagged using Wildlife Computers SPOT tags in DRTO. In 5201 tracking days, mean tracking duration for green turtles was 195 days (range 46-734, SD 189), whereas it was longer for loggerheads (mean 498 days, range 41-1177, SD 599). Male green turtle sizes ranged from 81.5 cm – 105.2 cm straight carapace length to the notch (SCL-notch) while loggerhead sizes ranged from 79.7 cm – 92.7 cm SCL-notch. We used switching state-space modeling (sSSM) to identify time periods when and locations where individuals displayed directed movement versus area-restricted search activity. For 21/23 turtles (2 loggerheads, 19 green turtles), successful sSSM results showed that 10 of them migrated; all 10 migrants were green turtles. In a total of 319 migration days, average start date of migration was June 16, and average end date was July 18. For those that migrated, the mean days in migration was 31.9 days (range 1-227). Although many individuals displayed high site-fidelity to DRTO, two migrated to the Yucatan Peninsula (Mexico), and four others made shorter exploratory movements. Timing and location of looping movements were variable across individuals, yet all indicate potentially "risky" behavior that warrants further study. For example, several turtles interacted with paths of high-use vessel traffic or moved internationally where U.S. laws prohibiting harvest would not apply. Furthermore, though much of the tracking time documented to date occurs in Marine Protected Areas (MPAs) there are still anthropogenic pressures such as recreational boat races and fishing that are allowed that put these imperiled sea turtles in harm's way. Understanding the timing and extent of these risky movements will help to predict risk for males outside of protected waters.

GOING BEYOND EDUCATION AND CONSERVATION: WHAT CAN SATELLITE TRACKING REHABILITATED SEA TURTLES TELL US?

Whitney Crowder and Caitlin Bovery

Gumbo Limbo Nature Center, Florida, USA

Applications of satellite tracking sea turtles in a rehabilitation setting are likely fundamentally underappreciated. Sea turtles are admitted to rehabilitation facilities for natural causes such as injuries from predators or illnesses, as well as pressures from anthropogenic activities including boat strikes and fishing gear interactions. Sea turtles from Gumbo Limbo Nature Center's (GLNC) Sea Turtle Rehabilitation Facility are occasionally satellite tracked to monitor the rehabilitation success post-release and serve as a tool for education and outreach. Satellite telemetry of rehabilitated and released sea turtles' movements could be a useful tool to the scientific community when assessing resource management practices. A comparative analysis of movements and behaviors of rehabilitated sea turtles verses wild caught individuals should be further explored. In a comprehensive review of satellite tracking conducted in 2008, results identified specific gaps in satellite tracking coverage that could possibly be filled by tracking rehabilitated sea turtles. Many wild caught sea turtle satellite tracks are collected from adult female sea turtles as they are accessible from nesting beaches or hand captured from well-known rookery locations. GLNC often encounters several size classes, species, and sexes of turtles that are currently underrepresented in the published literature. Satellite telemetry of these individuals could provide invaluable data. Here we present the results from satellite telemetry of eight sub-adult and adult loggerhead sea turtles that were treated at GLNC's Sea Turtle Rehabilitation Facility. Post-release movements of these turtles indicate a strong alignment with National Marine Fisheries Service designated critical habitat for Atlantic loggerhead sea turtles. Additionally, preliminary comparisons between satellite tracked rehabilitated and wild adult loggerhead sea turtles suggest that these turtles use similar habitats as wild caught sea turtles studied in traditional research projects. Due to the limited information in published literature regarding rehabilitated sea turtle movements and behaviors post-rehabilitation, there is a wide gap in our understanding of the value of these data. In direct response to this scarcity, Gumbo Limbo Nature Center is facilitating a study involving several sea turtle rehabilitation centers in the southeastern United States in collaboration with the United States Geological Survey to better understand rehabilitated sea turtles' behaviors post-release. With this study, we hope to examine post-rehabilitation movements of sea turtles in direct comparison with wild tracked sea turtles to identify any commonalities among habitat preferences and behaviors and determine if rehabilitated sea turtles return to their normal behaviors after release. Acknowledgements: The authors would like to thank the Friends of Gumbo Limbo for their constant support and funding of sea turtle conservation and rehabilitation at Gumbo Limbo Nature Center. All work was authorized by the Florida Fish and Wildlife Conservation Commission (MTP#084). Thank you, United States Geological Survey, for the opportunity to collaborate on this project.

SEA TURTLES OF BISCAYNE NATIONAL PARK IN SOUTH FLORIDA

Andrew G. Crowder[1], Michael S. Cherkiss[2], Brian J. Smith[1], David C. Roche[1], Derek Burkholder[3], and Kristen M. Hart[2]

[1]*Cherokee Nation Technologies, Contracted to the U.S. Geological Survey, Davie, FL, USA*
[2]*Wetland and Aquatic Research Center, U.S. Geological Survey, Davie, FL, USA*
[3]*Nova Southeastern University, Halmos College of Natural Sciences and Oceanography, Davie, FL*

Little information is available about the composition of the sea turtle population in Biscayne National Park, south Florida. Both loggerhead (Caretta caretta) and green (Chelonia mydas) turtles nest in low numbers on the ocean-facing beaches, but surveys and captures of in-water turtles have been irregular. In 2018, we initiated a project in Biscayne Bay to capture and tag turtles to determine turtle community composition and to identify areas of the park that serve as important foraging grounds. A long-term research goal is to determine turtle use of the national park area and whether individuals are resident or instead just transiting through the park waters. To date we have successfully rodeo-captured two green and ten loggerhead sea turtles (n=12), including one adult female that was originally sampled by Sanibel Captiva Conservation Foundation in the summer of 2017 while nesting on Sanibel Island; all other turtles were previously untagged. Both green sea turtles sampled were sub-adults (n=2) ranging from 62.8 – 73.3 cm straight carapace length to the tip (SCL-tip), with a mean of 68.1 cm (SD=7.4). The loggerheads (n=10) ranged in size from 61.2 – 93.1 cm SCL-tip, mean 71.7 cm (SD=8.8) with three unknown sub-adults, six females, and one adult male captured thus far. In three sampling days, we logged 15.1 hours of search effort, and average daily catch per unit effort (CPUE) was 0.8 turtles/hour (SD=0.4). Future sampling plans include bi-monthly surveys and captures to establish turtle habitat use patterns through the combined use of mark-recapture, satellite tracking, stable isotope analysis, and molecular genetic techniques. This research specifically addresses habitat requirements that may be necessary for the recovery of these threatened and endangered species.

EXAMINING THE GREEN AND KEMP'S RIDLEY SEA TURTLE "LOST YEARS" USING STABLE ISOTOPE ANALYSIS

Tiffany Dawson[1], Simona Ceriani[2], Ryan Chabot[3], Jake Kelley[1], Katrina Phillips[1], and Kate L. Mansfield[1]

[1]*Marine Turtle Research Group, Department of Biology, University of Central Florida, Orlando, Florida, USA*
[2]*Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, Florida, USA*
[3]*Inwater Research Group, Inc., Jensen Beach, Florida, USA*

Understanding habitat use across sea turtle life stages is critical for informing species and habitat conservation measures. The pelagic life stage of young, oceanic-stage turtles, also called the 'lost years', has been understudied due to the challenges of sampling offshore and size-limited tracking technology. In the Gulf of Mexico, large Sargassum algae lines provide protection and foraging habitat for young turtles. To better understand habitat use and foraging ecology, we used carbon (13C) and nitrogen (15N) stable isotope analysis of tissue samples collected from green (*Chelonia mydas*, n=59) and Kemp's ridley sea turtles (*Lepidochelys kempii*, n= 19) between 2012 and 2017. Green turtles were sampled from Sargassum habitat in two different locations in the Gulf of Mexico, 40-195 km offshore of Venice, Louisiana or Sarasota/Cortez, Florida, USA. Using a model selection framework, we evaluated the relative importance of curved carapace length (CCL), sampling year, and sampling location on 13C and 15N of Kemp's ridley and green turtle skin samples. Carbon signatures of green turtles were best explained by sampling year and sampling location, indicating that the two sampling sites have unique carbon signatures. The model also indicated that 15N significantly increased with CCL, highlighting the potential for size-based prey selection. Kemp's ridleys were only captured offshore of Venice, LA; 13C signatures significantly varied by CCL, sampling year and distribution within the sampling region (based on individual capture location latitude and longitude). There was not a variable that best explained the 15N signatures, as there was minimal variance within the data. Overall, isotopic signatures along with morphometric data provide insight into foraging ecology of these sea turtles during the 'lost years'. Understanding diet and habitat use at this life stage is important for filling knowledge gaps of sea turtle life history and creating comprehensive management plans to protect these species. Funding and acknowledgements: Funding in support of this work was provided in part by the Florida Restore Act Centers of Excellence Program grant. We also thank Inwater Research Group, C. Long, and G. Stahelin for field assistance.

ALL DEPLOYMENTS ARE CREATED EQUAL: USING MOVEMENT SIMULATION TO 'EVEN OUT' SATELLITE TELEMETRY HOME RANGES

Andrew DiMatteo[1], Gwendolyn Lockhart[2], Danielle Jones[2], and Susan Barco[3]

[1]*CheloniData LLC, Virginia, USA*
[2]*Naval Facilities Engineering Command Atlantic, Virginia, USA*
[3]*Virginia Aquarium & Marine Science Center, Virginia, USA*

A major issue when comparing satellite telemetry-derived home ranges between individuals, or developing composite ranges for a population, is differing deployment lengths. Different deployment lengths can lead to a single individual having an outsized or undersized influence on a combined home range analysis (in the case of a longer or shorter than average deployment, respectively) or make for invalid comparisons of individual home ranges, particularly for migratory or highly mobile animals. Additional simulated locations for individuals with shorter satellite tag deployments can be derived using movement parameters from the animal's existing track and used to provide parity to individuals with longer deployments. Here we present a case study using satellite tagged Kemp's ridley (*Lepidochelys kempii*) turtles that were deployed in or near Chesapeake Bay, Virginia, USA. The Chesapeake Bay is a large estuarine environment on the east coast of the United States with many small embayments and a range of salinities based on river outflows. Juvenile Kemp's ridley sea turtles are found in the bay seasonally, arriving in May when the water is warm and prey is abundant, and leaving in October/November as water temperatures drop. Given their small size and rapid growth rates, these animals are challenging to satellite tag. Deployments are often short, requiring creative solutions to assess habitat use at the population level. Tagged turtles were a mix of wild caught, hooked, and rehabilitated animals. Among all successfully tagged animals, the average deployment length was calculated (17 days, N=21). In order to limit the amount of simulation required, turtles with deployments longer than 17 days had their tracks truncated to the average deployment length, and locations were estimated for 6-hour time intervals. Turtles with deployments shorter than 17 days had additional locations simulated based on individual movement parameters to increase the track lengths to 17 days. Ten different simulated tracks were generated for each turtle with a deployment shorter than 17 days to account for uncertainty in the simulated track. All tracks were combined into a joint home range analysis, where simulated tracks were weighted 1/10. This yielded a joint analysis where all turtles contributed equally to the home range of the population. The derived home range identified important habitat along the fringes of the bay where the Kemp's ridley's preferred prey, blue crabs, are abundant and no single individual had an outsized importance in identifying habitat. A sensitivity analysis, also using simulated deployments, indicated that we did not identify all of the habitats that animals could possibly travel to in the bay. This approach eliminates some sources of bias in joint home range analysis but introduces others. Information is lost where longer deployments are truncated. There is an unknown amount of uncertainty introduced by simulating additional locations for shorter tag deployments. While simulated deployments seemed plausible based on comparison to the non-simulated portions of the deployment and other animals, these locations do not represent true animal locations. Simulations for highly mobile and migratory animals may become more unrealistic as track length increases and simulation should be limited as much as possible. This approach is best applied in relatively restricted areas and for populations where extensive tagging is impractical and average deployment length is short.

POST-RELEASE BEHAVIOR OF REHABILITATED JUVENILE KEMP'S RIDLEY SEA TURTLES LEPIDOCHELYS KEMPII FROM MASSACHUSETTS, USA

Kara L. Dodge[1], Constance Merigo[2], Charles J. Innis[3], Adam Kennedy[2], Linda Lory[2], and Robert Prescott[4]

[1]*Anderson Cabot Center for Ocean Life, New England Aquarium, Boston, MA 02110, USA*
[2]*Marine Animal Rescue Program, New England Aquarium, Boston, MA 02110, USA*
[3]*Animal Health Department, New England Aquarium, Boston, MA 02110, USA*
[4]*Massachusetts Audubon Wellfleet Bay Wildlife Sanctuary, Wellfleet, MA 02663, USA*

The Kemp's ridley (*Lepidochelys kempii*) is one of the most cryptic sea turtle species found in New England, USA waters. While in-water sightings are infrequent, beach-stranded Kemp's ridleys have been reported in New England for over one hundred years. The majority of strandings are documented in boreal fall and winter (October – December) when cheloniid sea turtles remaining in New England and New York waters experience hypothermia or "cold stunning". In New England, the state of Massachusetts records the highest number of Kemp's ridley strandings annually. Live turtles are rescued, transferred to rehabilitation facilities, and ultimately released back into the wild in the Northwest Atlantic or the Gulf of Mexico. The number of cold stunned Kemp's ridleys stranding in Massachusetts has increased dramatically over the past ten years, with a record high of 1,179 turtles (669 alive, 510 dead) washing ashore in 2014. With increased stranding numbers comes increased costs associated with rescue and rehabilitation, and the need to evaluate the conservation benefit of rehabilitation to Kemp's ridley population recovery efforts. Assessing post-release survival and behavior of rehabilitated turtles is a critical first step in this process. To investigate post-release outcomes, we satellite tagged 16 immature (mean SCL 37.1 cm; range 33.8 – 54.9 cm), rehabilitated (mean 261 days; range 233 - 321 days), Kemp's ridleys between 2005 and 2016. Turtles were released off Massachusetts during summer months (July – September) and tracked for 8 to 232 days, with a mean tracking duration of 118 days. Kemp's ridley movements were restricted to the Northwest Atlantic, with most (81%) of the turtles remaining neritic during the entire tracking period. Ten out of sixteen Kemp's ridleys were tracked long enough to observe a seasonal southward and/or offshore migration. Six turtles were tracked to coastal North Carolina, USA, one turtle was tracked to coastal Maryland/Virginia, USA, one turtle was tracked into the Gulf Stream, and one turtle was tracked to North Carolina before it moved offshore into the Gulf Stream. Post-release monitoring of immature Kemp's ridleys in New England demonstrates that rehabilitated turtles can survive, at least short-term, in the wild after prolonged periods of medical treatment and captivity. This is consistent with findings from telemetry studies of rehabilitated green and loggerhead turtles. Two out of sixteen turtles in our study transmitted for <30 days, but an assessment of tag transmission patterns and dive behavior was inconsistent with mortality based on previous studies. Short track durations for immature Kemp's ridleys have been recorded within other regions of the Northwest Atlantic and Gulf of Mexico, and may be associated with tag loss, fouling, or failure. The majority of turtles in our study were young juveniles, and rapid growth associated with this life stage may contribute to premature tag shedding. The remaining turtles all transmitted for at least 49 days, with ten turtles tracked long enough to observe full or partial migratory routes from northern habitats to coastal or offshore overwintering grounds. Post-release behavior of immature Kemp's ridleys in our study was consistent with incidentally captured conspecifics in the Northwest Atlantic and the Gulf of Mexico, as well as turtles released after short-term (mean 2 weeks) rehabilitation. To evaluate long-term outcomes for rehabilitated turtles, additional types of monitoring (e.g., passive acoustics) are needed.
Acknowledgements: We thank the many staff and volunteers of Wellfleet Bay Wildlife Sanctuary and New England Aquarium for their collective efforts to rescue, transport, rehabilitate and release stranded sea turtles in Massachusetts. We thank NOAA Fisheries and US Fish and Wildlife Service (USFWS) for support and guidance. Special thanks to USFWS for assistance with permits.

LONG-TERM CHANGES IN LOGGERHEAD SEA TURTLE DIET INDICATE SHIFTS IN THE BENTHIC COMMUNITY ASSOCIATED WITH WARMING TEMPERATURES

Julia Donaton[1], Kimberly Durham[2], Robert Cerrato[1], Jenna Schwerzmann[1], and Lesley H. Thorne[1]

[1]*Stony Brook University, New York, USA*
[2]*Atlantic Marine Conservation Society, New York, USA*

Long-term studies of marine communities are critical to understanding shifts in marine ecosystems in response to ecological change. We examined the diet of stranded loggerhead sea turtles (*Caretta caretta*) in New York waters between 1995 and 2014 using stomach content analysis, and quantified variability in loggerhead diet using Non-Metric Multidimensional Scaling (NMDS). Our results provide compelling evidence for a shift in the benthic community in New York waters associated with warming temperatures. We found two distinct clusters in loggerhead sea turtle diet, comprising samples in the years before and after 2000, respectively, indicating a temporal shift in prey composition after 2000. These patterns represented a shift from larger crab species such as rock crab (*Cancer irroratus*) to smaller crab species such as hermit crabs (*Pagurus* spp.) in recent years. Sea surface temperature (SST) in New York waters increased during the 20-year study period, and changes in SST and the position of the Gulf Stream were the most important environmental variables explaining variability in loggerhead sea turtle diet. Our results reflect the importance of long-term data collection in evaluating ecological responses to climate-driven warming, and highlight the utility of marine vertebrates as indicators of changes to lower trophic level organisms.

TWO CATEGORY 5 HURRICANES IN TWO WEEKS DID NOT DESTROY A CRITICAL JUVENILE HAWKSBILL HABITAT, YIPP-EI!

Scott Thomas Eanes, Jordan Matley, and Paul Jobsis

University of the Virgin Islands, U.S. Virgin Islands

Hurricanes are a naturally occurring meteorological phenomenon in the North Atlantic. Due to human based climate change, some models are now predicting storm frequency won't increase, but storm intensity will, with some scientists calling for a "Category 6" to be added to the Saffir Simpson Hurricane Wind Scale. An increase in the intensity is particularly concerning to the Caribbean region for its human inhabitants, its flora, and its wildlife. One of those wildlife inhabitants is the hawksbill sea turtle (*Eretmochelys imbricata*). Hawksbill turtles are critically endangered throughout the Caribbean and use hundreds of islands and nearshore reefs as nesting and foraging habitat at different developmental stages. The increase in storm intensity could have consequences on all coastal and coral reef environments and consequently, hawksbill turtles. On the island of St. Thomas, USVI, an ongoing mark and recapture study in Brewer's Bay and Hawksbill Cove began in 2014 because of observed hawksbill turtle density. The following year an acoustic telemetry study began and between February 2015 and August 2017 a total of 20 hawksbill turtles were acoustically tagged and tracked using an approximately 40 receiver array (Vemco). Unfortunately, St. Thomas took a direct strike by category 5 Hurricane Irma on September 6th, 2017, and then again by category 5 Hurricane Maria on September 20th, 2017, when it passed within 40 miles of the island. Hurricane Irma is on record as the strongest hurricane in the open Atlantic Ocean Basin, followed by Hurricane Maria as the 10th strongest storm. At the time Hurricane Irma struck St. Thomas (Brewer's Bay/Hawksbill Cove) there were 11 hawksbills transmitting acoustically and after the storm, all 11 turtles

remained inside the array and continued to transmit their signal. When Hurricane Maria hit two weeks later, the same 11 turtles transmitted before, during, and after the storm event. Further examination of post hurricane telemetry data suggests subtle changes in habitat location and preference type during and immediately following the storms. Brewer's Bay and Hawksbill Cove present a unique habitat location due to the Cyril E. King runway extension construction which created a 6-hectare artificial reef, the presence of multiple natural reef systems (fringing and patch), sea grass beds (in both bodies of water), and the last remaining mangrove habitat on the west side of St. Thomas. While it is possible that other juvenile hawksbills left after the storms (as we have documented over 55+ individuals), these 11 turtles remained in the acoustic array. If the climate models are correct and there is an increase in the intensity of hurricanes this acoustic telemetry data of hawksbill site fidelity post two category 5 hurricanes (in a 14-day period) should be viewed positively because hawksbill turtles are an indicator of a healthy coral reef ecosystem.

PHOTO-ID AS AN ALTERNATIVE TO MONITOR MARINE TURTLES IN THE GULF OF VENEZUELA

María Sandoval[1-3], María José Petit-Rodriguez[1-3], and Hector Barrios-Garrido[1-6]

[1]*Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela*
[2]*Laboratorio de Ecología General, La Universidad del Zulia*
[3]*Centro de Modelado Científico (CMC), La Universidad del Zulia*
[4]*TropWATER – Centre for Tropical Water and Aquatic Ecosystem Research*
[5]*College of Marine and Environmental Sciences, James Cook University, Townsville, Australia*
[6]*Marine Turtle Research, Ecology and Conservation Group, Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL 32306, USA*

Worldwide, multiple marine turtle monitoring programs have used diverse methods that vary in effectiveness, duration, and costs; making its implementation a challenge. Marine turtles in the Gulf of Venezuela (GV) face many threats, including intentional take, coastal development, and pollution; hence, their monitoring its crucial to develop conservation programs in the future. Indeed, GV represents one of the most important feeding areas in the country, where migration, residence, and development have been described for diverse marine turtle rookeries. Therefore, it is considered essential to increase the monitoring efforts of their populations. Herein, we present the use of photo-identification as an economical and efficient alternative for marine turtle monitoring in the GV, this is possible due to its unique and unrepeatable facial scales patterns that allow clear differentiation between individuals. We compiled and assessed a database of photo-identifiable profiles available from four species of marine turtles rescued and released in the GV from 2000 to 2018 (n= 118). Then, we implemented two photo-matching software (I3S Pattern, and Nature Pattern Match-NPM) to optimize the identifying process of individuals, later we evaluated their efficiency in comparison with the non-assisted manual method (by naked-eye). Our results indicate that I3S Pattern was more effective during the matching process than NPM (90% and 65% accuracy respectively), while the manual method was much more accurate than the software, but the non-assisted manual method is impractical when working with large databases due to its time-consuming effort. Based on the photo evaluated, I3S Pattern represents the most efficient method of image matching by reducing the time needed and simplifying the manual "by eye" analysis. The application of these photographic catalogs in the marine turtle conservation programs in Venezuela accompanied by their biometric and physical data can result in a national database that could be used to expand the knowledge on the behavior and status of marine turtles in the Venezuelan coast, including the participation of local stakeholders in the data-gathering process as occurs currently in other countries (citizen science).

SPATIAL MODELLING USED TO IDENTIFY AND CHARACTERIZE OCEANIC AREAS OF CONSERVATION IMPORTANCE FOR THE EASTERN PACIFIC OLIVE RIDLEY TURTLE, LEPIDOCHELYS OLIVACEA

Christine Figgener[1], Joseph Bernardo[1], and Pamela Plotkin[2]

[1]*IDP Marine Biology, Texas A&M University, College Station, TX 77843, USA*
[2]*Texas Sea Grant & Department of Oceanography, Texas A&M University, College Station, TX 77843, USA*

Effective habitat management plans require reliable information about spatiotemporal patterns of habitat use. Understanding these dynamics requires quantitative knowledge of a focal species' home range and the abiotic and biotic characteristics of that home range. In turn, such quantitative descriptions inform predictions of general habitat-suitability and species occurrence in unstudied areas. Here we explore some of these issues in the olive ridley turtle (*Lepidochelys olivacea*). Although common and geographically wide-spread, the habitat use and movement ecology of *L. olivacea* have only been studied in a small part of its overall range. Consequently, there is little data available to be included in comprehensive and meaningful management plans. *Lepidochelys olivacea* engages in long-distance, oceanic foraging migrations. Previous satellite tracking studies of post-nesting *L. olivacea*, tagged at Nancite, Costa Rica in the Eastern Tropical Pacific (ETP), documented nomadic, wide-ranging movements that were unassociated with discrete geographic foraging areas. However, these previous studies did not use spatial modelling to quantify habitat use. The aim of this study was to investigate the movement ecology of *L. olivacea* in the ETP to identify areas of conservation importance. We first estimated home-ranges using Kernel Density Estimation (KDE) to identify areas of high habitat use. We then analyzed and characterized these areas using spatial distribution modelling (SDM). Generalized Additive Models (GAM) were used to fit seven environmental variables: distance to coast, bathymetry, sea surface temperature, sea surface height, slope, chlorophyll-a concentration, and depth thermocline. We also analyzed whether habitat use has changed over the past two decades by comparing recent satellite tracks with those of females tagged in the 1990s. The spatial data were obtained from 27 post-nesting females (females that had completed their nesting for the season) that were satellite-tracked from five beaches in Costa Rica in 2016 and 2017. Post-nesting status was determined by using ultrasound imaging to assess whether any yolked follicles were present. Only females with no yolked follicles were chosen for study. Despite great inter-individual variation among tracks, a couple of patterns of habitat use were evident by inspecting the tracks. One pattern was a dichotomy in the latitudinal trajectory (north vs. south) of post-nesting migration, with the northern trajectory being the most common. Most individuals that migrated north then spent a significant amount of time in oceanic waters off the coast of Guatemala and southern Mexico. The ETP is known for its high level of fishing activity and the high rates of bycatch, including *L. olivacea*. Hence, an assessment of key areas for foraging and migration of *L. olivacea* will contribute data necessary to establish effective, protective measures in the ETP, such as no-take zones, other marine protected areas, and migratory corridors.

FORAGING PATTERN OF JUVENILE GREEN TURTLES (CHELONIA MYDAS) IN RELATION TO DIETARY SHIFT FROM GELATINOUS PREYS TO MACRO-ALGAE OBSERVED IN A SUMMER-RESTRICTED FORAGING HABITAT IN THE NORTHWEST PACIFIC OCEAN

Takuya Fukuoka, Tomoko Narazaki, Chihiro Kinoshita, and Katsufumi Sato

The University of Tokyo, Tokyo, Japan

Green turtles in neritic year-round foraging habitats are widely considered to have small home ranges and mainly feed on plant-based diets. However, previous studies have focused on warm, year-round habitats, and few studies have examined the summer-restricted habitats to which the turtles seasonally migrate. In this study, we investigated the foraging pattern of green turtles migrating to the Sanriku Coast, which is a summer-restricted foraging habitat in a temperate area (38 – 39°N) of the northwest Pacific Ocean, using stable isotope analysis and biologging experiments from 2007 to 2015. Stable isotope analysis (n = 40) indicated that most of the turtles relied on gelatinous preys before arriving at the Sanriku Coast. According to the biologging experiments (451.2 hours of behavioral data and 43.2 hours of video data from 6 turtles), the turtles shifted their main food to macro-algae (135 out of 148 feeding events) and consumed it at the sea bottom during their stay in the specific localized area (133 events). However, the turtles still consumed gelatinous prey in midwater during their movement to other locations along the Sanriku Coast and/or during their migration to southern overwintering habitats (13 events). These results indicated that green turtles in this area display a complex foraging pattern relative to year-round habitats. This is the first study to investigate the fine-scale foraging pattern of this species in summer-restricted habitat, and the turtles migrating to the Sanriku Coast seem to consume gelatinous prey during the transit period in addition to macro-algae feeding during the resident period.

DOES SIZE MATTER? DIET AND AGE OF JUVENILE GREEN TURTLES IN PARANÁ COAST, SOUTH BRAZIL

Luciana Rolinski Gama[1] and Camila Domit[2]

[1]Center for Marine Studies, Federal University of Paraná, Paraná, Brazil
[2]Ecology and Conservation Lab in Center for Marine Studies, Federal University of Paraná, Paraná, Brazil

An important ecological area for green turtles is the Paraná coast, southern Brazil, which is used by juveniles for feeding and development. This area provides many vegetal food resources to this species, once there are rocky shores, mangroves, seagrass meadows and inshore islands. Paranaguá estuarine complex (PEC), part of Paraná coast, is considered a world heritage for biodiversity, including several marine protected areas; nevertheless, the area is highly negative impacted by fishing, ports and other anthropogenic activities. Since 2004, diet studies of this species have been performed in PEC aiming to evaluate how diet changes along the seasons, years and also green turtles size classes and sex. Therefore, the present study contributes to the current knowledge evaluating potential changes among green turtles ages. To determine the diet, we collected stranded dead green turtles monthly during beach surveys along 60 km, from Matinhos county to Guaratuba county, between 2008 and 2013. All specimens had their curvilinear carapace length (CCL) measured and, after necropsy, their entire digestive tracts removed and maintained in freezer. Digestive tracts contents were separated, weight-measured (g) and the feeding index was calculated. A

sample of 37 juvenile green turtles was age estimated by humerus skeletochronological methodology. The results show that the green turtles specimens assessed are from two to eight years old. These juvenile turtles mostly consumed the green algae *Ulva* sp., the mangrove *Avicennia schaueriana*, the seagrass *Halodule wrightii*, and the brown algae *Sargassum cimosum*. A significant variation in diet among specimens ages was observed ($p < 0.05$), with early-development stage's individuals presenting a higher feeding index. Moreover, younger specimens consumed animal matter items, such as cephalopod beaks; whereas, the oldest ones present vegetal matter food resources only, with seagrass *H. wrightii* being the most frequent item in the digestive tracts analyzed. We also found a large rank of CCL sizes among green turtles' ages, with three years old specimens ranging from 31.5 cm to 55.0 cm of CCL; and eight years old specimens ranging from 40.0 cm to 48.0 cm of CCL, for instance. These data stress the importance in evaluating juvenile turtles' ages in diet studies, besides size classes. Many abiotic factors can interfere in reptiles' metabolism, such as temperature, which influences sea turtle productivity and, hence, the growth. This is one of the reasons to find size ranges inside the same age grouping. Besides, specimens of different age groupings use distinct habitats, which lets them exposed to different impacts and threats. Thus, a better understanding in juvenile green turtles foraging ecology will be possible by estimating age and verifying if this diet shift is constant along the years of monitoring, the regions monitored, and also better guide conservation actions to protect juvenile sea turtles. Acknowledgements: We thank CAPES and MarBrasil Association for financial support and the ISTS.

SEASONAL AND SPATIAL VARIATION IN JUVENILE GREEN TURTLE DIET

Meagan Gary[1] and Sam Gierhart[2]

[1]Cape Eleuthera Institute, Bahamas
[2]University of Exeter, UK

Green turtles (*Chelonia mydas*) have been historically harvested throughout the Caribbean and are currently threatened due to a variety of factors including but not limited to: coastal development, climate change, and pollution. Due to these numerous threats, green turtle populations have experienced a wide-scale decline and are globally endangered (IUCN red list - 2004). In 2009, The Bahamian government banned the harvest of sea turtles. This policy change was a vital step for the protection of sea turtles throughout the Western Atlantic. Juvenile green turtles from Western Atlantic nesting grounds recruit to the shallow coastal waters of The Bahamas, where they remain for the majority of this life stage. The Bahamas provides important foraging areas for juvenile green turtles, especially with its expansive network of shallow seagrass beds. Once in these coastal environments, green turtles become predominantly herbivorous, feeding almost exclusively on turtle grass (*Thalassia testudinum*) and to a lesser extent on other seagrasses (i.e. manatee grass *Syringodium filiforme* and shoal grass *Halodule wrightii*) and algae. Unfortunately, there are still significant misconceptions regarding sea turtles in The Bahamas, specifically regarding their diet and that green turtles eat economically important fish and queen conch. This perception of competition between fishermen and green turtles for key fishery species makes it difficult to effectively conserve sea turtle populations. In addition to clarifying species-specific green turtle diet components to help resolve this perceived conflict, this study aimed to elucidate seasonal diet shifts and the subsequent variation in food availability for juvenile green turtles. To accomplish these goals, we seasonally collected diet samples from juvenile green turtles, monitored turtle grass growth rates, and mapped the distribution of vegetation throughout six sites across South Eleuthera. We collected over 180 diet samples using esophageal lavage and measured over 2,000 blades of seagrass. Preliminary results confirmed that green turtles primarily consume turtle grass. However, the proportional importance of turtle grass fluctuates with the season. In the summer, green turtle diet samples contained an average of 80% turtle grass while in the winter this declined to 67%. We hypothesize that this seasonal decrease in turtle grass consumption may be due to

turtle grass availability, as turtle grass growth rates were significantly lower in the winter than in the summer. In the winter, green turtles consumed four times more turtle grass rhizomes than they did in the summer. As the availability of turtle grass decreases in the winter, green turtles consume a higher proportion of other vegetation such as shoal and manatee grass, various red and green algae, and the rhizomes of turtle grass. Lastly, their diet consisted of less than 1.5 % animal protein - none of which included fish or queen conch. This indicates that fishermen and green turtles are not competing for the same marine organisms. This information will be vital as we continue to speak to fishermen and students throughout The Bahamas about sea turtle biology and conservation. Future studies are required to determine how these seasonal shifts in the diet may affect sea turtle nutrition. Additionally, as climate change continues to create more extreme temperature shifts in these shallow foraging grounds it is vital to understand the effects on seagrass growth rates and thus green turtle diet.

DRIVERS OF SEAGRASS PRODUCTIVITY IN GREEN TURTLE FORAGING AREAS ACROSS A GRADIENT OF MEADOW CHARACTERISTICS

Alexandra G. Gulick[1], Robert A. Johnson[1], Clayton Pollock[2], Zandy Hillis-Starr[2], Alan B. Bolten[1], and Karen A. Bjorndal[1]

[1]*University of Florida, Florida, USA*
[2]*National Park Service*

Green turtles (*Chelonia mydas*) are the primary consumers of seagrasses worldwide and fulfill an important role in determining the structure and function of seagrass communities. While herbivory is a well-established mechanism for regulating plant growth in terrestrial ecosystems, our knowledge of how seagrass productivity is regulated in meadows grazed by green turtles is very limited. In the age of green turtle recovery and global seagrass decline, it is imperative that carrying capacity models for green turtle foraging habitats incorporate robust measures of seagrass productivity. Previous estimates of carrying capacity for Caribbean seagrass meadows however, lack measures of seagrass growth from naturally grazed pastures across gradients of depth, seagrass structural characteristics, nutrient content, and meadow composition. This is largely due to the formerly difficult task of locating naturally grazed areas, a result of previously low green turtle populations, and the bias of seagrass growth measurements toward shallow (<6m) meadows. For this study, we used herbivore exclusion cages to evaluate the role of environmental and biotic factors in regulating seagrass productivity in naturally grazed meadows at Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands. Seagrass meadows at this location are dominated by *Thalassia testudinum* and support an increasing population of juvenile and adult green turtles. Green turtle grazing plots were identified in both shallow (3-4m) and deep (9-10m) seagrass habitats and selected for measurements of *T. testudinum* growth (linear, area, mass, and specific mass). Exclusion cages (n = 130) fitted with HOBO data loggers were deployed for 7-10 day intervals in grazed and ungrazed meadows from July 2017 to February 2018. Data loggers recorded hourly temperature and irradiance for the duration of cage deployment. Using generalized additive models (GAM), we then assessed how abiotic factors (depth, temperature, irradiance, salinity), *T. testudinum* structure (shoot density, blade morphology, above and belowground biomass), *T. testudinum* nutrient content (total Carbon, Nitrogen, and Phosphorus in blades and rhizomes), and meadow composition (density and biomass of other seagrass species and benthic macroalgae) affect *T. testudinum* productivity in grazed and ungrazed meadows. Site-specific characteristics and growth dynamics of seagrass meadows may play a significant role in determining the distribution, grazing patch use patterns, and sustainability of grazing for recovering green turtle populations.
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OVER A DECADE OF SATELLITE TRACKING DATA IDENTIFIES HOTSPOTS FOR PROTECTED MARINE TURTLES IN THE FLORIDA KEYS NATIONAL MARINE SANCTUARY

Kristen M. Hart[1], Brian J. Smith[2], Autumn R. Iverson[2], Michael S. Cherkiss[1], and Derek Burkholder[3]

[1]Wetland and Aquatic Research Center, U.S. Geological Survey, Davie, FL, USA
[2]Cherokee Nation Technologies, Contracted to the U.S. Geological Survey, Davie, FL, USA
[3]Nova Southeastern University, Florida, USA

Use of marine protected areas (MPAs) to preserve habitat for marine vertebrates has become an important tool for conservation managers. One of 14 MPAs that make up the US National Marine Sanctuary System, the Florida Keys National Marine Sanctuary (FKNMS), was designated on 16 November 1990 in response to a series of ship groundings in 1989, as well as mounting threats from coral disease and declining water quality. The sanctuary covers 2,900 square nautical miles of waters surrounding the Florida Keys and protects the third largest coral barrier reef ecosystem in the world, including more than 6,000 species of marine life, as well as cultural resources. We fit a switching state-space model (sSSM) to estimate regular locations and movement mode in the presence of observation error. We classified movement mode as either area restricted search (ARS) or migration. We then fit 95% kernel density estimates (KDE) of home ranges to each turtle's ARS locations and linked them together with migration polygons 1 km wide. We combined these polygons to make a single polygon for each turtle. We overlaid these polygons on a grid covering the continental shelf on both coasts of Florida from Tampa Bay in the north to ~75 km south of Key West. Each grid cell was 5 km x 5 km, and the resulting values were a count of unique turtle polygons in that cell. A total of 42,684 turtle tracking days across all species, 23.6% (10,080) were within current boundaries of the FKNMS. We observed differences in FKNMS habitat use by species: loggerheads were within the FKNMS 20.1% of their tracking days (5,879 out of 29,260 days); green turtles were within the FKNMS 33.9% of their tracking days (3,667 out of 10,810 days); hawksbills were within the FKNMS 25.6% of their tracking days (497 out of 1,940 days); and hybrid loggerhead x hawksbills were within the FKNMS 5.5% of their tracking days (37 out of 674 days). Further, sSSM results showed use of FKNMS during migration periods, with 15.6% of migration days within the boundaries (296 out of 1,896 tracking days); migration days by species included loggerheads (1,601), green turtles (271), and hawksbills (10). We determined "hotspot" grid cells (# of turtle polygons > 30) where turtle tracking days were concentrated during both breeding (April-August) and non-breeding (September-March) seasons. Multispecies hotspots were located both inside and outside of currently designated national wildlife refuges, FNKNMS, and national park boundary lines. Several important hotspots also serve as year-round habitat for adult marine turtles, including Dry Tortugas National Park and the Key West National Wildlife Refuge. This unique geospatial summary provides managers with information on areas serving as important year-round habitat for imperiled sea turtles from multiple regional management units and distinct population segments. Future work includes evaluating overlap of turtle hotspots and areas of human use.

LOGGERHEAD NESTING IN EVERGLADES NATIONAL PARK: INTEGRATING BEACH SURVEYS, SATELLITE TRACKING, AND GENETICS

Kristen M. Hart[1], Andrew G. Crowder[2], Michael S. Cherkiss[1], Brian J. Smith[2], and David C. Roche[1]

[1]*Wetland and Aquatic Research Center, U.S. Geological Survey, Davie, FL, USA*
[2]*Cherokee Nation Technologies, Contracted to the U.S. Geological Survey, Davie, FL, USA*

Despite state-wide monitoring efforts on mainland Florida beaches to map and enumerate nesting effort for loggerhead sea turtles (*Caretta caretta*), very little focus has been on sampling sea turtles on nesting beaches in Everglades National Park (ENP). The remote sandy beaches of the ENP are comprised of 18 individual beaches that cover a total length of 56 km. Intense surveys of these beaches in the 1970s and 1980s indicated that they are used by federally-threatened loggerhead sea turtles for nesting. Recent genetic analyses of loggerheads in the southeastern United States have distinguished seven subpopulations in the region. However, it is currently unclear to which subpopulation loggerheads nesting in the Everglades belong, as they have not been included in these analyses. In May 2014, we initiated nightly surveys of Cape Sable beaches (i.e., Middle and East Capes) to intercept nesting females. We conducted surveys from 8pm to 5am via boat and approached turtles on land to capture them after nesting or false-crawling. We tagged each turtle with unique flipper and PIT tags and collected samples for genetic and stable isotope analyses. Thus far we have captured 25 unique individuals, with 2 turtles recaptured in 2018. We deployed satellite tags on 21 nesting loggerheads; none of these had any tags from other research projects. Preliminary analysis of the genetic samples has revealed the presence of haplotypes CC-A2.1 (n = 17) and CC-A3.1 (n = 1). Despite the small sample size, this suggests a stronger affiliation with the Dry Tortugas Recovery Unit than the southwestern Florida Management Unit based on samples from Keewaydin Island. We fit switching state-space models (sSSMs) to the satellite location data to delineate movement modes, allowing us to distinguish directed migratory movement from area-restricted search. We currently have sSSM results from 20 turtles, totaling 4,373 tracking days. Mean migration start date for these turtles was June 29th (range = June 3rd – July 21st), and migrations lasted an average of 13.8 days (range = 1 – 41). Individual turtles spent an average of 15% of their tracking days inside the boundaries of ENP (range 0 – 93%). We tracked turtles post-nesting to other locations in the region where they took up residence at foraging sites; locations were in the waters of the Everglades and Dry Tortugas National Parks, Florida Keys National Marine Sanctuary, Florida Bay, Gulf of Mexico, Bahamas, and off the northeastern coast of Cuba. These data, combined with additional samples and tracks as well as future analysis of stable isotope samples, will allow us to define movement corridors and foraging habitats, providing a new understanding of regional connectivity of disparate sites that are important for this threatened species.

DIET COMPOSITIONS OF SURFACE-PELAGIC JUVENILE TURTLES

Shigetomo Hirama[1], Robert F. Hardy[1], and Blair Witherington[2]

[1]*Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute*
[2]*Inwater Research Group, Florida USA*

Surface-pelagic juvenile turtles (hereafter pelagic turtles) inhabit surface-pelagic drift communities (hereafter *Sargassum* communities) and feed on items associated with this habitat. We have categorized and reported the ingested items in seven categories (marine animals, terrestrial animals, marine plants,

terrestrial plants, unknown plants, minerals, and synthetic materials) using the data collected from 2006 and 2011 (Witherington et al. 2012). The goal of the project is to update the information on diet compositions of pelagic turtles up to 2018. In addition, we provide information on gastro-intestinal content of stranded turtles (n = 7) that were pelagic-stage turtles, between 10 and 20 cm straight carapace length. From pelagic turtles, we collected recently ingested items using esophageal flush (lavage) and fecal samples (collected opportunistically). All samples were preserved in jars of 70 % ethanol for later examination. Using a binocular dissecting scope, we identified all sample items to the lowest possible taxon or object grouping. After dividing items into three groups (animal tissue, plant tissue, and synthetic) we dried them in an oven and weighed each group. The results from 73 pelagic turtles – five loggerheads, 30 green turtles, 38 Kemp's ridleys – and seven stranded pelagic turtles will be presented.

TURTLE TRACKING TROUBLE: DO CARAPACE MORPHOLOGY AND COMPOSITION DICTATE OBSERVED SATELLITE TRACK DURATIONS FOR KEMP'S RIDLEY (LEPIDOCHELYS KEMPII) AND ATLANTIC LOGGERHEAD (CARETTA CARETTA) SEA TURTLES?

Katherine M. Hoffman[1] and Michael D. Arendt[2]

[1]*Graduate Program in Marine Biology, Graduate School of the University of Charleston, College of Charleston, SC 29412, USA*
[2]*South Carolina Department of Natural Resources, Marine Resources Division, Charleston, SC 29412, USA*

For several decades, satellite telemetry has enabled global collection of spatial distribution data across sea turtle species. Data collection windows vary among species and location, but generally speaking shorter track durations are associated with Kemp's ridley sea turtles (*Lepidochelys kempii*) than loggerhead sea turtles (*Caretta caretta*) across studies in the SE USA. Using similar transmitter attachment procedures, researchers with the South Carolina Department of Natural Resources (SCDNR) have obtained track durations of 17 to 173 days (mean = 64 days) for 17 Kemp's ridley sea turtles, but 6 to 510 days (mean = 161 days) for 80 loggerhead sea turtles since 2004. Given extensive overlap in spatial distribution and diving behavior for these tracks, additional research is needed to investigate potential causes of track duration disparities. As such, the present study will evaluate potential interactions between carapace morphology and composition on transmitter adhesion, and in turn, track longevity. The first objective will utilize a suite of morphometric data for both species captured by the SCDNR survey (2000 to 2018) to test for significant differences in carapace curvature, and a subsequent laboratory study will investigate the relative importance of carapace curvature and epoxy footprint on transmitter retention. The second objective will test for differences in epoxy adhesion strength between species (as well as among scutes) using keratin obtained from stranded sea turtles. Both of these thesis objectives will be completed in fall 2018 and results will be presented in this poster. Additional thesis objectives focused on evaluating keratin composition and adhesion strength of different epoxies and attachment techniques will not be completed in time for inclusion in this poster.

SEA TURTLE AND CETACEAN DIVERSITY AND DISTRIBUTION ALONG SOUTHEASTERN COASTAL AND MARINE AREAS OF BANGLADESH

Mohammad Zahirul Islam

Marinelife Alliance, Bangladesh

We have been monitoring Cetaceans along the southeast coast of Bangladesh from 1996. Small to large cetaceans have been recorded along the coast of Cox Bazar and Chittagong. Data were collected by offshore marine survey, stranding record, dead washed specimen, live observation, data from offshore fishermen and marine megafauna bycatch information. Habitat diversity included estuary, rivers, coastal channels, intertidal flats, mangrove canals, offshore area etc. The diversity of the cetacean species is the least. The region is a very important trans-boundery habitat with Myanmar marine territory. The recorded species include Indopacific humpback dolphin (*Sousa chinensis*), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), Irrawaddy dolphin (*Orcaella brevirostris*), Risso's dolphin (*Grampus griseus*), Spinner dolphin (*Stenella longirostris*) and Finless porpoise (*Neophocaena phocaenoides*). The habitat loss mostly happened due to indiscriminate construction of dam for shrimp farming, use of estuarine and marine set bag nets (ESBN and MSBN) as well as fishing gears setting across waterways those entirely blocks cetacean movement especially in Naf river, Moheskhali channel, canals of Sonadia -Moheskhali mangrove. Indo-pacific Humpback and Irrawaddy dolphins have been observed very close to coast at Matarbari, Kutubdia, Haserchar, Sonadia and in several other spots along the Teknaf peninsular coast. Interactions with nearshore fishing activity was observed common along Sonadia west coast, near Reju canal and Naf estuary. Alarming number of dead washed individuals due to bycatch during fishing were recorded every year. Project location: Mainly south eastern coast of Bangladesh: Project area include trans-boundary Naf river area of Myanmar & Bangladesh border, 100 kms south & 150 kms west of St. Martin Island, including the coastal rivers & channels, like Moheskhali channel, Kutubdia channel, Bakkhali river, Baradia canal between Moheskhali & Sonadia Island, Kuhelika river of northern Moheskhali.

LONG-TERM TELEMETRY STUDIES REVEAL IMPORTANT SEASONAL HABITATS FOR THE ATLANTIC CANADIAN LEATHERBACK TURTLE FORAGING POPULATION

Michael C. James[1], Emily P. Bond[1], and Kyle C. Mitchell[2]

[1]*Population Ecology Division, Fisheries and Oceans Canada, Dartmouth, Nova Scotia, Canada*
[2]*Nature Seekers, Matura, Trinidad*

Many Northwest Atlantic leatherback turtles, *Dermochelys coriacea*, occur at high latitudes, including waters off Eastern Canada, during the summer and fall. In these areas, they exploit gelatinous zooplankton prey, and are vulnerable to entanglement in lines associated with pelagic and coastal fisheries. An in-water research program focused on scientific sampling and tagging of leatherbacks has operated off Nova Scotia, Canada, since 1999. Here we use two decades of telemetry data, from 123 leatherbacks equipped with satellite tags at sea and on nesting beaches, to identify important seasonal foraging habitats used by turtles from the Canadian foraging population in both northern and southern waters. The sample encompasses adult and subadult turtles of both sexes, including mature females in post-nesting and inter-nesting years. Mean tracking duration was 243 days (range: 33-831 days), with many turtles followed through a second high-latitude foraging period or to nesting areas. Results indicate persistent population-level affinity for broad foraging and overwintering domains, and the existence of more discrete high-use continental shelf foraging areas in Canadian waters. This research illustrates how long-term telemetry datasets and large sample sizes benefit the understanding of movement patterns and residency behaviour in marine turtles and the delineation of specific areas where targeted conservation and management efforts may be most effective. However, insights gained from other marine species that forage seasonally at high latitudes, including recent experience with the North Atlantic Right Whale, Eubalaena glacialis, suggest that ongoing monitoring of species' distribution and abundance patterns, and dynamic management approaches, should be conservation priorities.

DIETARY CONTENT ANALYSIS OF LOGGERHEAD TURTLES (CARETTA CARETTA) STRANDED ON URUGUAYAN COAST (SOUTHWESTERN ATLANTIC) BETWEEN 2010-2018: A PROGRESS REPORT

M. Jáuregui[1], F. Scarabino[2], D. Gonzalez Paredes[1,3], Marina B. Reyes[1,4], Alejandro Fallabrino[1], Andrés Estrades[1], and Gabriela M. Veléz-Rubio[1,2]

[1]Karumbé NGO, Montevideo, 11600, URUGUAY; Qarapara NGO, Santiago, Chile
[2]Centro Universitario Regional del Este, Sede Rocha (CURE), Universidad de la República, Uruguay
[3]College of Science and Engineering, James Cook University, Townsville, Queensland, 4811, Australia
[4]Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina

The Uruguayan coast has a special relevance as an important feeding area and migratory corridor for large juveniles and adult individuals of Loggerhead turtle (*Caretta caretta*). According to previous studies these belong mainly to Brazilian nesting colonies and feeds on a variety of benthic invertebrates, such as crustaceans and mollusks as well as on fishes discarded from coastal fisheries. In order to add new data on the loggerhead turtle diet in the Uruguayan waters, we collected gut contents from 30 stranded turtles between 2010 and 2018. For sex classification we used the minimum size of females of this nesting colony (CCL= 83 cm). Turtles analyzed were characterized as large juveniles and adults, with a CCL notch to tip = 74.2 ± 12.3 cm, range = 53.2 to 99.6 cm (mean CCL notch to tip ± SD). The relative importance of each dietary item found was recorded as Frequency of Occurrence (%FO). We identified 21 dietary items; most preyed items belong to Crustacea (*Libinia spinosa*, 56,66 %FO and *Loxopagurus loxochelis*, 40,0 %FO), followed by Gastropoda (*Buccinanops cochlidium*, 33,3 %FO) and finally Actinopterygii (*Trichiurus lepturus*, 23,3 %FO). All these preys possess a wide distribution in coastal temperate waters between southeastern Brazil, Uruguay and north Argentina. *Libinia spinosa* (spider crab), *L. loxochelis* (hermit crab) and *B. cochlidium* (blind snail) are common benthic organisms mainly found on sand and mud between 5 to 80 meters depth while *T. lepturus* (sable fishes) is benthopelagic and has a wider bathymetric distribution. Two loggerheads stranded in the estuarine zone (Río de la Plata) only presented in their gut opercula of the invasive gastropod Rapanavenosa. Marine debris (styrofoam and soft plastic) were found in one individual (CCL= 61.8 cm), which also contained other floating items as the gastropod *Janthina janthinaand* wood remains. Probably, this turtle is a recent recruit to neritic habitats where *C. caretta* shifts its feeding from an epipelagic diet to prey mainly on benthic invertebrates. These results confirm previous studies in the zone, highlighting the plasticity of the opportunistic and generalist foraging strategy of loggerheads in Uruguayan waters.

LONG-TERM TRACKING REVEALS HIGH SITE FIDELITY OF JUVENILE GREEN AND HAWKSBILL TURTLES AT NIGHT ALLOWING DEPENDABLE IN-WATER RECAPTURES

Paul Jobsis[1], Lora Kay Johansen[2], Jon Jossart[3], Jordan Matley[4], and Scott Thomas Eanes[1]

[1]*University of the Virgin Islands, U.S. Virgin Islands*
[2]*Dallas Aquarium, Texas, USA*
[3]*NOAA*
[4]*Great Lakes Institute of Environmental Research, Ontario, Canada*
[5]*University of the Virgin Islands , U.S. Virgin Islands*

Habitat partitioning is an important factor influencing resource-use among sympatric sea turtles. Green turtles (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*) are iconic species in tropical oceans that co-exist at relatively small spatial scales, particularly as juveniles. Previous research has shown spatial segregation during the day (i.e., green turtles feed in seagrass meadows, while hawksbills remain over coral or rock reefs), however limited comparative information is available concerning behavior of both species at night. To explore habitat partitioning and space-use differences between these species at night, a four-year active tracking study was conducted in Brewers Bay, St. Thomas in the U.S. Virgin Islands, using acoustically tagged juvenile green and hawksbill turtles. Fourteen green (9 Vemco and 5 Sonotronic tags) and 24 hawksbill turtles (19 Vemco and 5 Sonitronic tags) were tracked for periods ranging from two weeks to over two years. Long-term tracking with Vemco V13 and V16 tags revealed little emigration from the approximate 100 Ha bay and distinct daily movement patterns. A dramatic decrease in the activity of juvenile turtles at night was suggestive of resting or sleeping in distinct locations. Furthermore, our data shows that both species seek the refuge of reefs at night. Fine-scale positioning of five green and five hawksbill turtles over a two-week period (11 sampling nights) was estimated using Sonotronics active tracking tags (70-79 kHz) and a Vemco VR100 receiver with its VH110 directional hydrophone. An accuracy of +/- 25m was determined using test tags in known locations. The average nightly minimum convex polygon (MCP; an estimate of spatial extent) for green and hawksbill turtles, respectively, were 0.065 Ha (sd 0.02 Ha) and 0.11 Ha (sd 0.089 Ha), orders of magnitude smaller than previously reported. Interestingly, hawksbill turtles showed less site fidelity than the green turtles on the reefs, with two tracked hawksbill turtles moving their resting locations dramatically during the monitoring period and therefore were not included in the MCP analysis. Additionally, recapture rates were 100% for the 10 turtles used in the fine scale tracking at night. In-water night captures and recaptures increase our catch per unit effort, and decreases several possible stressful stimuli for the turtles. This allows dependable equipment removal and enables growth and other metrics to be collected reliably. Both species had higher site fidelity and smaller spatial extent than previously reported, demonstrating the value of reef habitat in the life history of both sea turtle species.

GREEN TURTLE GRAZING CAUSES A CONSISTENT RESPONSE IN SEAGRASS ECOSYSTEM METABOLIC CARBON CAPTURE ACROSS CARIBBEAN MEADOWS

Robert A. Johnson[1], Alexandra G. Gulick[1], Nerine Constant[1], Alan B. Bolten[1], Fee O. H. Smulders[2], Marjolijn J. A. Christianen[3], Mabel I. Nava[4], Keith Kolasa[5], and Karen A. Bjorndal[1]

[1]Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, Florida, USA
[2]Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Amsterdam, Netherlands
[3]Wageningen University & Research, Aquatic Ecology and Water Quality Management Group, Wageningen, Netherlands
[4]Sea Turtle Conservation Bonaire, Caribbean Netherlands
[5]Hernando County Public Works, Florida, USA

Green turtle abundance is increasing in some areas. As populations recover, this will lead to greater areas of seagrasses returning to a natural grazed state. Seagrass ecosystems are recognized as important locations for carbon storage, due to their high rates of carbon capture and ability to store carbon for long periods of time. It is therefore important to understand how green turtle grazing affects carbon dynamics in seagrass habitats and what this will mean as more seagrass areas are grazed in the future. Prior results from one site showed that rates of metabolic carbon capture were lower in areas grazed by turtles than in ungrazed seagrass, but carbon stored in the substrate was not released as a result of grazing. It is critical to know if effects of grazing on these carbon dynamics vary among meadows under differing conditions and in different areas. We surveyed metabolic carbon dynamics across a series of *Thalassia testudinum* seagrass meadows grazed by green turtles at five sites in the Caribbean and Gulf of Mexico to evaluate effects of grazing on these important carbon processes. We also measured metabolic carbon dynamics in three meadows dominated by the invasive seagrass Halophila stipulacea for comparison to the native seagrass meadows. Our results show that the strength of the effect of grazing on seagrass meadow metabolic carbon capture varies among locations. In some locations, metabolic carbon capture was significantly lower (up to 96% in Little Cayman, Cayman Islands) in grazed meadows, but in others there was no significant difference between grazed and ungrazed meadows. Importantly, rates of net ecosystem production always remained positive, showing that meadows grazed long-term by green turtles still capture carbon, albeit at a slower rate than ungrazed seagrass, and grazing does not stimulate a metabolic release of carbon already stored in the system. These results improve our understanding of the effects of grazing on seagrass meadows in the face of recovering green turtle populations and show that for metabolic carbon dynamics, while the strength of the response to grazing may vary, the overall effect is consistent among locations.

USING ACOUSTIC TELEMETRY TO INVESTIGATE HABITAT USE PATTERNS AND RESIDENCY TIME FOR SEA TURTLES IN THE CHESAPEAKE BAY AND COASTAL WATERS OF VIRGINIA, USA

Danielle Jones[1], Gwendolyn Lockhart[1], Susan Barco[2], Andrew DiMatteo[3], and Laura Busch[4]

[1]*Naval Facilities Engineering Command Atlantic, Virginia, USA*
[2]*Virginia Aquarium & Marine Science Center, Virginia, USA*
[3]*CheloniData LLC, Virginia, USA*
[4]*United States Fleet Forces Command, Virginia, USA*

Loggerhead (*Caretta caretta*) and Kemp's ridley (*Lepidochelys kempii*) sea turtles are the most abundant and regularly occurring species in Virginia, United States (U.S.). The Lower Chesapeake Bay and nearshore waters surrounding the mouth of the bay represents the busiest hub of naval activity on the U.S. east coast and hosts many pierside facilities, bases, vessels, shipyards, and in-water training areas, in addition to being the 7th largest container port in the U.S. Between 2013-2017, a total of 66 loggerhead (n=25) and Kemp's ridley (n=41) sea turtles were equipped with acoustic transmitters (Vemco™) to better understand how these species utilize waters near U.S. Navy facilities in southeastern Virginia. Acoustic transmitters were used for this project to leverage the existing underwater acoustic receiver array (maintained by the U.S. Navy and other members of the Atlantic Cooperative Telemetry Network), located within the Chesapeake Bay and off the coast of Virginia. Fifty-two (77.6%) of the tagged sea turtles (loggerhead: n=20; Kemp's ridley: n=32) were detected in the receiver array. To begin investigation of presence, habitat use, and residency time for each species, we looked at date, numbers of detections, and location information, which is recorded by the receivers. Loggerheads and Kemp's ridleys were detected between May and November, providing further evidence that both of these species utilize this region from late spring to fall. For loggerheads, the number of days detected ranged from 1-39 with a mean of 8.37 days (SD=9.99), and deployment duration (deployment date to last detection) ranged from 0-319 days with a mean of 71.35 days (SD=89.14). For Kemp's ridleys, the number of days detected ranged from 1-110 with a mean of 8.03 days (SD=19.28), and deployment duration ranged from 0-149 days with a mean of 46.63 days (SD=53.71). There was no significant difference between the two species for number of days detected (p=0.93) and deployment duration (p=0.27). Differences in deployment duration indicate that loggerheads may occur in Virginia across seasons and exhibit inter-annual site fidelity. For example, two of the 20 (10%) tagged loggerheads were detected in two consecutive seasons/years. Loggerheads were detected on 46 acoustic receivers, with most being associated with military zones. Number of detections were highest for the following zones: Norfolk Naval Base (n=1946), Joint Expeditionary Base (JEB) Little Creek (n=1502), and JEB Fort Story (n=547). Kemp's ridleys were detected on 54 acoustic receivers, with most being associated with military zones. Detection levels were highest for the following zones: Norfolk Naval Base (n=2108), Elizabeth River (n=1950), and JEB Little Creek (n=472). The high number of detections for both species at particular zones compared to others could indicate potential hot spot areas, though receiver distribution was not uniform. The Elizabeth River may be a foraging area for Kemp's ridley turtles and Little Creek may be a foraging area for loggerhead turtles, whereas, Norfolk Naval Base may be a foraging area for both species. Results from switching state-space modeling of satellite tagged loggerheads and Kemp's ridleys have displayed relative foraging area levels in these areas. Future analysis will include further investigation of habitat use and the relationships between detections and species, and if and how these detections varied within and between years for both species. The results from this study will enhance our understanding of sea turtle habitat use and residence time in the lower Chesapeake Bay and nearshore mid-Atlantic and will allow for a better assessment of the potential impacts that U.S. Navy activities may have on these protected species.

SHARED HABITAT USE BY JUVENILES OF THREE SEA TURTLE SPECIES

Margaret Lamont[1] and Autumn R. Iverson[2]

[1]US Geological Survey
[2]Cherokee Nation Technologies/contractor to US Geological Survey

The first step in understanding how sympatric species share habitat is defining spatial boundaries. While home range data for juvenile sea turtles exists, few studies have examined spatial overlap of multiple species in foraging habitat. Using satellite tracking technology, we define home ranges for juveniles of three sea turtle species (loggerheads, Kemp's ridleys and greens; n= 21) captured at two adjacent foraging sites in the northern Gulf of Mexico. Green turtles are known to be primarily herbivorous whereas Kemp's ridleys forage predominately on crabs and loggerheads on various hard-shelled benthic invertebrates. No differences in home range size or characteristics, such as water depth and distance to shore, were observed among species. A high degree of overlap in habitat-use among all three species was documented in summer at both sites. Seasonal movements, triggered by colder winter temperatures, were documented and appeared to differ among species with Kemp's ridleys and loggerheads leaving the bays and greens overwintering inside bays. In both of these bays, overlap among all three species occurred in summer but seasonal movements by Kemp's and loggerheads minimized overlap in winter. By identifying shared habitat-use by juvenile sea turtles, we have created a foundation for further fine-scale studies on resource partitioning that will aid in habitat management and conservation of these threatened and endangered species.

OVERWINTERING BEHAVIOR OF JUVENILE SEA TURTLES AT A TEMPERATE FORAGING GROUND

Margaret Lamont[1], David R. Seay[2], and Kathleen Gault[3]

[1]US Geological Survey
[2]Cherokee Nation Technologies/contractor to US Geological Survey
[3]Eglin Air Force Base

Most turtle species that inhabit temperate environments hibernate to survive extreme cold periods. However, for sea turtles, the question of whether these species use hibernation as an overwintering strategy has not been resolved. St. Joseph Bay, located in Northwest Florida, supports a year-round assemblage of foraging turtles including threatened green turtles (*Chelonia mydas*) and loggerheads (*Caretta caretta*), and endangered Kemp's ridleys (*Lepidochelys kempii*). Although winter temperatures in St. Joseph Bay frequently fall below 15°C, some individuals forgo seasonal migrations and remain within the bay year-round. Over a 7-year period, we conducted random vessel-based surveys, deployed temperature data loggers at various depths in the bay and tracked juvenile green turtles using acoustic tags to assess overwintering behavior by sea turtles. In addition, from January 2 to January 19, 2018 during a period of extreme cold in which water temperatures in St. Joseph Bay dropped as low as 2°C and more than 1,200 turtles stranded, we were able to directly observe turtle behavior. On January 16, the sea in St. Joseph Bay was abnormally calm and exceptionally clear. On this day, using our boat-based Garmin (echo-MAP 74sv with GT41-TM transducer), we recorded sea surface temperatures over deep water (>5 m) that ranged from 9.5°C to 10°C and in shallower water (2–5 m) at the southern end of the bay from 8.0°C to 9.0°C. Water clarity was exceptional and we observed turtles swimming in the water column and resting on the seafloor. Using a GoPro Hero4 Black 2 mounted on a 96.5 cm pole and hand-held in the water column, we captured video images of two juvenile greens and one juvenile Kemp's ridley. In total, we captured 5:03 minutes of video. During these videos, turtles swam, crawled and rested on the bottom. These observations, along with our previous survey and water temperature data, indicate that turtles alternate relatively short periods (i.e., hours) of resting on the seafloor with periods of basking in the sun and in warmer surface waters. These cold-stun mortality events may serve as a primary force regulating the structure of juvenile turtle populations at temperate foraging sites. Examining the demographics of this population would help us understand the impacts of cold stun events on turtles at temperate foraging sites.

NEW FEEDING AREAS REVEALED BY SATELLITE TRACKING OF LOGGERHEAD TURTLES SHOWS THAT THERE ARE STILL MANY CONSERVATION CHALLENGES IN BRAZIL

Paulo Hunold Lara[1], Frederico Tognin[1], Luciana Verissiomo[1], Denise Mora[1], Alexsandro Santana dos Santos[1], Maria Angela Marcovaldi[1], Milagros López-Mendilaharsu[1], and Yonat Swimmer[2]

[1]*Projeto TAMAR*
[2]*NOAA NMFS PIFSC*

The Southwest Atlantic Ocean is an area of development, feeding and reproduction of loggerhead turtles. The major nesting areas are located in southeastern and northeastern Brazil mainly in the state of Bahia. The northern coast of Bahia state receives each year about 6300 loggerhead nests on 214 km of beaches, which represents 50% of the total number of loggerhead nests monitored by TAMAR throughout the Brazilian coast. The first telemetry study of loggerheads females nesting in Bahia revealed that main foraging areas for this species were located along the northern coast of Brazil, especially off the coast of Ceará State. In addition, after a second post-nesting migration, five loggerhead turtles returned to the same foraging area indicating strong philopatry to specific foraging areas. To complement previous studies we deployed satellite transmitters on 13 loggerhead females in 2013 and 2014 at Praia do Forte, Bahia. Among these turtles, 3 stopped transmitting before leaving the nesting grounds. During the inter-nesting period, 12 females remained between 15 and 100 days. Ten females migrated to neritic foraging areas located throughout the northeastern and southeastern coast of Brazil. We obtained a short migration of only 200 km while the longest was 2000 km. In contrast to our previous studies, some of the post-nesting turtles migrated to foraging areas located in southern Brazil, revealing that this population foraging destinations are very diverse. Additionally, two turtles tracked for the second time in 2017 returned to the same foraging areas, which confirmed their high site fidelity. Results increased our knowledge about the foraging areas used by this population, which were widely distributed along the Brazilian continental shelf from the south to north. A recent study that tracked the movements of laboratory-reared yearling loggerhead turtles from northern Bahia showed that post hatchlings were exposed to seasonally varying ocean conditions that lead some individuals further into the South Atlantic and others into the Northern Hemisphere. It has been shown that migration routes of adult turtles are strongly related to hatchling drift patterns, with adults travelling to foraging sites that they experienced in their earlier oceanic juvenile stage. For conservation, these results mean new challenges. There is still much to know about the loggerhead turtles that nest along the Brazilian coast. Loggerhead populations such as those nesting in southeastern Brazil (i.e. Espírito Santo and Rio de Janeiro) are probably influenced by other ocean current regimes, which can affect hatchling initial dispersal patterns and possibly the location of their foraging sites as adults. Understanding the areas of use of loggerhead turtles is of great importance in determining threats and inform future management actions to protect this species. Integrative studies that combine satellite tracking with stable isotope analysis will be used to determine their differential habitat use.

CHARACTERIZING KEMP'S RIDLEY (LEPIDOCHELYS KEMPII) AND LOGGERHEAD (CARRETTA CARETTA) HABITAT PARTITIONING IN VIRGINIA AND MARYLAND STATE WATERS USING SATELLITE TAG DATA

Gwendolyn Lockhart[1], Andrew DiMatteo[2], Susan Barco[3], Danielle Jones[1], and Laura Busch[4]

[1]*Naval Facilities Engineering Command Atlantic, Virginia, USA*
[2]*CheloniData LLC, Virginia, USA*
[3]*Virginia Aquarium & Marine Science Center, Virginia, USA*
[4]*United States Fleet Forces Command, Virginia, USA*

Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Carretta caretta*) sea turtles are the most abundant sea turtle species regularly observed in Virginia and Maryland waters. Virginia and Maryland state waters are important foraging habitat for both species; as well as being near one of the busiest naval activity hubs on the U.S. east coast. This study was conducted to support U.S. Navy environmental compliance efforts, by understanding how Kemp's ridley and loggerhead turtles utilize areas in and around the Chesapeake Bay that are designated as military operation zones. State waters in the region include the Chesapeake Bay, rivers within the Chesapeake Bay watershed, and ocean waters within three nautical miles from the Virginia and Maryland coastline. We used Argos/GPS location data from 45 satellite tags, attached to Kemp's ridley (n=19) and loggerhead (n=26) turtles. All tags were deployed between 2009-2017 and transmitted more the seven days within state waters. We applied the Douglas filter and used the resulting data to derive interpolated tracks, with points at six-hour intervals, using a switching state space model (SSM). We used ArcGIS™ 10.3 to calculate the distance from shore, calculate the distance from the nearest coastal naval installation, and extract a depth value (from the ETOP01 model) to each interpolated location point. Mean distance from shore, distance to installation, and depth were compared within state waters, for both species, using a one-way analysis of variance. The 45 turtles were tracked for 4,362 days (Kemp's ridley=482 days; loggerheads=3,880). Kemp's ridleys spent 89% of the tracking duration (430 days) within state waters and loggerheads spent 39% of the tracking duration (1,516 days) within state waters. Based on the SMM analysis, the Kemp's ridley points (n=1,737) were located closer to the shore with a mean of 1,699 meters (range=0-15,392 meters; standard deviation=1,975 meters) compared to loggerhead points (n=6,078), which had a mean of 5,281 meters (range=0-17,120 meters; standard deviation=3,956 meters). Additionally, Kemp's ridley points (n=1,737) were located closer to naval installations with a mean of 30,137 meters (range=0-123,496 meters; standard deviation=27,541 meters) compared to loggerhead points (n=6,078), which had a mean of 4,1912 meters (range=0-187,497 meters; standard deviation=39,015 meters). On average, the Kemp's ridley depth values (n=1,737) were shallower, at -3.91 meters (range=-26-5 meters; standard deviation=3.17 meters) than the loggerhead depths (n=6,078) at -9.47 meters (range=-30-5; standard deviation=5.08 meters). The difference between the two species' distance from shore, distance from installations, and depth values were all statistically significant ($p < 0.001$). This study shows that the two species are utilizing different habitats. Kemp's ridleys prefer shallower areas, while loggerheads prefer deeper areas. If we assume that these patterns are driven by foraging strategies, it may be that these species are exhibiting resource partitioning. It is important for the U.S. Navy to understand these habitat use trends in order to apply effective mitigation measures. In particular, given that Kemp's ridley sea turtles spend a significantly greater amount of time near installations, the risk to these species should be given additional consideration during Navy exercise planning within the study area.

JUVENILE GREEN TURTLE DIET AFTER REPEATED HARMFUL ALGAL BLOOMS

Chris Long, Erin E. Seney, and Kate L. Mansfield

Marine Turtle Research Group, University of Central Florida, Florida, USA

Coastal habitats are at risk worldwide due to increasing environmental degradation caused by dense human populations at the land-sea interface. In many areas, coastal habitats are changing due to the effects of nutrient pollution, i.e., the input of excess nutrients from anthropogenic sources. One of the most dramatic examples of habitat changes which can be caused by nutrient pollution is harmful algal blooms (HABs). As HABs increase in frequency and magnitude, we must increase our understanding of how they impact sea turtles in these habitats. The Indian River Lagoon, located along the east coast of Florida, USA, is an important juvenile sea turtle habitat that has been repeatedly impacted by HABs in recent years. Unlike other marine mammals and fish, sea turtles have not experienced die-offs in the IRL during HABs, but the sublethal effects of habitat degradation on sea turtles are largely unknown. Long-term University of Central Florida Marine Turtle Research Group (UCFMTRG) data indicate declines in both capture rates and body condition for juvenile green turtles (*Chelonia mydas*) in the lagoon during the effects of algal blooms. These data suggest that human impacts on the coastal environment have adversely affected central Florida's coastal juvenile sea turtles, possibly by disrupting their foraging ecology after documented HAB-associated die-offs of seagrass and algae. Previous UCFMTRG diet characterizations in the late 1990s and mid-2000s indicated that juvenile green turtles in the IRL primarily fed on macroalgae, but a small percentage foraged on seagrasses (18.9% of diet volume in late 1990s, 11.8% in mid-2000s). However, the primary producer dynamics in the IRL were altered by the repeated HABs and the impact of these changes are unknown. The previously existing diet data and long-term nature of the UCFMTRG program in the IRL are an ideal combination for examining the impacts of HABs on juvenile green turtle diet. We collected 93 esophageal lavage samples, which are snapshots of recent diet, from juvenile green turtles in the IRL in 2017 and 2018. Using genetic barcoding markers (ITS and CO1) and next-generation sequencing, we determined the composition of these samples and compared them to the previous diet studies at the same site to look for differences after repeated HABs. We also analyzed these data for differences among seasons and size classes, which could be important factors in determining diet and in determining the impacts of HABs on population structure, foraging ecology, and habitat use. Visual inspection of our diet samples suggests that seagrasses are now very uncommon diet items (<5% of samples), indicating a large decline in seagrass importance to the diet of IRL green turtles. As HABs become more frequent, intense, and widespread, understanding their impacts on sea turtles will aid management and conservation efforts. Acknowledgments: This work was funded by a grant from the Lerner-Gray Fund for Marine Research, and was conducted under Florida MTP#231 and NMFS permit #19508.

LOGGERHEAD TURTLE (CARETTA CARETTA) TAGGED IN RIO DE JANEIRO, BRAZIL, CONNECTING THE SOUTHWESTERN ATLANTIC

Gustave G. Lopez[1], Sérgio Estima[2], Danielle Monteiro[3], Daphne Wrobel Goldberg[3], and Victor J. Patiri[4]

[1]*UFBA – Universidade Federal da Bahia*
[2]*NEMA – Núcleo de Educacão Ambiental e Monitoramento Ambiental*
[3]*FURG – Universidade Federal do Rio Grande*
[4]*Braço Social Consultoria Ambiental*

The loggerhead turtle (*Caretta caretta*) has a wide nesting distribution throughout the mainland coast of Brazil, with its main nesting area extending from Sergipe, Northeastern Brazil, to the northern coast of Rio de Janeiro, in Southeastern Brazil. According to genetic studies, three management units within the Southwest Atlantic population have been recognized: northeastern coast (Sergipe and Bahia), Espírito Santo, and Rio de Janeiro. However, most information on long-distance movements for Brazilian loggerheads was gathered for the northeastern stock. Despite this, data from scientific literature indicates a distinctive migratory behavior among the 2 subpopulations. Here we report the post-nesting migration of a loggerhead originally tagged on the northern coast of Rio de Janeiro. The turtle, found on December 15th 2017 at Farol de São Thomé (-22.01517; -40.99654), was measured (CCL = 99 cm; CCW = 88.5 cm), tagged with Inconel metal tags (Style 681; NBT Co.) and a satellite transmitter (Spot 352-B; Wildlife Computers) was attached to its carapace. After leaving the nesting ground on Jan 15th, the animal traveled west/southwest crossing the Santos Basin, first using areas deep offshore waters, reaching nearshore shallower areas north of Florianópolis (-27.2787; -48.3782) on Jan 31st. From this point on she swam parallel to the coast sometimes as close as 1nmi, reaching the larger external mouth of the Plata River on Feb 20th, near Maldonado, Uruguay (-35.1201; -54.7803). Crossed to Samborombón Bay in Argentina and settled near Montevideo, by the beginning of March. Used a small area (approx. 3,7 km2) and left May 22ndheading north, then east towards the open sea, north towards Brazil and then west towards the coast. The turtle was found dead by the NEMA team during beach monitoring on 08 June 2018, on the southernmost region of Rio Grande do Sul coast, 50 km north of the Uruguay border (-33.44731, -52.98156), after three days from its last reported location (-33.47450, -52.98382). According to gross examination, the animal was in good body condition and its gastrointestinal tract was full, including the esophagus, meaning the turtle had been feeding recently. Recent studies indicate this region as an important foraging area for adult and sub-adult loggerheads, as well as a high mortality rate due to incidental capture in fishing activities. This telemetry experiment highlights the connection with the nesting ground of Rio the Janeiro as other ten females were observed migrating to Southern Brazil, Uruguay, and Argentina, using nearshore areas to feed and live. Finally, the opportunity to report this specific animal was made possible by network activation of different institutions that carry on research and protection of sea turtles in the Southwestern Atlantic Ocean (ASO). Colleagues from the region were frequently contacted and informed about turtles' movements observed near their working areas, as part of an informal network. In this context, we call attention towards two aspects: 1- the importance of cross-border collaboration in sea turtle conservation and research, focusing on effort integration among researchers and the development of a common agenda for collective initiatives; 2- the need for ecosystem-based approach on future collaborative research.

SIZE RANGE, GROWTH RATES AND DISTRIBUTION OF HAWKSBILL TURTLES IN THE SOUTHERN PACIFIC OF COSTA RICA

Magali Marion and Didiher Chacón-Chaverri

Latin American Sea Turtles -LAST. Tibas, San Jose, Costa Rica

The ability to establish effective conservation strategies relies on the understanding of life history components of a population such as somatic growth rates, the time required to reach sexual maturity, as well as the assessment of the quality of foraging habitat. The hawksbill turtle (*Eretmochelys imbricata*) inhabiting the Eastern Pacific Ocean is one of the worlds most endangered sea turtle population in the world. Yet, critical information about their life history, especially in foraging habitats, are spare. Golfo Dulce, a tropical fjord-like embayment of approximately 50 km length and 15 km width and has a diverse range of habitats ranging from coral reefs over mangroves to seagrass beds. An ongoing monitoring project, started in 2010, aims to record life-history and habitat-use related estimates for hawksbill turtles through a mark-recapture approach. From 2010 to 2018, 203 individual hawksbills were measured, weighted, and flipper tagged internally and externally. Of the marked indiviuals,112 were recaptured at least once within a distance of four kilometers. The curved carapace lengths ranged from 32.8 to 82.8 cm (x? = 57.7, SD =± 11.4 cm) and the growth rates registered ranged from 0.2 to 9.9 cm year-1 (x^2= 2.5 cm, SD =± 1.9 cm) with a peak growth reached within the 35 to 45 cm curved carapace length size-class. The population is largely dominated by juveniles and only 19 turtles were positively identified as males thanks to the presence of an elongated tail. Nine of these males were captured originally as juvenile or subadult stages and were recaptured during their transition into maturity. Our data show that Golfo Dulce is an important foraging habitat for juvenile hawksbill turtles and the demographic data combined with the high site fidelity are compelling evidence that needs to be factored into the development of appropriate of conservation strategies.

FORAGING AND OVERWINTERING BEHAVIOR OF LOGGERHEAD (CARETTA CARETTA) SEA TURTLES IN THE WESTERN NORTH ATLANTIC

Joanne Braun McNeill[1], Larisa Avens[1], April Goodman Hall[1], Ikuko Fujisaki[2], and Autumn R. Iverson[3]

[1]NOAA Fisheries, Southeast Fisheries Science Center
[2]University of Florida, Florida, USA
[3]USGS

Sea turtles are slow-growing, late-maturing species that undertake wide-ranging migrations, which are life-history traits that make them especially vulnerable to extinction. To protect and successfully manage these imperiled populations, an understanding of their spatial ecology is required. Thus, research to characterize critical foraging habitat, identifying high-density areas, and determining migratory pathways is essential. To address those data needs, we tracked 30 loggerhead (Caretta caretta) sea turtles captured in North Carolina inshore waters; the sample group included both juveniles (n = 24) and adults (n = 6) and track durations ranged from 26 to 682 days, with a mean of 165 days. Despite capture in a geographically-restricted area, we observed diverse behaviors following release, with subsequent turtle distribution spanning much of the US Atlantic coast. Summer foraging habitat varied; some turtles (n = 11) traveled north to areas off Virginia or New York, a few (n = 3) traveled south to South Carolina or Florida, but most (n = 16) remained within 150 km of their release location in North Carolina. Of the 12 turtles for which we documented winter foraging habitat, some turtles (n = 4) migrated to South Carolina or farther south (including one that entered the Gulf of Mexico), but the majority (n = 8) remained within nearshore waters of North Carolina. Track data were filtered and a switching-state space modeling (SSM) approach incorporating the best location for each turtle for each tracking day was applied to distinguish migratory, foraging, and overwintering periods. Behavioral state data were then incorporated into Generalized Additive Mixed Models (GAMMs) along with location-specific environmental data to evaluate potential factors influencing shifts between states, such as date, geographic position, bathymetry, sea surface temperature, and net primary production. To determine extent of overlap in foraging areas among individuals, we also estimated mean home range and core use areas and determined the extent of overlap. The results of these analyses will yield insight into loggerhead sea turtle habitat characteristics and provide a baseline against which to compare future habitat use data.

NEWLY DISCOVERED MIGRATING AND FORAGING HABITATS FOR EAST ATLANTIC GREEN TURTLES

Emily Mettler, Chelsea Clyde-Brockway, Shaya Honarvar, and Frank V. Paladino

Purdue University, Indiana, USA

This study is the first to use satellite telemetry to track post-nesting movements of endangered green turtles (*Chelonia mydas*) in the Gulf of Guinea. Understanding the in-water movements and foraging habitats of green turtles is essential for creating effective conservation plans and reducing anthropogenic threats. Satellite transmitters were attached in 2018 to six Atlantic green turtles nesting on Bioko Island, Equatorial Guinea to track their post-nesting movements and locate their foraging grounds. Track lengths of 20-198 days were analyzed, for a total of 536 movement days for the six turtles. Turtles exhibited a combination of coastal and oceanic migrations pathways that ranged from 957 km to 1,131 km. Of the six turtles, five completed their migration and maintained residency at the same foraging ground near the coastal waters of Accra, Ghana for a significant time. These resident turtles inhabit heavily fished and polluted waters and are vulnerable to a variety of anthropogenic threats. The identification of these previously unknown foraging grounds highlights the importance of these coastal waters for the protection of the endangered Atlantic green turtle, and supports the creation of effective, informed management plans.

HAWKSBILL 'LOST YEARS' IN THE EASTERN PACIFIC: ACOUSTIC AND SATELLITE TELEMETRY REVEAL MOVEMENT PATTERNS OF HATCHLINGS AND NEONATES

Cristina Miranda[1], Felipe Vallejo[1], George Shillinger[2], Jeffrey A. Seminoff[3], Mike Liles[4], Ingrid Yañez[1], and Alexander Gaos[1,5]

[1]*Equilibrio Azul, ICAPO – Eastern Pacific Hawksbill Initiative, Equilibrio Azul, ICAPO – Eastern Pacific Hawksbill Initiative*
[2]*Upwell*
[3]*NOAA Southwest Fisheries Science Center*
[4]*Asociación ProCosta, El Salvador*
[5]*NOAA-NMFS Pacific Islands Fisheries Science Center, Marine Turtle Biology & Assessment Program*

Research on the genetics and movement ecology of hawksbills (*Eretmochelys imbricata*) in the eastern Pacific Ocean has identified the nesting population within Machalilla National Park (MNP), in south-central Ecuador as distinct Management Unit (MU). An average of approximately 20 hawksbill nests are laid per year. Management and conservation of hawksbills at MNP continues to be hindered by a lack of basic biological information on the species' dispersal and movement, particularly for recently hatched turtles. The first years of a turtle's life, known as the "lost years", continue to be one of the most mysterious life-stages across all sea turtles, particularly for hawksbills in the eastern Pacific. For many sea turtle species and populations, it is commonly accepted that once recently emerged hatchlings reach the ocean they become part of the oceanic, epipelagic community, where they can passively drift, actively swim or both. However, there are studies that show that hatchlings can actively swim during not only the first hours of life (i.e., "swim frenzy"), but also during the entire lost years. Under such scenario it is possible that post-hatchling turtles can actively choose where to remain during this life stage. It is also widely accepted for many species and populations that post-hatchlings and juveniles become entrenched in large ocean gyres, which results in multiyear forays during which turtles can circumnavigate entire ocean basins, before recruiting to more fixed habitats. Recent genetics and fisheries-based studies in the eastern Pacific suggest that some hawksbill populations may remain in coastal regions during early life-stages or undergo a truncated pelagic dispersal phase that keeps them out of major offshore currents. Nonetheless, empirical support for this possibility remains scarce. In this study we used acoustic tracking of hatchlings that recently emerged from nests (referred to here as post-hatchlings), and satellite tracking of juveniles of < one year old (referred to here as neonates) (CCL average 21cm), to study their dispersal and movement ecology during these early life stages. A total of 43 hawksbill post-hatchlings were tracked with acoustic tags from La Playita beach in MNP, which we paired with measurements of ocean currents, wind speed and wind direction. For satellite tracking, we equipped three approximately one-year old neonates with mini-SPOT tags, two at La Playita and one at Playa Rosada (a more recently discovered hawksbill nesting beach approximately 50km south of MNP). These turtles were released approximately 2 km from shore. The results of the acoustic tracking provide evidence of active swimming for the post-hatchlings immediately after release. The two neonates tracked from La Playita using satellite telemetry moved north approximately 800 km after release, but remained <280 km from shore during their entire tracking period (30-50 days). The third neonate released from Playa Rosada almost immediately retired to neritic habitat and travelled approximately 150 km to a rock bottom reef south from Playa Rosada over the course of 4 weeks, where it remained for the duration of transmissions (~ 2 months). This study suggests an active swimming behavior for juvenile hawksbills from MNP and provide empirical support that hawksbills at MNP may remain in near-shore habitat for the duration for the post-hatchling (i.e., lost years) phase. Our findings may be indicative of other hawksbill populations in the eastern Pacific; additional research is currently underway in Central American rookeries to confirm this possibility.

CAN TURTLE-BORNE TEMPERATURE-DEPTH OBSERVATIONS HELP IMPROVE OCEAN MODELS?

Samir Patel[1], Leah Crowe[2], James Manning[3], Ronald Smolowitz[1], and Heather Haas[3]

[1]*Coonamessett Farm Foundation*
[2]*Integrated Statistics*
[3]*Northeast Fisheries Science Center*

From 2009 to 2017, we deployed 167 satellite tags on loggerheads within the U.S. Mid-Atlantic Bight of the Northwest Atlantic Ocean. These tags collected and transmitted location, temperature and depth information and yielded 18,790 temperature-depth profiles during the highly stratified season (01 June – 04 October) for the region. This included 16,371 profiles exceeding the mixed-layer depth, and, of those, 11,591 full water column profiles reaching the ocean floor. To verify the accuracy of these animal borne-sensors, we compared vertical profiles from the tag data with shipboard CTD casts, the more common approach for collecting oceanographic measurements. We then compared the *insitu* data with regional models as a first step in determining if the tag data can be used to improve them. We used two local models, ROMS ESPRESSO and FVCOM and one global model HYCOM, which all provide temperature estimates through depth. The US MAB is a dynamic ecosystem that is difficult to model due to a combination of complex seasonal water masses and currents and a limited set of tools for taking in situ measurements. This region is also prime foraging habitat for loggerhead sea turtles during the late-spring to summer months. Here we suggest that the habitat usage of loggerhead turtles in the Mid-Atlantic Bight make them good ocean observers within this difficult to model, highly stratified region and data from tag deployments on these animals can be used to improve resolution of in situ temperature through depth data and in turn improve oceanographic model outputs.

LOGGERHEAD INTER-NESTING MOVEMENTS, MIGRATORY ROUTES, AND FORAGING SITES IN THE GULF OF MEXICO

Katrina Phillips[1], David Addison[2], Christopher Sasso[3], and Kate L. Mansfield[1]

[1]*Marine Turtle Research Group, University of Central Florida, Orlando, Florida, USA*
[2]*The Conservancy of Southwest Florida, Naples, Florida, USA*
[3]*NOAA Fisheries, Southeast Fisheries Science Center, Miami, Florida, USA*

Migratory species present a conservation challenge because their habitat use varies over space and time. Most marine turtles travel long distances during reproductive migrations between foraging areas and nesting beaches; information about the routes they take and sites they choose are needed to inform management and reduce potential human interactions. We used satellite telemetry to track the post-nesting movements of 32 female loggerheads (*Caretta caretta*) from Keewaydin Island, Florida, USA, in the southeastern Gulf of Mexico between 2009 and 2016. Thirteen of these turtles were re-captured and tracked in two or more nesting seasons to assess individual fidelity. The average track duration was approximately one year (mean 358 days, SD +/- 227, range 42-1093), and included inter-nesting movements, post-nesting migration, and foraging. Inter-nesting movements consisted mainly of loops away from and back to the nesting beach over the West Florida Shelf at water depths of less than 50m. Post-nesting migrations averaged 12 days (SD +/- 11) to foraging sites in the Gulf of Mexico and subtropical northwest Atlantic. In general, larger turtles made post-nesting migrations to more distant foraging sites, while smaller turtles foraged closer to the

nesting beach. We documented high individual foraging site fidelity as well as overlap of foraging areas among individuals. Our results build a more complete picture of space-use patterns during reproductive migration and foraging periods that may be used to develop targeted management strategies to conserve loggerheads and their habitats. Support for this research was provided by the Conservancy of Southwest Florida and friends of the Conservancy's sea turtle program, Florida Sea Turtle Grants Program, Rookery Bay National Estuarine Research Reserve, National Oceanic and Atmospheric Administration, and numerous Conservancy interns, field staff, and volunteers.

MODELING MOVEMENTS AND HABITAT USE FOR OVER 100 REEF-DWELLING MARINE TURTLES IN THE MARIANA ARCHIPELAGO

Anna Poulton[1,2], Summer L. Martin[1], Tammy M. Summers[3], Jessy R. Hapdei[4], Shawn B. Wusstig[5], Jamie D. Bass[5], Francisco D. Manibusan[5], Cristian M. Cayanan[5], Johnedel H. Ducusin[5], Carlos S. Quintanilla[5], Julie Rivers[6], Kevin Brindock[1,3], Alexander Gaos[1,7], Camryn Allen[1,7], Kyle S. Van Houtan[8], Jay T. Gutierrez[5], Celestino F. Aguon[5], and T. Todd Jones[1]

[1]*NOAA Fisheries, Pacific Islands Fisheries Science Center, Hawaii, USA*
[2]*Illinois Wesleyan University, Illinois, USA*
[3]*Naval Facilities Marianas, Naval Base Guam, Guam, USA*
[4]*CNMI Department of Lands and Natural Resources, Saipan, Northern Mariana Islands, USA*
[5]*Guam Department of Agriculture, Division of Aquatic and Wildlife Resources, Guam, USA*
[6]*Navy Pacific Fleet Environmental Readiness Office, Hawaii, USA*
[7]*Joint Institute for Marine and Atmospheric Research, University of Hawaii at Manoa, Hawaii, USA*
[8]*Monterey Bay Aquarium, 886 Cannery Row, California, USA*

Green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) sea turtles are found throughout the Mariana Archipelago in the western Pacific Ocean. Understanding their distribution and habitat use is critical for assessing their conservation status and developing effective management strategies. In 2013-2017, GPS-equipped satellite telemetry tags were deployed on 110 turtles (98 green, 12 hawksbill) captured during nearshore snorkel surveys around the islands of Guam, Saipan, and Tinian. All but one of the tagged turtles were immature, with a mean straight carapace length of 57.7 cm (sd = 8.3) for green turtles and 59.7 cm (sd = 6.7) for hawksbill turtles. The tags transmitted signals for a mean of 168 days (sd = 113) on green turtles and 593 days (sd = 375) on hawksbill turtles. This comprehensive data set poses three key challenges for understanding habitat use: (1) fine-scale horizontal movements in close proximity to the shore can be problematic when calculating measures of habitat use, (2) the large number of tags can be challenging to analyze efficiently, and (3) analyses should be easily reproducible to allow for near real-time updates when new data are received. To tackle these challenges, we developed code within the R statistical computing environment. Within R, poor quality (B and Z) Argos points were removed and a biological speed filter (5 kph) was applied. The R package "crawl" was used to predict movement paths between observed locations (GPS and Argos merged). This package was also used to remove erroneous points (e.g., those on land) and predict each turtle's movement such that it traveled around land rather than over it. Using the R package "adehabitatHR", we produced a utilization distribution (UD) for each turtle using kernel density estimations with biased random bridges. From each UD, the home range (smallest area inhabited 95% of the time) and core use area (inhabited 50% of the time) were generated. Maps for fixed movement paths around land and home range/core use areas were generated for each turtle. Maps that included multiple turtles were created by combining UDs produced through grouping by tag deployment location and species. Using the R package "shiny", an application with a convenient user-interface was created to facilitate future analysis of these (and similar) telemetry data. The fast runtime of the code (3-5 minutes per turtle) offers significant improvements over previously used methods of analysis in ArcGIS (e.g., >1 hr/turtle). Results indicate a

mean 95% home range area of 1.1 km2 (sd = 1.2) for non-migratory green turtles and 2.7 km2 (sd = 4.1) for hawksbill turtles. The 50% core use areas were 0.2 km2 (sd = 0.2) and 0.4 km2 (sd = 0.5) for green and hawksbill turtles, respectively, suggesting high foraging site fidelity. The code developed allows for efficient, reproducible analyses of tracking data, and effectively addresses the challenges of analyzing fine-scale movements near land barriers. These results improve our understanding of turtle movements and habitat use in the Mariana Archipelago and can provide insight into their exposure to threats in the areas they inhabit. This project was supported with funding from the Ernest F. Hollings Undergraduate Scholarship Program, the Navy Pacific Fleet Environmental Readiness Office, and Naval Base Guam.

FORAGING ECOLOGY AND HABITAT USE OF JUVENILE GREEN TURTLES (CHELONIA MYDAS) WITH AND WITHOUT FIBROPAPILLOMATOSIS

Monica Reusche, Chris Long, Erin E. Seney, and Kate L. Mansfield

Marine Turtle Research Group, University of Central Florida, Florida, USA

Fibropapillomatosis (FP) is a benign tumorous disease that has been recorded in juvenile green turtles since 1982 by the UCF Marine Turtle Research Group (UCFMTRG). The infectious agent of the disease has been identified as chelonid herpesvirus 5 (ChHV5). While the method of infection is not currently known, one hypothesis is that the virus is spread through horizontal transmission (e.g., from one turtle to another). Increased incidence of FP is correlated with areas of poorer water quality, often near residential and agricultural runoff. However, exactly how water quality increases the disease prevalence is uncertain. It has been hypothesized that eutrophication leads to increased levels of arginine in macroalgae, which is known to promote the replication of latent ChHV5 virus. Here we hypothesize that there is a difference in the foraging ecology, and thus the isotopic signatures, of juvenile green turtles with and without fibropapillomatosis. We compared stable isotope signatures from the skin tissues of juvenile green turtles with and without the FP to (1) determine if there is a significant difference between groups and (2) better understand the etiology of FP. These samples were collected from turtles caught in large mesh tangle nets bimonthly in the IRL as part of a long-term study conducted by the UCFMTRG in the Indian River Lagoon on the east coast of central Florida, USA. Carbon and nitrogen stable isotope signatures were determined for 140 skin samples taken from juvenile green turtles in the Indian River Lagoon (IRL), from 2010 to 2017. We compared the carbon and nitrogen stable isotope signatures of juvenile green turtles with and without tumors using two methods: ANOVA and cluster analysis. Preliminary analysis of 72 green turtle samples indicates that carbon signatures of turtles without FP are higher than those with FP, potentially indicating a different diet or a greater use of oceanic habitats. By increasing our understanding of the relationship between foraging ecology and FP, we can aid conservation efforts focused on FP and its impact on marine turtle populations. Funding and acknowledgements: This project was funded by a grant awarded from the Sea Turtle Grants Program. The Sea Turtle Grants Program is funded from proceeds from the sale of the Florida Sea Turtle License Plate. Learn more at www.helpingseaturtles.org

SATELLITE TRACKING OF JUVENILE GREEN, LOGGERHEAD, AND KEMP'S RIDLEY TURTLES RELEASED FROM REHABILITATION CENTERS IN SOUTHERN NEW ENGLAND AND LONG ISLAND

Nathan J. Robinson, Kayla Deguzman, Robert Digiovann, and Theodora Pinou

Cape Eleuthera Institute, Bahamas

The northeast coast of the USA hosts important seasonal foraging habitats for several species of sea turtle, including green (*Chelonia mydas*), loggerhead (*Caretta caretta*), and Kemp's ridley (*Lepidochelys kempii*) turtles. However, seasonal declines in water temperatures in the post-summer months means that most turtles must move to warmer waters either further south or off-shore to avoid the risk of becoming cold-stunned. This is especially important for small juveniles that are more sensitive to temperature changes than their larger counterparts. Several organizations dedicate substantial resources to rehabilitating these cold-stunned turtles, yet the real conservation impact of these efforts depends on whether these rehabilitated animals can resume typical foraging and seasonal migratory behavior. To assess whether cold-stunned sea turtles are able to resume typical behavior after rehabilitation, we deployed satellite transmitters onto 12 green (curved carapace length: 25 – 59 cm), 7 loggerhead (curved carapace length: 18 – 70 cm), and 12 Kemp's ridley (curved carapace length: 25 – 39 cm) onto turtles that were initially found cold-stunned in the water's around southern New England and Long Island Sound and then released the subsequent summer from a nearby location. To remove spurious locations from the 4791 daily locations generated by the 31 tracked sea turtles (averaging at 154 tracking days per turtle), we used speed filter than removed all locations that required a movement speed exceeding 100 km d-1 to all tracks. We then used a Hierarchical Bayesian State Space model to further smooth the tracks and provide daily position estimates. Binned dive depth and duration summaries were also provided by 15 of the 31 satellite transmitters. The movement patterns of all three different species were roughly comparable, with individuals initially moving south local water temperature begin to decline between September – October. While moving south these animals would remain within 200 km of the USA coastline until reaching the Gulf Stream around North Carolina. Although some individuals of each species continue to follow the coastline south and into habitats in Florida, others following the prevailing Gulf Stream into the open ocean. These individuals following the Gulf Stream exhibited meandering movements that were clearly associated with the presence of large mesoscale eddies. Considering the similarity between the movements of these animals and wild-caught, non-rehabilitated turtles in these habitats, we conclude that cold-stunned animals appear to be able to resume typical behaviour after being released. Moreover, if rehabilitated turtles show similar movement patterns as non-rehabilitated animals, satellite tracking of cold-stunned turtles could be a logistically straightforward alternative for studying the movements of wild-caught turtles.

MISSISSIPPI MITIGATION: USING RELOCATION TRAWLING TO LEARN ABOUT SEA TURTLES

Lisa Rodriguez, Chris Slay, and Gib Frye

Coastwise Consulting Inc

Dredging projects that use relocation trawling to mitigate sea turtle mortality provide a unique opportunity to gather information on local turtle populations, especially in areas lacking data. Mississippi, centered in the northern Gulf of Mexico, has a small coastline consisting of five barrier islands, located 10 miles from the mainland. There is a paucity of data on sea turtle use of these islands and especially the waters adjacent to these islands. Mississippi Coastal Improvement Program (MsCIP) Phase 1, a project by the Army Corps of Engineers to reconnect East and West Ship Islands, provides a large data set of sea turtles captured, tagged and relocated during mitigation trawling efforts. Live capture trawling occurs in borrow areas where dredging is imminently or actively taking place and is accomplished using large-mesh nets without TEDs and tow times limited to 30 minutes. All sea turtles captured are tagged, relocated and released 3- 5 miles from the borrow area. There have been 305 captures since December 2017. Of these captures, 75% were Kemp's Ridleys and 24% were Loggerheads, with a 4% recapture rate for the project. Various other factors are recorded and will be evaluated to learn more about what effects local sea turtles. Such long-term projects like this one provide a unique opportunity to gather data on sea turtle habitat use in nearshore waters.

DETECTING OCEANIC SEA TURTLE HABITAT FROM SPACE

Alexander E. Sacco and Kate L. Mansfield

Marine Turtle Research Group, University of Central Florida, Florida, USA

Oceanic-stage juvenile sea turtles are often associated with *Sargassum* spp., a brown macroalgae that provides foraging opportunities, transportation at large scales, a thermally beneficial developmental habitat, and safety from predators. *Sargassum* spp. is typically found in aggregations near oceanic fronts and major surface currents and is pushed into Langmuir cell-generated windrows. These upwelling areas can coincide with aggregations of surface chlorophyll. Describing and mapping the spatial extent and dynamics of *Sargassum* spp. is critical for understanding the contributions of this macroalgae as pelagic habitat for marine megafauna. Currently, *Sargassum* spp. is mapped using electro-optical satellite data, most notably the ocean color Floating Algal Index (FAI) detection algorithm. To supplement this effort, we adapted a new algorithm based on synthetic aperture radar (SAR; RADARSAT-1 and Sentinel-1 satellites, specifically). We used the SAR instrument's day/night and all-weather observation capabilities to address the current spatial and temporal limitations of using optical remote sensing methods. Results are promising; our new algorithm is capable of detecting *Sargassum* spp. at a fine scale (< 1 km) and during weather patterns that cause previous methods to fail (storm activity, cloud cover, night-time). *Sargassum* spp. location results were ground-truthed using ship-based observations and FAI detection results. This enhanced approach can be used to map *Sargassum* spp. and ultimately inform marine fisheries and megafauna managers and policy-makers about *Sargassum* spp. distribution in the North Atlantic, Sargasso Sea, and Gulf of Mexico. Knowing more about this essential habitat can assist in conservation efforts for protected species like sea turtles and important fish stocks. In addition, using existing algorithms and this SAR algorithm will provide an expanded baseline of *Sargassum* spp. data. This increased data availability will also help inform prediction methods for *Sargassum* spp. beaching events that can negatively affect coastal economy and tourism, as well as the success of sea turtle nesting and hatching.

SEA TURTLE PREDATION ON PORCUPINEFISH AND SEAHORSES IN THE SOUTHEASTERN UNITED STATES

Erin E. Seney[1], Jennifer L. Keene[2], Jeffrey R. Schmid[3], and Brian Stacy[4]

[1]*University of Central Florida, Ocean Associates, Inc*
[2]*National Marine Fisheries Service*
[3]*Conservancy of Southwest Florida*
[4]*National Marine Fisheries Service*

Loggerhead (*Caretta caretta*) and Kemp's ridley turtles (*Lepidochelys kempii*) are largely benthic carnivores, with diets varying by life stage, geographic region, and over time. While individuals may specialize on specific prey types, loggerheads are considered generalists, and they consume a variety of marine invertebrates. Kemp's ridleys primarily prey on crabs but exhibit a preference for tunicates and tube worms in some regions. Individuals of both turtle species are also known to consume bony fishes (Osteichthyes), but fish are largely assumed to have been obtained as discarded bycatch or bait, from nets, or during fish kills. Here, we report the consumption of two slow-moving types of fishes, porcupinefish (*Diodontidae*) and seahorses (*Hippocampus* spp.). We reviewed detailed National Marine Fisheries Service (NMFS) necropsy records of 339 loggerhead and 1,716 Kemp's ridley strandings salvaged from Florida, Alabama, Mississippi, and Louisiana during 2010-2018. Of those necropsied by the NMFS veterinarian, ten turtles had consumed either porcupinefish or seahorses. Two juvenile loggerheads from Florida's east coast and two subadult Kemp's ridleys from Florida's west (Gulf of Mexico) coast had consumed 1-13 porcupinefish (*Diodon* sp. and/or *Chilomycterus* sp.). Another six Gulf of Mexico ridleys (3 Florida, 2 Louisiana, 1 Alabama), ranging from oceanic (< 20 cm SCL) to adult size (>60 cm SCL), had consumed 1-6 seahorses. All ten strandings were in fair to good body condition, and cause of death was attributed to trauma (n=5), brevetoxicosis (n=1), or asphyxiation (n=1), or was undetermined (n=3). One loggerhead died from asphyxiation due to an inflated long-spine porcupinefish (*Diodon holocanthus*) in the oral cavity and had consumed others, which were found in both the stomach and intestines. Seahorse consumption was only documented in ridleys, which may have encountered these largely stationary, poor swimmers in crab-rich seagrass beds. We believe it is probable that all ten turtles described here consumed live porcupinefish or seahorses, given the overall good body condition of the turtles and slow swimming capability of the fishes. Although *Tetradontidae* (true puffers) can be highly toxic, the *Diodontidae* consumed by turtles in the southeastern USA are likely non-toxic. Two of the diodontid-eating turtles described here had consumed multiple individuals found throughout the digestive tract, and the gut of another contained spines of a digested fish. While consumption of porcupinefish and seahorses by loggerheads and Kemp's ridleys is relatively rare, these fishes may represent an important food source for some individuals. To our knowledge, these represent the first reports of seahorse predation by sea turtles in the northern Gulf of Mexico and the second reports of seahorse and porcupinefish consumption in Florida.

SITE FIDELITY AND FORAGING ECOLOGY OF IMMATURE GREEN TURTLES (CHELONIA MYDAS) ON MULTISPECIFIC SEAGRASS MEADOWS IN MARTINIQUE, LESSER ANTILLES

Flora Siegwalt[1], Jordan Martin[1], Marc Bonola[1], Simon Benhamou[2], Lorène Jeantet[1], Julie Gresser[3], Denis Etienne[4], Sidney Regis[1], Nicolas Lecerf[1], Fabien Lefebvre[1], Cédric Frouin[1], Pierre Lelong[1], Clément Grand[1], Cindy Assio[1], Kyrian Medjkal[1], Charles Renaud[1], Barbara Leibnitz[1], Emmanuel Sutter[4], Fabien Vedie[4], Julien Mailles[4], Gaelle Hielard[3], Laurent Thieulle[1], Frédéric Flora[5], Matthieu Duru[1], Myriam Bouaziz[1], Nicolas Benguigui[1], Christelle Guimera[5], Nathalie Aubert[1], Adrien Pinson[5], Noémie Chanteux[5], Bénédicte Chanteur[6], Christelle Beranger[6], Abdelwahab Benhalilou[7], Céline Murgale[7], Thomas Maillet[7], Patrick Queneherve[8], Thierry Woignier[9], Luc Rangon[9], Jean-Pierre Allenou[10], Emmanuel Thouard[1], Yvon Le Maho[1], Jean-Patrice Robin[1], and Damien Chevallier[1]

[1]*Université de Strasbourg, CNRS, IPHC UMR 7178, F-67087 Strasbourg, France*
[2]*CEFE, CNRS, UMR 5175, 1919 route de Mende 34293 Montpellier, France*
[3]*Office de l'Eau Martinique, 7 Av. Condorcet, BP 32, 97201 Fort-de-France, France*
[4]*DEAL Martinique, Pointe de Jaham 97274 Schoelcher Cedex, France*
[5]*Surfrider Foundation Europe Martinique*
[6]*PNR Martinique, avenue des caneficiers, 97200 Fort-de-France, France*
[7]*Association POEMM, 73 lot papayers, Anse à l'âne, 97229 Les Trois Ilets, France*
[8]*Centre IRD Martinique-Caraïbe, 97285 Le Lamentin, France*
[9]*Aix-Marseille Université, Université d'Avignon, CNRS, IRD, IMBE, 13007 Marseille, France*
[10]*IFREMER Délégation de Martinique, 79 Route de Pointe-Fort 97231 Le Robert, France*

Perhaps one of the greatest issues in implementing effective conservation and management of sea turtles is the lack of scientific investigations regarding in-water biology and ecology. Although the Western Atlantic Ocean and Caribbean Sea region shows positive trends in green turtle population changes, these estimates are derived from numbers of nesting females only. Due to turtle's late maturity, they do not reflect current life circumstances and pressures experienced by younger individuals in marine environments. While scientists have tried to resolve the mystery of the "lost years", there are still major uncertainties concerning the locations of coastal feeding grounds and the ecology of green turtles in these habitats. Either used as inter-nesting or developmental areas, these foraging grounds represent key marine habitats, not only for adults, but also for immatures. Aggregations of green turtles have been recorded and extensively studied along the Caribbean coast of the American continent, from trends in abundance to habitat use. Nevertheless, the literature remains scarce about the ecology of green turtles in the Lesser Antilles, where they have suffered an intense harvest in the past. To address these gaps, we focused on the French island of Martinique, where green turtles are commonly seen foraging on multi-specific seagrass meadows of the southwestern coast, partially colonised by an invasive alien species coming from the Red Sea, *Halophila stipulacea*. To characterise the green turtle aggregation of Martinique, we organised annual capture-mark-recapture campaigns since 2010 during which we marked individuals and recorded morphometric parameters in order to determine the life stage of individuals. 32 captured individuals were also equipped with satellite beacons to document space use and determine whether turtles were resident or migratory. Direct in-water observations and on-board cameras also helped us defining activity-budgets and small-scale movements of foraging individuals, and gave an insight into the diet of green turtles. Our study aims at answering some of the global research priorities for sea turtles in the 21st century, that is, identifying and protecting critical foraging habitats, investigating spatial ecology of chelonians on these areas and describing populations' structure. Here we provide the first results of a long-term study about in-water ecology of resident immature green turtles in the Lesser Antilles. I heartfully aknowledge the International

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AN ECOLOGICAL AND BEHAVIORAL ASSESSMENT OF A MALE-BIASED LOGGERHEAD TURTLE (CARETTA CARETTA) POPULATION IN AN IMPORTANT IN-WATER HABITAT IN THE EASTERN MEDITERRANEAN

Doğan Sözbilen[1,2] and Yakup Kaska[1]

[1]Pamukkale University, Denizli, Turkey
[2]Acipayam Vocational School, Department of Veterinary, Acipayam, Denizli, Turkey

The information about the population abundance, demography, and foraging areas of the loggerhead turtle (*Caretta caretta*) in the Mediterranean is limited, especially in the eastern Mediterranean. Turkey has many important nesting beaches for loggerhead turtle and nesting population is regularly monitored for decades. In addition, previous stranding reports and limited satellite tracking data suggests that Turkey may have important foraging sites. However, in-water population monitoring of loggerhead turtles has not been conducted. In this study, we present the first in-water monitoring results of loggerhead turtles in Köyceğiz-Dalyan Specially Protected Area (SPA), Turkey. Köyceğiz-Dalyan SPA is an important nesting area, contains a delta, marine habitats, provides rich food sources, and frequented by loggerhead turtles. Loggerhead turtles are creating an important touristic attraction point. Marine vehicle traffic is high and recreational fishing is common in the area. Turtles are also fed by locals for touristic purposes. The Capture, Mark, and Recapture (CMR) study was carried out during late winter and early spring in 2016 and 2017. Data collected on sex, size, and weight of captured turtles, as well as carapace and blood samples for Stable Isotope Analysis (SIA). We also collected tissue samples from nesting females for comparison. All marks and previous injuries were also recorded for assessing the anthropogenic threats for loggerhead turtles. A total of 113 captures of 88 individuals yielded in the two sampling years. Turtles were mainly captured in the delta (92.0%). The population was highly male-biased (62.5%), while female (25.0%) and immature turtles (12.5%) were observed in the region. The males were statistically larger than the females but the Body Condition Index (BCI) was higher in the females. SIA results showed significant differences between the in-water population and nesting females ($t\text{-test}_{61}=3.80$; $p= 0.000$). 13C levels of the in-water population were more negative results then nesting females. Three females turtle from the in-water population nested in the same year of capture or the other year. Our results showed that Köyceğiz-Dalyan SPA is an important overwintering and foraging area for loggerhead turtles. Our results also suggest that an important proportion of the population is resident in the area and shows non-migratory behavior. Additionally, we found that the population is under heavy anthropogenic threats with 42.4% of the captured individuals having previous injuries, and the hand-feeding of turtles for touristic purposes may affect their behavior. As a result, the suitable environmental conditions, food availability, as well as the hand-feeding of turtles, may be a reason for the high fidelity to the region and the non-migratory behavior of the loggerhead turtles. Considering the female-biased hatchling production in the Mediterranean, this male-biased population is important, but the level of anthropogenic threats is high and immediate conservation measures should be taken.

POST-NESTING HAWKSBILL MIGRATIONS FROM JUMBY BAY, ANTIGUA, WEST INDIES

Andrew S. Maurer[1,2], Jeffrey A. Seminoff[3], Alexandra L. Fireman[4,2], Elizabeth Brammer-Robbins[2], Spencer Wyand[2], and Seth P. Stapleton[2,5]

[1]*Applied Ecology, North Carolina State University, Raleigh, North Carolina, USA*
[2]*Jumby Bay Hawksbill Project, Antigua, West Indies*
[3]*Southwest Fisheries Science Center, NOAA-National Marine Fisheries Service, La Jolla, California, USA*
[4]*University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, Solomons, Maryland, USA*
[5]*Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota, St. Paul, Minnesota, USA*

Our ability to support hawksbill sea turtle (*Eretmochelys imbricata*) conservation and population recovery in the Caribbean is constrained by a lack of information regarding the migrations and foraging areas of nesting adults. Although survival and productivity of adults at sea is disproportionately important to population recovery, most research happens on nesting beaches. Here, we present data characterizing the post-nesting movements and foraging destinations for 14 hawksbill females tracked during 2016 to 2018. Turtles nested on Long Island (also known as Jumby Bay), Antigua, in the eastern Caribbean. Platform terminal transmitters were deployed by field staff of the Jumby Bay Hawksbill Project (JBHP) immediately after oviposition using standard attachment protocols. Hawksbills adhered to one of three general post-nesting movement strategies, including short-, medium-, and long-distance migrations. A majority (n = 9) of transmitter-equipped turtles migrated very short distances (~10 - ~80 km straight-line distance); these turtles remained in waters near Antigua, swam to neighboring Monserrat or Nevis, or moved to Barbuda, Antigua's sister island to the north. Two hawksbills travelled more intermediate distances to foraging areas around Sint Maarten/Saint-Martin and Saint Barthélemy (~150 km straight-line distance). In contrast, three turtles exhibited trans-Caribbean migrations to the Bahamas, the Grenadines, and Nicaragua; the straight-line migration distances from Jumby Bay to these distant foraging sites ranged from ~500 km to >2,000 km. We will continue to build this dataset, allowing us to improve our understanding of how foraging geography is related to reproductive output (e.g., remigration interval, number of clutches) by leveraging the JBHP's 32-year mark-recapture dataset. We also aim to use this information to identify regional conservation partners at foraging locations.

ARE DIET SAMPLES CONSISTENT BETWEEN DIFFERENT SECTIONS OF THE GREEN TURTLE DIGESTIVE TRACT?

MacKenzie Tackett[1], Karen Holloway-Adkins[2], and Erin E. Seney[1]

[1]*Marine Turtle Research Group, University of Central Florida Department of Biology, Florida, USA*
[2]*Kennedy Space Center Ecological Program, Florida, USA*

Examining sea turtle diet allows for a better understanding of ecological roles, habitat needs, and behavior. Sea turtle diet varies across species and life stages, with items that range from plants to invertebrates to fishes. Green sea turtles (*Chelonia mydas*) are primarily known for eating seagrasses and macroalgae but are omnivorous early in life. Both lavage and fecal sampling help to determine diet composition of live

turtles. Esophageal lavage provides a sample of freshly eaten food items from the upper digestive tract, whereas fecal samples comprise food items that have been completely digested. Gut content samples from dead stranded turtles are taken from one or multiple locations in the digestive tract, and these samples may range from freshly consumed to severely decomposed and/or digested. The goal of our study was to compare contents of the upper and lower regions within the digestive system in order to determine if sampling one region provides a complete description of diet for individual turtles. In an effort to better describe diet sampling comprehensiveness, we examined the stomach and colon contents of a mix of 25 adult and juvenile green turtles that stranded along the coast of the Gulf of Mexico in Florida, USA from 2010 to 2015. Identification of food items was preformed visually for the upper digestive tract (stomach) and lower digestive tract (colon) via microscopy. We estimated percent volume of the overall sample for each identified item and categorized each into eight broader taxa. These taxa included: seagrasses, green algae (Chlorophyta), brown algae (Ochrophyta), red algae (Rhodophyta), tunicate, sponge, vertebrate tissue, and unidentified digesta; we excluded unidentified digesta from our comparison. Sixteen of the twenty-five turtles had 50% or more overlap between the two digestive regions in identified taxa, including six turtles exhibiting 100% overlap in taxa between stomach and colon. By determining the differences between the upper and lower digestive tract, we have a better understanding of data collected from both live and dead samples. Specifically, our data suggest that multiple sample types are necessary to fully describe green turtle diet. Studies utilizing one sample type, while providing valuable information on foraging, may not identify all food items consumed by an individual. Funding and acknowledgements: This research was supported in-part by a 2017 award from the Sea Turtle Grants Program funded by the Florida "Helping Sea Turtles Survive" license plate. Diet samples were collected and archived by Dr. Brian Stacy of the National Marine Fisheries Service and transferred to UCF for further analysis.

VARIATION IN AGE-AT-MATURITY AND HABITAT USE OF EASTERN PACIFIC GREEN TURTLES: IMPLICATIONS FOR POPULATION RECOVERY

Calandra Turner Tomaszewicz[1], S. Hoyt Peckham[2], Larisa Avens[3], Lisa Goshe[3], Juan M. Rguez-Baron[4], Carolyn Kurle[5], Tomo Eguchi[1], and Jeffrey A. Seminoff[1]

[1]NOAA/NMFS Southwest Fisheries Science Center, La Jolla, California, USA
[2]Center for Ocean Solutions, Stanford University, Palo Alto, California, USA
[3]NOAA/NMFS Southeast Fisheries Science Center, Beaufort, North Carolina, USA
NOAA/NMFS Southeast Fisheries Science Center, Beaufort, North Carolina, USA
[4]JUSTSEA Foundation, Bogota, Colombia; University of North Carolina Wilmington, North Carolina, USA
[5]University of California, San Diego, Biological Sciences Division- Ecology, Behavior & Evolution Department, La Jolla, California, USA

Intrapopulation variability in basic life history and demographic parameters such as age-to-maturity and reproductive lifespan can have a significant effect on a population's ability to recover. Yet because age is difficult to estimate without long-term mark-recapture studies or skeletochronology analysis, body size, rather than age, is a common metric used to infer maturity status, which is often based on population-specific mean nesting sizes (MNS). And within a region that has many nesting subpopulations, there may be wide variation in MNS. If smaller MNS corresponds to younger age, turtles at some nesting beaches may begin breeding sooner and could potentially have a much-reduced generation time resulting in a disparate effect on population growth rates in comparisons to nesting sites with larger MNS. Given these implications for population assessments, understanding how age-at-maturity may vary with MNS at distinct rookeries is important. Another key factor to examine is potential intrapopulation variation in residency duration in distinct habitats and the resulting survivorship, particularly at sites known to have high mortality rates. Through the synergistic application of multiple tools and long-term population monitoring, we are beginning to unravel some of these mysteries about sea turtle life history. We examined the long-term demographics and habitat use of the green turtle (*Chelonia mydas*) population in the eastern Pacific at a foraging area known to have historically high bycatch rates. The East Pacific green turtle population is gradually recovering, with increasing nesting numbers observed at the mainland Mexico nesting sites, such as Colola, Michoacán, over the past two decades. There is another primary nesting site for this population at the Revillagigedos Islands, and although lesser-studied, these turtles have a notably larger MNS than those at Colola (95 cm curved carapace length (CCL) vs. 82 cm CCL). Knowing if, and how, the age-at-maturity varies for these distinct nesting groups, would improve assessments for this population. In addition, while foraging sites for this population are typically lagoon-type neritic habitats, green turtles have also been observed interacting with pelagic fisheries in the Gulf of Ulloa off the coast of the Baja California Peninsula, Mexico. However, whether these interactions occur as a result of turtles using the area for long-term active foraging or while turtles are migrating between coastal foraging and breeding sites was unknown. Here, we combined skeletochronology with stable carbon (13C) and nitrogen (15N) isotope analysis of skin as well as sequential annual bone growth layers of humerus samples collected from dead green turtles stranded along the Baja California Peninsula at Playa San Lázaro, adjacent to the Gulf of Ulloa foraging site known for historically high rates of regional fisheries bycatch. Using these complementary techniques, we present the first detailed characterization of age-at-maturity (~17-30 yr), as well as age-at-settlement (~3-5 yr) and long-term resource use patterns for this population. Our results showed unexpected and prolonged use of a pelagic foraging area which could benefit the turtles by facilitating increased body growth, but may also be of conservation concern given the high fisheries turtle bycatch rates observed in the past. And upon estimation of the age and size at maturity for two of the turtles, we found that one matured at ~17 yr and ~73 cm CCL, near the MNS of the mainland rookeries; whereas the other turtle matured at ~30 yr and ~95 cm CCL, the MNS for the Revillagigedos rookeries. This wide range observed for age-at-maturation, 17 to 30 years, indicates that green turtles in Pacific Mexico are comprised of at least two subpopulations with substantially different demographic parameters. We discuss the implications of these findings when coupled with genetic analysis and on-going studies for this population.

HIDDEN RIGHT UNDER OUR NOSE: AN INWATER PROJECT ON FLATBACK TURTLES IN THE KIMBERLEY REGION OF WESTERN AUSTRALIA

Tony Tucker[1], Scott Whiting[1], Sabrina Fossette-Halot[1], Chris Nutt[1], Anthony Richardson[1], Jason Richardson[1], Luke Puertollano[1], Tim Crawford[1], Daniel Balint[1], Jason Fong[1], Jenna Hounslow[2], and Erina Young[2]

[1]*Western Australia Depart. Biodiversity, Conservation and Attractions*
[2]*Murdoch University, Perth, Australia*

Multiple tracking studies initiated at flatback turtle rookeries in the last decade have revealed that they forage in water depths < 120 m, often in remote locations, but with little information about relative density or demography. Herein we report results of the first foraging ground study of flatback turtles in the Yawuru Nagulagun/Roebuck Bay Marine Park, Kimberley, Western Australia. The close proximity to the city of Broome enabled initial boat surveys to detect 105 observations of surface feeding or basking flatbacks. We sampled 43 turtles (including one within season recapture) by dip netting or rodeo jumping, including juveniles, sub-adults and adult males and females in ten days of field work (June 25-29; August 27-31). We affixed GPS or Argos satellite telemetry tags to 1 juvenile, 3 sub-adults, 7 females and 9 males. One female had been originally flipper-tagged in 2006 nesting on Barrow Island (770 km away and last recorded nesting there in 2017 SW) Diving and foraging behaviour were investigated using deployments of an underwater video camera (n=1 male), and daily diary accelerometers (n=2 males, 2 females). Blood collection and health examinations were undertaken to develop baseline data for sea turtles in WA. These are the first blood samples collected from foraging flatback turtles and together with nesting flatback samples will form haematological and biochemical blood reference values for this species. New food sources were described with half of collected animals feeding on jellyfish. Some animals remained in Roebuck Bay during tracking, but adult males and females migrated by mid-October to vicinities of known nesting beaches to the north (James Price Point) and south (Ecobeach, Anna Plains, Wallal Downs, beyond). These are the first studies on the movements of sub-adult and adult male flatback turtles. Additional sampling will bolster regional studies of stable isotope baselines and enable the analysis of mixed genetic stocks in a Western Australia foraging ground. The identification of YNRB Marine Park as a flatback foraging area is nationally and globally significant. The Park provides the first opportunity to study flatback turtles at a life stage other than the nesting beach. It provides an opportunity to investigate diet, habitat use, diving behaviour, health status, movements and demographic data. Other species found within the Park include green, hawksbill, loggerhead and olive ridley turtles. This study will furnish novel information that can be fed directly into the management of the Western Australian Marine Parks that are jointly managed by state government and the local indigenous people. We thank the Nyamba Buru Yawuru Country Managers for assisting the field work.

FIRST REPORT OF EPIZOIC DIATOMS COMMUNITY ASSOCIATED WITH JUVENILE GREEN TURTLES, CHELONIA MYDAS, IN URUGUAYAN COASTAL WATERS

Gabriela M. Velez-Rubio and Laura Perez Becoña

NGO Karumbe/Centro Universitario Regional del Este, UdelaR (Uruguay), Centro Universitario Regional del Este, UdelaR (Uruguay)

The Uruguayan coastal waters are an important feeding and developmental area for juvenile green turtles, Chelonia mydas. During the austral winter most of the individuals of the aggregation migrate to northern waters to avoid cold waters. But a small proportion of this aggregation remains in coastal habitats, overwintering on the seafloor and undergoing winter dormancy to tolerate low temperatures (SST<16-18ºC) making these turtles vulnerable to colonization of benthic organisms. After the winter is common to found stranded turtles with a high presence of macro-epibiotic fauna and flora. But little is known of the micro-epibiotic communities, as the diatoms. These micro-algae are widely use as environmental indicators, since they are abundant in aquatic systems, they are preserved for long time due to their siliceous nature, and they present different optimums and environmental tolerance ranges. Diatoms have a short generation times and they respond rapidly to environmental changes. The diatoms are part of the phytoplankton but also are part of the periphyton and we can find them on seaweeds and other organism as marine turtles. Here, we provide the first taxonomic identification of diatoms present on juvenile green turtles in Uruguayan coastal waters. We collected samples of three stranded live green turtles in La Coronilla and Santa Teresa (Rocha, Uruguay). Samples were collected scraping the carapace, were treated with H_2O_2 (30%) and was cleaned with distilled water using a centrifuge. After that samples were mounted with Entellan® was analysed in an optical microscope (1000x). We identify the diatoms to the lowest taxonomic level by consulting appropriate literature. We identified a total of 43 diatoms taxa and we found difference in the individuals analysed. All turtles present in common the taxa: *Navicula* sp.2; *Licmophora cf. gracilis*; *Tabularia tabulata* and *Melosira cf. moniliformis*. Turtles #1 and #2 stranded in the same beach presenting similar specific richness (13 diatoms taxa) and share seven species. These two turtles stranded close to Andreoni Channel, a discharge channel of agrochemicals and domestic waters, turtle #1 probably stayed for longer period in this area due to the presence of *Gomphonema parvulum*, *Staurosirella martyi* and *Cocconeis placentula*, indicators of eutrophic systems. Turtle#3 present the highest species richness (27 identified taxa). Most of the diatom taxa identified were perifitic diatoms commonly found in different substratum, and only three taxa, *Thallassionema* sp, *Paralia sulcate*, and *Aulacoseira* spp, presented on turtle #2 and turtle #3 were planktonic and common in Uruguayan coastal waters. As far as we know, this is the first report of diatom taxa on green turtle in the South Atlantic Ocean. Probably most diatom taxa identified in this study might be associated with other epizoic organisms rather than with the turtle itself, but we think is a good proxy to help the researchers to understand the habitat use of green turtles in coastal waters. The next steps are to compare our results with the diatom diversity of coastal habitat (intertidal communities) and analysed the samples with the Scanning Electron Microscopy (SEM) to help in the diatoms identification. We really thank to La Coronilla community that helps with the strandings turtles, also thank to Diego, Colo and Pablo for their help.

SIZE CLASS SEGREGATION OF GREEN TURTLES ON A HIGH-DENSITY FORAGING GROUND USING NULL MODEL ANALYSIS

Ryan C. Welsh[1,2], Jonathan C. Gorham[1], Ryan Chabot[1], Jeff Guertin[1], Cody Mott[1], and Kate L. Mansfield[2]

[1]*Inwater Research Group, Florida, USA*
[2]*Marine Turtle Research Group, University of Central Florida, Florida, USA*

Intraspecific interactions among green turtles (*Chelonia mydas*) remain an understudied aspect of the specie's ecology. Previous work on intraspecific interactions in green turtles has focused solely on individuals within size classes and no published accounts have focused on interactions between size classes. With densities of up to 120 green turtles per square kilometer, an area of water known as the Eastern Quicksands, located in the Florida Keys, USA, possibly hosts the highest density adult and sub-adult green turtle foraging aggregations in the world. With such a high volume of green turtles, these foraging grounds provide an opportunity to investigate these interactions. In this study, we placed six standardized transects through the Eastern Quicksands. Each transect was six kilometers long and positioned one kilometer from adjacent transect lines. Surveys along the transect grid were conducted by boat, with two observers located atop a two-meter elevated central tower, while a helmsman marks each sighting with a Garmin Global Positioning System. In total, 18 surveys have been completed since 2006. Green turtles observed during these surveys are identified to life stage (e.g., subadult), while distance from the transect line is estimated. Environmental factors that could affect animal detectability were also recorded during these transects. Density surface modeling (DSM) is a generalized additive model-based (GAM) approach used to calculate spatially-explicit estimates of abundance. We used DSM to determine how both green turtle size classes are distributed in the Eastern Quicksands, while incorporating the effects of water depth and benthic habitat type. These results were then used to create an abundance prediction grid over the entire foraging region, including areas that were not directly surveyed based on their water depth and habitat type. We used this grid to create abundance heat maps for the entire study area, providing distributions for both size classes. We converted these prediction grids into abundance matrices, and used null model analysis to look for evidence of co-occurrence among the adult and subadult green turtles. Co-occurrence is measured through the U-ratio ($U = V/W$), which compares the variance of row totals V with the sum of the column variances W. This observed U-ratio is then compared to the expected U-ratio, which is generated from 5000 random null matrices implemented by an IT algorithm. If species are segregated, we expect the U-ratio to be smaller than expected by chance. Significance of this is assessed using a standardized effect size (SES). The best fit model for subadult distribution consisted of an additive model of the spatial component (latitude, longitude) and benthic habitat type, while the best fit model for adults consisted of a complex three-way multiplicative interaction of the spatial component, benthic habitat type, and water depth. Segregation between size classes was found to be highly significant; the observed U-ratio was found to be 19 standard deviations below the mean of the expected U-ratio (SES score: -19). To our knowledge, there has been no

research investigating adult and sub-adult interactions in a shared foraging area. Understanding how intraspecific competition shapes the distribution of size classes is necessary for the management and conservation of species with complex life histories. As these previously-depleted populations recover, they may encounter degraded or fragmented habitats, in which competition could play a role in further recovery. This can be especially true for long-lived and late-maturing green turtles, where the effects from conservation programs may not become evident for many years.

GREEN TURTLE FORAGING HABITAT USE AND RESOURCE SELECTION IS AFFECTED BY THE INVASIVE SEAGRASS, HALOPHILA STIPULACEA, IN THE FRENCH WEST INDIES

Elizabeth Whitman, Michael Heithaus, Vincent Quiquempois, Manon Niviere, Jeffrey Bernus, and Jeremy Kiszka

Florida International University, Florida, USA

Invasive plant species can alter grazer foraging habitat use and resource selection - and ultimately affect survival and fitness - if the invasive species is of lower quality than native species or herbivores fail to recognize it as potential food. Across three islands of the French West Indies (Guadeloupe, Martinique, and Saint Martin), I explored how Caribbean green turtles (*Chelonia mydas*) selected microhabitats, and resources within those microhabitats, at foraging areas that featured mixes of native *Syringodium filiform*, *Thalassia testudinum*, and *Halodule wrightii*, and the invasive seagrass *Halophila stipulacea*. From 2016-2017, I used belt transects to assess spatial variation in turtle densities and resource selection relative to macrophyte abundance, species composition, and nutrient content (C, N, P). Each study site presented unique relationships of nutrients among seagrasses. There was little detectable difference between native *S. filiforme* and invasive *H. stipulacea* in nutrient content off Guadeloupe, however, off Martinique, native *T. testudinum* contained greater N but less P than *H. stipulacea*, and *S. filiforme* was lower in both nutrients than the invasive. Off St. Martin invasive seagrass was not abundant and *T. testudinum* had the highest nutrient content of native species. At all sites, turtles selected for areas with abundant native seagrasses (*T. testudinum, S. filiforme*) and avoided areas typified by macroalgae and the invasive seagrass. Together, these data suggest that the spread of invasive seagrasses is currently resulting in a decrease in the habitat area that turtles perceive as quality foraging habitat, and interspecific variation in nutrient content alone may not be responsible for this pattern. If turtles are energy or nutrient-limited, restricted use of space and resources should have negative consequences on individual- and population-level energy budgets. In addition, turtle avoidance of the invader likely is facilitating its spread. The ability of green turtle populations to adapt to decreases in habitat due to the invasion of a non-native seagrass or to expand their diets to take advantage of novel food resources, however, remains unclear and is an important aspect of turtle foraging ecology for further investigation in the face of macrophyte invasions. Acknowledgement: This work was funded by the TOTAL Foundation. The bulk of the field assistance was provided by Lisa Allioud, Phil Matich, and Caitlyn Webster. Permits and assistance were provided by Office National de la Chasse et de la Faune Sauvage (French Wildlife Service), Reseau Tortue Guadeloupe (Sea Turtle Network - Guadeloupe), DEAL Guadeloupe, and the National Park of Guadeloupe. Thanks to DEAL Martinique for delivering research permits and for their assistance in the field and the Reserve Naturelle de Saint Martin for their support and involvement in field activities, particularly Julien Chalifour.

CHARACTERIZING THE HAWKSBILL SEA TURTLES OF THE FLORIDA KEYS, MONROE COUNTY, USA

Lawrence Wood[1,2]

[1]Florida Hawksbill Project, Florida, USA
[2]National Save The Sea Turtle Foundation, USA

Considerable gaps remain in our understanding of the abundance and distribution of hawksbill turtles in Florida waters. Though nesting is rare in Florida, studies in Palm Beach and Monroe Counties have identified significant local in-water aggregations of juvenile and subadult hawksbills closely associating with coral reef habitats. Still, due to the large extent of the Southeast Florida Reef Tract, many potential sites have not been thoroughly surveyed for hawksbill abundance. In this study, we report on the hawksbills encountered during in-water surveys on the shallow (<12m) barrier reefs from Key Largo to Key West, Florida Keys, USA. Between June 2015 and September 2018, twenty-seven hawksbills were hand-captured during 148 snorkel surveys. The turtles ranged in straight carapace length from 27.4 cm - 56.6 cm (mean 42.0 cm, median 39.8 cm). Seven were recaptured or re-identified in the close vicinity of their original capture site. Our results suggest that the shallow barrier reefs of Monroe County are settlement sites for juvenile hawksbill turtles transitioning from epipelagic to neritic habitats. Once established, these individuals are likely to remain in Florida's coastal waters for the duration of their sub-adult lives, underscoring the importance of preserving coral reef habitats throughout southeast Florida. We gratefully acknowledge the National Save The Sea Turtle Foundation for supporting this research, and the many volunteers who donated their time and effort to assist with surveys.

LUNA: A STORY OF AN EASTERN PACIFIC HAWKSBILL

Alan Zavala[1], Catherine Hart[2,3], César P. Ley-Quiñónez[1], Alejandra Sandoval-Lugo[1], Renato Leal-Moreno[1], Brenda Aracely Espinoza-Romo[3], Carlos Romero-Urías[3], Maria del Rosario Vejar-Rubio[3], Kevin Alan Zavala-Félix[4], Valeria Leal-Sepulveda[4], and A. Alonso Aguirre[5]

[1]IPN-CIIDIR SINALOA/GTC, Mexico
[2]Red Tortuguera, Mexico
[3]Grupo tortuguero de las Californias A.C., Mexico
[4]Universidad Autonoma de Occidente/GTC, Colombia
[5]George Mason University, Virginia, USA

Hawksbill turtles of the Eastern Pacific are considered one of the most endangered sea turtles in the world. The main nesting sites have been identified in El Salvador and Nicaragua. In the Mexican Pacific, Hawksbills main nesting sites are in the states of Nayarit and Jalisco, which are the northern nesting limits of the Eastern Pacific Hawksbill, the juveniles are continuously reported by fishermen and divers, however, Adults are reported occasionally. In August 2014, a group of fishers from the Navachiste lagoon system, Guasave, Sinaloa, Mexico, reported the incidental capture of an adult Hawksbill in a gillnet, with a size of 78 cm CCL (Curved Carapace Length) and 68 cm CCW (Curved Carapace Width), presented some slight injuries for what was delivered to the IPN-CIIDIR Sinaloa for rehabilitation and was named as "Luna", we placed a Sirtrack satellite transmitter model Kiwisat KG Long Life and was released on July 19, 2015. The satellite tracking for "Luna" was 1,106 days total, the home range was determined through an effort-weighted Kernel Density Analysis (KDA) of 2,603 filtered positions to derive an index of turtle residence probability per unit area, providing probability contours for the 50%, 75%, and the 100% contour reflecting the total range (Peckham et al. 2007). Total home range for this turtle was in the Mazatlán Bay area exclusively. Based on the Argos Location Class classification, we determined the coverage (percentage of travel days with successful transmissions) and accuracy (percentage of days with transmission accuracy better than 1km (LC: 1, 2 or 3) as reported by Etnoyer et al. (2006). Luna spent 20 days in the María Islands, indicating possible nesting activity. Finally, the story of “Luna” ended as a start, in October 2018 it was again reported because of incidental fishing, but on that occasion the luck did not favor it and it was found dead stranded on the beaches of Mazatlan, Sinaloa.

MIGRATION, NAVIGATION, & NATAL HOMING

LONG-DISTANCE MOVEMENTS OF GALÁPAGOS HAWKSBILLS (ERETMOCHELYS IMBRICATA)

Juan Pablo Muñoz-Pérez[1,2], Jason G. Castañeda[1,3], Felipe Vallejo[2], Maximilian Hirschfeld[1], Cristina Miranda[2], Gregory A. Lewbart[1,4], Kenneth J. Lohmann[1,5], Alexander Gaos[6], John W. Rowe[7], and Daniela Alarcón-Ruales[1]

[1]Galápagos Science Center GSC (Universidad San Francisco de Quito-University of North Carolina at Chapel Hill), Av. Alsacio Northia, Isla San Cristobal, Galápagos, Ecuador
[2]Fundación Equilibrio Azul, Machalilla Ecuador
[3]Galápagos National Park Service, Galapagos, Ecuador
[4]North Carolina State University, College of Veterinary Medicine, Raleigh North Carolina, 27601, USA
[5]University of North Carolina, Department of Biology, Chapel Hill, North Carolina, 27599, USA
[6]Eastern Pacific Hawksbill initiative (ICAPO)
[7]Alma College 614 West Superior Street Alma, MI 48801

Three hawksbill turtles originally tagged in the Galápagos were recorded undertaking migrations outside of the archipelago, including two males and one female. Two came from a pool of 23 tagged between 2013 and 2016, while the third came from a pool of 6 tagged between 2000 and 2008 (this capture data object to be confirmed by Charles Darwin Foundation (CDF) team Zarate et al). Minimum distances travelled for the three long-distance migrants ranged from 975 km to 1,383 km. With times between first recorded sighting and recapture ranging from 242 days to 4,745 days. The 1stconsisted of a turtle recaptured off the north coast of Ecuador (Esmeraldas) in 2015, the 2nd a turtle recaptured along the south coast Ecuador Machalilla National Park (MNP) in 2017, and the 3rdwas a movement tracked via satellite telemetry, with the final transmission received near Clipperton Island. Case 1: Recapture after 411 days by fishermen off the coast of mainland Ecuador inside a Marine Protected Area (MPA) (Reserva ecológica Manglares Cayapas Mataje) straight line distance voyage: 1,368 km. This female was originally tagged by the Galápagos Science Center (GSC) team in 2014 at San Cristóbal Island INCONEL tags JC268/JC269, one on each hind flipper and a Pit tag#464E3B6F0C. Standard measurements (SM) varied from 70 cm CCL and 38 Kg to 71 cm LCC to 37 Kg. Case 2: Recapture after 13 years by the Ecuadorian non-profit organization EquilibrioAzul (EA) team off the coast of mainland Ecuador MNP. Straight line distance voyage 975 km. This male was originally tagged by the CDF team in 2004 at Fernandina Island INCONEL tags BA623/BA624, one on each fore flipper, SM= 38,1 cm CCL and 12 kg (Data from the first capture to be confirmed by the CDF team Zarate et al). And was recovered as an adult male after being tagged originally as a juvenile. Standard measurements at recapture 82 cm CCL to 70 Kg Case 3: Satellite track for 242 days, straight line distance voyage 1,383 km final transmission received near Clipperton Island. This is the first documented adult E. imbricate male in the Galápagos. It was originally tagged by the GSC team in 2016 at San Cristóbal Island INCONEL tags JG184/JG185, one on each back flipper, and a Spot 5 wildlife computers® satellite tag, SM=88 cm CCL and 78 Kg. Our findings are the first recorded long-distance migration of Galápagos hawksbills. Previous satellite telemetry work has indicated that in the EP are short distance migrants, nonetheless these findings demonstrate long distances migrations also occur, this could be tied to the circumstance that Ecuador is at a latitudinal extreme for the species and resource limitations may promote long-distance movements. Advances in genetic connectivity, population structure and additional tracking efforts on Galápagos Hawksbills are key conservation questions. It is vital to understand migration routes of an almost extinct species in the EP, and therefore, support the necessary protection that this migration routes must have. The fact that two of the individuals have been found in mainland Ecuador MPAs, gives an example of the key importance of MPAs, this linked to the likelihood that Galápagos could be an important recruitment area of individuals that will arrive from open ocean and stay in feeding areas many years until they reach the appropriate size for a migration to a long-distance reproductive area. One more reason to support the need for expansion of MPAs in the Continental Ecuador if these populations are to be protected. Acknowledgements: Galápagos National Park (GNP), and Galápagos Science Center (GSC) Satellite tag was provided by Dow Digital Science Center at Alma College.

LEATHERBACK HATCHLING DISPERSAL IN THE WESTERN ATLANTIC: ACTIVE SWIMMERS OR PASSIVE DRIFTERS?

Nicole Barbour

University of Maryland Center for Environmental Science, University of Maryland College Park

Leatherback turtles (*Dermochelys coriacea*) are vulnerable to extinction and like many sea turtles, the movement ecology of their juveniles is understudied. Short-term tracking with acoustic tags allows for fine-scale tracks of their dispersal from the nesting beach to be made. The resulting data can be used to determine their relationship with oceanographic variables (ocean currents, tides, water temperature) and predators. Past studies on leatherback hatchling dispersal in the Western Atlantic has shown they demonstrate active swimming against the currents in speeds less than 0.5 m/s. I tagged 52 hatchling leatherbacks in Pacuare, Costa Rica (July-Aug 2018) to determine their swimming speeds in relation to the currents to compare to these results. I also tracked the hatchlings in different tidal current directions and strengths, different stages of the lunar cycle, and different Beaufort states to assess their relationship with hatchling direction and movement. I deployed drifters at different intervals along the tracks to determine the speed of the currents in relation to the hatchlings. Hatchling tracks ranged from 0.5-3.0+ hours, with a mean duration of 98 minutes and a mean distance of 3.4 kilometers. The mean over-ground speed of the hatchlings was 0.57 m/s and the mean over-ground speed of the currents was 0.52 m/s. The mean in-water swimming speed of the hatchlings, considering the effect of the currents, was 0.22 m/s. Results showed no significant impact of tidal strength and direction, lunar cycle, or Beaufort state on swimming speed of the hatchlings. These results are unexpected, as they differ from the results of past studies and show that there might be a "current speed threshold", above which the hatchlings are able to maintain a constant direction but are not swimming faster than the currents. In currents less than 0.5 m/s, hatchlings may be using active swimming to maintain a favorable direction offshore. As currents speeds increase above this, the hatchlings' bearings move more perpendicular to the current and in high current speeds above 0.7 m/s, hatchlings are demonstrating "bursts" of active swimming but overall are being advected by the currents. These results will be further analyzed using a First Passage Time Analysis that breaks the tracks up by their speed and can be used to determine where they are most at risk spatially and temporally for predator interaction. Further, these results will be applied to dispersal models that can incorporate their swimming behavior and large-scale ocean currents into simulations of their habitat use during the "Lost Years", helping us fully characterize the life history of an endangered species in order to better protect them at sea. Acknowledgements: Hoover, A. 2017. Leatherback turtle movement and dispersal from nesting beaches in Costa Rica with implications for management and conservation. Masters Thesis. University of Maryland, College Park.

SPATIAL ECOLOGY OF HAWKSBILL TURTLES (ERETMOCHELYS IMBRICATA) FROM GANDOCA MANZANILLO NATIONAL WILDLIFE REFUGE, COSTA RICA

Quintin Bergman[1], Luis Fonseca[2], Wilbert Villachica[2], Didiher Chacón-Chaverri[2], and Frank Paladino[1]

[1]*Purdue Fort Wayne*
[2]*Asociación Latinoamericana de Tortugas Marinas (LAST)*

For migrating animals, it is important to identify links between habitat use and spatial ecology. In September of 2018, we deployed SIRTRACK's KiwiSat 202 PTT satellite transmitters on 4 nesting female hawksbills on the beaches of the Gandoca Manzanillo National Wildlife Refuge, located on the southeastern coast of Costa Rica. Satellite locations were analyzed to evaluate their internesting habitat and migration routes to distant foraging grounds. Gravid turtles selected internesting habitats close to beaches and may be exposed to anthropogenic threats such as entanglement in fishing gear, harvesting or boat strikes. Satellite tracks have revealed 2 distinctly different internesting behaviors, including remaining directly in front of the nesting beach, and moving 50 km south into the Bocas del Toro islands of Panama. This indicates that hawksbill's internesting behavior is varied and may encompass areas significantly north or south of the nesting beach. Tracked hawksbills avoided strong coastal currents by moving in a circular pattern in the Caribbean Sea before migrating. Preliminary indications of postnesting movements are northward towards Honduras, remaining relatively close to the coast. This result shows that local ocean currents influence hawksbill behavior. Understanding routes from nesting sites to foraging areas is important in quantifying population-level impacts of anthropogenic threats and designing effective conservation responses to these threats. Elucidating to the need for an international approach for hawksbill conservation that spans many Central American countries. We would like to acknowledge the Boyd Lyon Sea Turtle Fund, Gandoca Manzanillo National Wildlife Refuge, Area Conservación La Amistad Caribe, Sistema Nacional de Areas de Conservación, Sonoma County Community Foundation, Schrey Distinguished Professor Fund, and the staff at The Leatherback Trust for financial and logistical support. We would also like to thank the following individuals: Ian Silver-Gorges, Abigail Parker, Maike Heidemeyer, Danny, Mireya McCarthy, lastly Kevin and Erin Bergman.

FORMATION OF FORAGING SITE ATTACHMENT IN MIGRATORY SEA TURTLES

Kayla Goforth and Kenneth Lohmann

University of North Carolina at Chapel Hill

Foraging ground fidelity, or a strong affinity to a specific foraging ground, is a phenomenon in which animals return to the same foraging area after migrating to distant sites. Juvenile sea turtles often demonstrate this sort of site fidelity: turtles have been shown to home to coastal foraging grounds following seasonal migrations or experimental displacements. Previous work has shown that turtles can use Earth's magnetic field to navigate to their foraging sites. We hypothesize that this navigation depends, in part, on the ability of turtles to sense two features of the magnetic field that vary geographically, similarly to latitude and longitude, and the combination of these two components likely functions as a bi-coordinate navigational system, in which each geographic location has a unique "magnetic signature". We further hypothesize that turtles learn to associate their foraging locations with magnetic signatures and retain this information to navigate back upon displacement. To assess whether turtles are capable of learning to associate a magnetic signature with food we classically conditioned sixteen hatchling loggerhead turtles (*Caretta caretta*) to a novel magnetic signature over the course of two months. Turtles were exposed to two novel magnetic signatures for equivalent amounts of time throughout the two months, but only received food in one of the magnetic signatures. In post-conditioning experiments, the food-seeking responses of the turtles demonstrated their recognition of the conditioned magnetic signature over the other novel field (P=0.0008). This study provides the first experimental evidence that sea turtles are capable of learning to associate a magnetic signature with a feeding location.

MIGRATION OF GULF OF MEXICO NESTING LOGGERHEADS

Autumn Iverson[1,2]

[1]*USGS*
[2]*University of California Davis*

Loggerheads in the Gulf of Mexico (GoM) are part of the Northwest Atlantic population, which is listed as threatened. Determining the migratory pathways and management of these habitats are listed as Recovery Objectives in the Loggerhead Recovery Plan. We use switching state-space modeling (SSM) to describe 89 migration routes from 2008 to 2015. Tagged turtles nested at five beaches across the GoM, including Gulf Shores, Alabama, and four Florida sites: St. Joseph Peninsula, Eglin Air Force Base, Everglades National Park and Dry Tortugas National Park (DRTO). To spatially depict migration, we created paths from SSM-identified migrations and quantified the number that intersected grid cells (10 x 10 km). We defined high-use cells as those with 4 or more turtle paths intersecting (406/4109 cells, or about 10% of cells). We calculated turtle speed and direction at each migration location and obtained water speed and direction using Hybrid Coordinate Ocean Model (HYCOM) data. We interpolated daily surface direction and absolute magnitude of water velocity for each location and extracted nighttime sea-surface temperature (NSST). Migration occurred primarily across the eastern half of the GoM and into the Bahamas. The total distance moved ranged from 23 - 4388 km. High-use cells occurred in two main areas: 1) along the coasts south of Alabama and northern Florida and 2) from DRTO across the Florida Strait, veering north before heading south into the Bahamas. Scattered high-use areas also occurred off the western coast of Florida, the northwestern coast of Cuba, and north of the Yucatan peninsula. In oceanic areas, grid cells generally had a low number of paths, with the middle of the GoM primarily having unique paths and a low degree of clustering. Water moved in all directions across turtle locations, from 0.005 to 359.97 degrees. In neritic areas, mean water magnitude was 0.7 km/h while in oceanic areas it was faster at 2 km/h. Mean turtle speed was 1.8 km/h (n = 3914 locations, n= 89 tracks). Average turtle travel speeds per grid cell were primarily slower in neritic areas, with high-speeds occurring more often in oceanic areas of the mid-GoM and between the Florida Keys and the Bahamas. Average speeds in these areas reached up to 8 km/h. Mean bathymetry values were -439 m and mean NSST values were 29.06 ºC. Turtles migrated from 7 June to 10 November. However, the majority of migration occurred during July and August. This peak was the same regardless of whether migration began in the northern GoM or at the more southerly DRTO. We tracked eight turtles twice during migration to their foraging grounds. Paths taken by turtles were similar across years. Migration can expose turtles to potentially dangerous anthropogenic factors. Therefore, we also overlaid threats during peak migration time (July and August) including commercial line fishing, shrimp trawling, harmful algal blooms and shipping lanes. We produced a map of threat hotspots along the migratory routes. Knowing both when and where threats to migrating turtles occur can inform targeted conservation efforts for loggerheads in the GoM. Acknowledgments: This work was supported by the Natural Resource Damage Assessment and the U.S. Geological Survey Priority Ecosystem Science Program.

POST-NESTING MIGRATIONS OF HAWKSBILL TURTLES (ERETMOCHELYS IMBRICATA) NESTING AT MOSO ISLAND, REPUBLIC OF VANUATU

Laura M.R. Jim[1], Holly Hoffbauer[1], Sara Thiel[1], Francis R. Hickey[2], George H. Balazs[3], and Marc R. Rice[1]

[1]Sea Turtle Research Program, Hawaii Preparatory Academy, Kamuela, Hawaii
[2]Traditional Resource Management Program at Vanuatu Cultural Centre, Republic of Vanuatu
[3]Golden Honu Services of Oceania, Honolulu, Hawaii

Hawksbill turtles (*Eretmochelys imbricata)* are considered critically endangered by the IUCN (International Union for Conservation of Nature) throughout most, if not all, of the southwest Pacific Ocean. The Republic of Vanuatu has a resident population and a migratory nesting population of hawksbill turtles. Little is known about the foraging territories of these nesting turtles. Nesting beaches on the northwest coast of Moso Island in central Vanuatu were monitored during the night between January 10 - 13, 2018, to locate nesting hawksbill turtles. When ascending tracks were observed and a turtle was found, it was harmlessly restrained post-nesting. Measurements of the carapace were taken and two titanium ID flipper tags applied if the turtle was not previously tagged. An ARGOS satellite-linked transmitter, TAM 2460, was attached to the turtles' second or third central scute. All transmitters were programmed with a duty cycle of 6 hours on 24 hours off to promote battery life. Three post-nesting hawksbills were tagged and left Moso Island between January 26 and February 9, 2018. Turtle 164949, "Teslaba," traveled approximately 2259 km in 50 days at an average speed of 1.9 km/hr. Her last recorded position on March 29, 2018, was ~226 km east of Cape Melville National Park Australia (14.42191 S and 147.37191 E). The second turtle, 164948, "Ethana," departed Moso Island on January 26, 2018, and traveled a total distance of 536 km in 13 days to the northern tip of New Caledonia at an average speed of 1.7 km/h. Ethana then moved along the coastline to Nehoue Bay (20.33996 S, 164.12625 E) where she appeared to take up residence. The third turtle, 164957, "Lucy," traveled 2073 km at an average rate of 1.6 km/hr. in a west-southwest direction, skirting around the northern tip of New Caledonia before continuing across the Coral Sea to Australia's Great Barrier Reef. After 55 days, her final position was received on March 21, 2018, 7 km from Collins Island in the Broad Sounds Islands National Park of Australia (22.17660 S, 150.31535 E). While the number of tracks is small, the data support the notion that there is a home range nesting site and forage ground connection between Moso Island and Australia's Great Barrier Reef, as well as New Caledonia. In 2015 a Vanuatu National Action Plan of Sea Turtles (NPOA Turtle) was completed by the Vanuatu Fisheries Department as a policy document that seeks to further protect, conserve and manage sea turtles in Vanuatu's waters. The local NGO Wan Smol Bag Vanua-tai has also continued to expand its turtle management network amongst rural communities and this has resulted in significantly more communities receiving awareness on turtle management and placing limitations on the harvest of eggs and turtles. The sustained management and recovery of this hawksbill population will require continued cooperative efforts between regional governments and indigenous cultures in a bottom-up fashion to conserve turtles that nest and forage across political boundaries. We wish to extend our appreciation to the Department of Fisheries and Acting Director, Mr. William Naviti for supporting our research. In addition, thank you to Owen Dres, ownder of

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ORIENTATION OF SEA TURTLE EMBRYOS IN EARLY DEVELOPING STAGES AND INFLUENCES OF ROTATING EGGS

Satomi Kondo, Chiyo Kitayama, and Hiroyuki Suganuma

Everlasting Nature of Asia

Sea turtles are known to be a migratory aquatic animal and migration patterns are diverse and long distance from a geographic birth place to feeding areas and eventually to the origin area for reproduction. Although the mechanism of this behavior remains unknown for the most part, previous studies indicate that geomagnetic imprinting and magnetic navigation are keys to accomplish natal homing. Also, other early studies imply that sea turtle embryos detect earth magnetic fields and show evidences of north-south alignment of sea turtle embryos as an ontogeny response of magnetic behavior. Thus, embryo development phase during incubation prior to hatching might be an important stage regarding to geomagnetic imprinting and magnetic navigation. This study aims to observe ontogeny of orientation in sea turtle embryos from early developing stages to later stages. Nonlethal methods which are transillumination and investigation of dead embryos, were applied to see orientation of embryos in three species, leatherbacks (*Dermochelys coriacea*) in Warmamedi beach in West Papua, hawksbills (*Eretmochelys imbricata*) on three islands in Java sea, Indonesia, and green turtles (*Chelonia mydas*) in three beaches in Indonesia and the Ogasawara islands in Japan from 2016 to 2018. The embryos at stage 16 (Classification of developmental stages are according to Miller, 1985.) which are the smallest embryo size visible by transillumination have alignment in three species but not north-south direction. Then, almost all of the embryos develop right side of their body upwards until around stage 19 to 23 in three species at all nesting sites. Thus, since ontogeny of organisms is based on genetic information and given the results, it is possible that position and direction of sea turtle embryo inside egg at an early development is decided genetically, so the orientation at the early stages might not be a response of magnetic behavior. However, this has not been proven yet. Embryos seem to move anticlockwise as developing larger until later stage of development and show north-south alignment at stage 27 to 28, which is corresponded to previous studies. Leatherback embryos at stage 26 do not have alignment in this study. Moreover, the north-south alignment is more strongly shown by leatherbacks than green turtles. This might indicate some species are more sensitive to magnetic field and show clear magnetic behaviors relating to species differences in pattern and extent of migration. To investigate influences of ontogeny at earlier developing stages where embryonic orientation is unable to be seen by transillumination on later orientation, eggs were divided into two groups, control and 90-degree rotated horizontally 2 to 3 hours after oviposition. Then, orientation of embryos was investigated after 8 to 12 days at stage 16 to 18 by transillumination. The control groups indicate the alignment, on the other hand, the 90-degree rotated groups showed random orientation. Therefore, horizontal rotation of eggs at early embryo development seems to influence embryo orientation at later stages. Further study is needed to unravel the influences of rotating eggs on magnetic behaviors and navigation ability in later phases of life.

SATELLITE TRACKING OF NESTING GREEN TURTLES IN TERENGGANU

Sharifah Ruqaiyah Syed Mustafa

WWF-Malaysia

The study focused on two districts in Terengganu, i.e. Kemaman and Setiu. In Kemaman, two beaches namely Ma'Daerah and Chakar Hutan record the second and third largest nesting population of green turtles on mainland Terengganu. Each year, between 300-500 egg clutches are laid on both beaches. In Setiu, Telaga Papan beach records an average of 200 egg clutches each year. The objective of the study is to identify the inter-nesting habitat and foraging habitat. By understanding their movement, the conflict between turtles and human activities such as fisheries, recreational and shipping could be reduced. A total of 24 platform transmitter terminals (PTT) were deployed on female green turtles who nested at the three beaches. Four turtles were tracked with Sirtrack KiwiSAT101 and 20 turtles were tracked with Telonics TGM4510. 11 turtles were tracked at post-nesting while 13 turtles were tracked at the beginning of the season to get the inter-nesting data. Data were collected by using the Argos System and analysed using the Satellite Tracking and Analysis Tool (STAT). Results show that the transmission period lasted between 10 to 167 days for each PTT. The average transmission period was between 31 and 60 days. Four out of 24 turtles migrated to the south-east heading towards Java Sea, Indonesia. Three turtles migrated to the Philippines while the rest were within the Malaysian waters. A turtle named Merdeka travelled the furthest at a distance of 2087 km near Pan de Azucar Island, Philippines. One turtle was last seen in north-west of Con Dao Island, Vietnam after being out-of-radar for 29 days. Its last location before Con Dao Island was at the south-east of Natuna Island, Indonesia in the South China Sea. This disappearance could be linked to bycatch or direct-take and kept under the fishing vessel, so no signal could be transmitted. Another turtle with semi-decomposed carcass was found stranded at Paka Beach, about 5 km north from Chakar Hutan Beach after 76 days of transmission. It was still in inter-nesting period. The PTT remained intact on the carapace and was recovered. We believed it was dead a few days at sea before stranded on the beach. The cause of death was unknown but we cannot rule out that the turtle drowned in fishing gear because this area is a hotspot for the illegal fishing gear, ray net. Migration patterns for green turtles from Terengganu spread across the South China Sea to the Philippines, and passed by Singapore towards the Java Sea. None of the migrated turtles stayed long enough at their final destinations to generate enough data of their foraging sites. Either the signals were lost while migrating or just 1-2 days of stay at a place making it difficult to conclude their foraging sites. Nevertheless, we managed to gather a good amount of data to generate the core inter-nesting areas and home range. The inter-nesting area is within 30 km radius from the released sites while the home range stretch to 50 km from the point of release.

SATELLITE TRACKING OF HAWKSBILL TURTLES BETWEEN NESTING SEASONS: A CASE STUDY OF HIGH FIDELITY

Armando J. B. Santos[1], Claudio Bellini[2], Erik A. P. Santos[2], Renata Ramos[3], and Maria Angela Marcovaldi[1]

[1]*Fundação Pró-Tamar*
[2]*Centro Tamar-ICMBio*
[3]*Engeo Soluções Integradas*

The Rio Grande do Norte state hosts the highest nesting density of hawksbill turtles in the South Atlantic, where Projeto TAMAR record near 1000 nests each nesting season along 42 km of beaches. Out of 24 nesting hawksbill turtles that were satellite tracked in the seasons 2014/2015 (12 PTTs) and 2015/2016 (12 PTTs), nine were recaptured in 2016/2017 (2 females) and 2017/2018 (7 females) with remigration intervals between 1.8 and 3 years. Five females (55.6%) had the PTT still attached, however all without antenna and quite burnt, including two in which the batteries become exposed, probably by the turtles scraping their carapaces into rocks. Eight of the nine turtles had new PTTs installed. Analysis of Argos locations was performed excluding land signals and filtering to retain only the best daily location. We estimated speed (km/h), and daily step lenght (km) for each segment. The inter-nesting and foraging residence areas (Minimum Convex Polygon -MCP) was estimated, as well the fidelity to these areas between tracking campaigns. Migratory movements were evaluated for total travel duration (days), distance (km) and speed (km/h), as well the similarity of the paths during migrations. Within and among nesting seasons, considering the nesting beach area, all females (N=8) returned to nest in a beach section up to 4 km in extension, except for one female that nested in two different beach sections, separated by 45 km from each other. The MCP internesting area between nesting seasons showed a complete overlap for five females (62%) and partially for two (25%), where they spend up to 67 days. For one female (12.5%) was not possible to determine the internesting area during the second remigration as it immediately migrated. All females that had the foraging ground detected twice (N = 7) returned exactly to the previous recorded site, where they remained transmitting up to 307 days, however 6 are still transmitting. The distances traveled during postnesting migrations ranged from 9 to 1285 km, lasting from 0 to 37 days. The daily displacement rate varied from 29 to 53 km (average 41 km), with speeds of 0.1 to 3.1 km/h (average 1.5 km/h). Four females migrated to the north, from 454 to 1233 km spending from 9 to 37 days to reach the states of Ceará (3) and Maranhão (1). Three females migrated to the south, from 79 to 280 km spending from 1.9 to 7.3 days to reach the sates of Paraiba (1) and Pernambuco (2). One female was considered resident, as its foraging ground was 9 km from the internesting area that was reached in less of 24 hours. Despite the foraging ground being the same for all individuals, the track of migration in km varied between seasons, with differences from 2 to 54 km (average 25.1 km) but the daily travel rates did not show significant variations between migrations. This report shows high fidelity of hawksbill turtles to the internesting and foraging areas, as well as in the migration paths in two consecutive nesting seasons. Identifying reproductive behavior, foraging areas and understanding migratory routes and connectivity between foraging and breeding grounds is essential for the design of effective conservation plans for marine turtles.

NESTING BIOLOGY

CYCLES AND COSTS OF LOGGERHEAD AND GREEN TURTLE NEST PREDATION BY RACCOONS, FERAL HOGS AND COYOTES ON A COASTAL BARRIER IN SOUTHWEST FLORIDA, U.S.A.

David Addison

Conservancy of Southwest Florida, Naples, FL, USA

The genesis of sea turtle monitoring on Keewaydin Island (KI) was extensive nest predation by raccoons (*Procyon lotor*). Initially (1983-1988), nests were relocated to a hatchery. From 1989-1992 nests were left in situ until the use of wire cages was implemented in 1993. Caging prevented predation by raccoons. Uncaged nests were often predated. Until 2007, raccoons were the only known mammalian egg predators. Feral hogs (*Sus scrofa*) were first seen in 2004. Sightings increased in 2005 and 2006. During this period, raccoon predation remained tolerable (mean 6.1%, n=214). By 2007, hogs were observed daily. The first nest was predated on 9 August. Fourteen uncaged nests were destroyed. Subsequently, hogs completely predated 36 caged nests. We conservatively estimated they destroyed 3,791 eggs. The seasonal frequency of tropical storms, fluctuations in predator populations, and changes in beach configuration influence hatchling recruitment. KI nest hatching success varies annually (40-75%). In 2007, it was 70% thus the value of the hatchlings lost to egg predation was 265,534 USD. In 2008, Rookery Bay National Estuarine Research Reserve contracted with USDA/Wildlife Services (14,020 USD) to remove the hogs. From May 16-June 7, 39 hogs were removed. Hogs on adjacent islands were not removed. No hog predation occurred from 2008-2012. Raccoon predation declined in 2008 and 2009 (4 and 2 nests); however, coyotes (*Canus latrans*) damaged two nests. From 2010-2012 raccoon predation increased to 95 nests. In 2012, hogs reappeared. They destroyed four nests in 2013. Coyotes predated two additional nests. The Conservancy of Southwest Florida's sea turtle staff began small-scale trapping in 2014. Thirteen hogs were removed. However, hog predation increased significantly (59). Coyote (7) and raccoon (52) predation also rose. Three hogs were removed in 2015. Hogs predated two nests; however, coyotes damaged 13. Six more hogs were removed in 2016. Hogs predated one nest; coyotes damaged 15. Hog and coyote predation spiked in 2017. Hogs destroyed 106 nests, coyotes 89 and 31 were predated by both species. Raccoons damaged three nests compared to 62 and 49 in 2015 and 2016. USDA staff removed one hog in 2017. In 2018, USDA hunters removed five hogs. Hogs predated six nests; coyotes damaged 15. Raccoons predated 22 nests. We don't fully understand what trigged the devastating predation in 2017, but, once hogs know they can compromise a cage, destruction quickly follows. In 2017, hogs predated 10,164 eggs, coyotes 7,919 while another 3,114 were predated by both species. Applying the 100 USD metric to the 59% hatching success of the surviving 2017 nests yields a value of 1,230,209 USD for the potential hatchlings predated. This far exceeds the cost of UDSA contracts and the average annual cost of 75,381 USD to fund the monitoring. Moderating these cycles will require more consistent control efforts than have been previously conducted.

ASSESSING THE EFFECT OF NESTING HABITAT ON THE EMERGENCE SUCCESS OF HAWKSBILL SEA TURTLES *ERETMOCHELYS IMBRICATA*, ON BUCK ISLAND ST. CROIX

Manouchehr David Afshar[1], Paul Jobsis[1], Sennai Habtes[1], and Clayton G. Pollock[2]

[1]*University of the Virgin Islands, US Virgin Islands, USA*
[2]*National Park Service, Buck Island Reef National Monument, St. Croix, USA*

This study aims to investigate the relationship between nesting environment and the success of hawksbill sea turtle (*Eretmochelys imbricata*) nests. Hawksbill sea turtles are an endangered species that live in the tropics. Several environmental variables will be used to quantify nesting habitat, such as shade cover, vegetation cover, underground root biomass, organic soil content, light intensity, distance from high-water mark, and incubation temperature. Emergence success will be determined by excavating sea turtle nests 60 days after oviposition, or three days after mass emergence. The number of hatched shells, undeveloped eggs, full term eggs, trapped hatchlings (alive and dead), will be determined during the excavation, and will be used to calculate emergence success. Variables will be compared to emergence success of different nests to test for correlation between them and emergence success. If this study is able to show a difference in the success of nests within different habitat types, the information collected will assist managers in the nest site locations of relocations, which occur on Buck Island during the summer months.

SIX YEARS OF NESTING DATA SUGGEST SEA TURTLES CONTINUE TO DECLINE IN GHANA, WEST AFRICA

Phil Allman[1] and Andrews Agyekumhene[2]

[1]*Florida Gulf Coast University, Fort Myers, FL, USA*
[2]*Wildlife Division, Ghana Forestry Commission, Winneba, Ghana*

Five of the world's seven species of sea turtles utilize West Africa's coastline for nesting grounds and the adjacent Gulf of Guinea for migrating, foraging, and breeding. Previous research has indicated fishery by-catch, direct exploitation, and sea level rise as the primary mortality risks in this region. Despite these anthropogenic threats and growing interest in protecting these animals, there are few reliable assessments of population abundance or trends in the region. Long-term population estimates are immediately needed to support the development of regional management plans. Nesting surveys can provide an inexpensive means of population assessment but requires long-term data that have been collected through a standardized protocol. Here we report on 6 years of nesting survey data collected from nightly walking surveys on 3.5 km of beach near Mankwadze, Ghana where olive ridley, green, and leatherback sea turtles have been documented to nest. Since 2012, we have recorded 430 olive ridley emergences (mean=84 per season) during the primary nesting season of November through February. We have applied tags to 175 individuals but have only documented 6 tag returns (4% recovery). Regression analysis indicates a 59% loss in emergence activity since 2012 with a slope of -11.4. We also have recorded 106 leatherback emergences (mean=18 per season) during the primary nesting season of November through January. We have applied tags to 45 individuals but have only documented 1 tag return (2% recovery). Regression analysis indicates a 67% loss in emergence activity since 2012 with a slope of -6.1. We documented the first green turtle emergence during the third year of the project (2014). Since then, we have documented 22 green turtles (mean 5.5 per season) during the primary nesting season of October through February. We have installed tags on 11 individuals and have documented 4 tag returns (36% recovery). We have

conducted 312 education activities since 2012 that include weekly radio programs, school education activities, and community education events. The survey teams' presence on the beach has eliminated poaching activities, protected nests from predators, and increased the awareness of sea turtle conservation in the region. New project initiatives are to (1) expand nesting surveys to three additional sites, and to increase the survey area in Mankwadze, (2) continue education programs, and (3) expand community outreach programs to include more fishermen in by-catch reduction activities. The decreasing nesting activity suggest the populations continue to decline although significant improvements have been made to improve sea turtle awareness and conservation throughout the country. The decline may be an artifact of only having six years of data since sea turtles are long-lived species and have nesting cycles that may expand several years. The low tag return can suggest high mortality rates but may be a function of the short distance we are able to survey. Recent data indicate sea turtles nest on different beaches throughout a single nesting season and will return to the region in subsequent years (but not necessarily the same beach). This project highlights the need for long-term data sets in many areas of the world where it is still difficult to accurately assess population status and trends.

IS A SMALL SEA TURTLES ROOKERY DOOMED TO LOCAL EXTINCTION? DECREASING NESTING TRENDS AT THE PARIA GULF, VENEZUELA

Clemente Balladares[1] and Enrique Quintero[2]

[1]*Universidad Central de Venezuela, Caracas, Venezuela*
[2]*Intituto Venezolano de Investigaciones Cientificas, Los Salias, Venezuela*

Small rookeries are rarely evaluated for marine turtles worldwide. Two species of sea turtles (hawksbill, *Eretmochelys imbricata*; leatherback, *Dermochelys coriacea*) nest on five main beaches of the northeast coast of the Paria Gulf in Venezuela. Population trends using Generalized Linear Models at this rookery were assessed and compared with other small rookeries. Both species shows significant negative nesting trends: Nesting by critically endangered hawksbills decreased over nine seasons 2009 - 2017 (64 to 142 nests per year, General Linear Model Slope Value = -0.061; data pooled for five beaches); similarly, vulnerable leatherback nests decreased across the same period in the main beach Los Garzos (0 to 69 nests/year; GLMSV = - 0.34). Besides human and natural predation of the nests, no significant environmental impacts affect the beaches except on Obispo Isthmus where a gas duct installation interrupted the nesting activity in 2014. Observed changes to the nesting trends in these small rookeries have a collective impact to broader conservation concerns for sea turtles in the region.

THE LINK BETWEEN TIDAL CYCLES AND SOLITARY NESTING EVENTS OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) SEA TURTLES ON TWO BEACHES IN COSTA RICA

Stephanie Barrett[1,2], Carmen Mejías-Balsalobre[2], Isabel Naranjo[2], Randall Arauz[3,4], and Daniela Rojas-Cañizales[2,5]

[1]*Dalhousie University, Halifax, Nova Scotia, Canada*
[2]*Rescue Center for Endangered Marine Species (CREMA), San Francisco de Coyote, Guanacaste, Costa Rica*
[3]*Fins Attached Marine Research and Conservation, Colorado Springs, CO, USA*
[4]*Migramar, Olema, CA, USA*
[5]*Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV), Maracaibo, Zulia, Venezuela*

Olive ridleys are the most common marine turtles in the word ranging from Mexico to Peru in the Pacific Ocean. In Costa Rica, Olive Ridleys commonly nest during the rainy season and are the main turtles found on Southern Nicoya Peninsula. The Rescue Center for Endangered Marine Species (CREMA) manages marine turtle conservation projects in four nesting beaches on the Southern Nicoya Peninsula. During the nesting season from July to December scientific night patrols and morning censuses are conducted each night to record the number of marine turtle nesting events, collect scientific data and protect nests from poaching and predation by relocating them to hatcheries. Night patrols are planned weekly according to the tidal cycles to maximize the chance of encountering nesting sea turtles. The aim of this study is to investigate if there is any correlation between tides and solitary nesting events in two neighbour nesting beaches, Costa de Oro and San Miguel, in order to better schedule patrols to maximize marine turtle encounters. We used the data collected from seasons 2014-2018 of San Miguel and Costa de Oro nesting beaches. We compared the time of the high tide with the time marine turtles were found nesting by determining the time difference between the two events and how many turtles nested at the various time differences. The results showed that on both beaches Olive Ridleys nested in similar abundances before and after the high tide, with the majority of the nesters between 1-3 hours before and after the high tide (Costa de Oro: 69.9% ± 21.8; San Miguel: 69.7% ± 18.6). There was no significant difference in the specific hours that had the most nesting turtles between the two beaches. The results of this study will help conservationists and researchers to better understand Olive Ridleys on other solitary nesting beaches and therefore maximize the efficiency of the monitoring by improving hours schedule for night patrols.

SHADING LEATHERBACK NESTS THREATENED BY EXTREME SAND TEMPERATURES TO IMPROVE HATCHLING PRODUCTION IN PAPUA BARAT, INDONESIA

Petrus Batubara[1], Deasy Lontoh[1], Fitryanti Pakiding[1], and Manjula Tiwari[2]

[1]*Lembaga Penelitian dan Pengabdian kepada Masyarakat, Universitas Papua, Manokwari*
[2]*Marine Turtle Ecology and Assessment Program, NOAA-SWFSC, La Jolla, CA, USA*

Located on the northwest coast of the Bird's Head region of Papua, Jeen Yessa (formerly known as Jamursba Medi) is one of the last remaining nesting habitats for critically endangered leatherback turtles (*Dermochelys coriacea*) in the western Pacific. Elevated sand temperature is one of the threats to leatherback nests in Jeen Yessa, especially in Wembrak beach, where the sand is darker. Universitas Papua

has been leading efforts to protect leatherback nests in Jeen Yessa for over a decade. The UNIPA team helped lower temperatures inside leatherbacks nests laid at Wembrak beach by shading each nest with palm fronds that are commonly found in the nearby forest. Results from several nesting seasons indicated that shading improved hatching success. To examine the effect of shading on sand temperatures, the team placed four temperature loggers in four plots in Wembrak at nest depth and placed two loggers in two shaded nests between May and September of 2018. One of the nests hatched while the other did not. From the logger temperature data, we learned: 1) the nest that hatched had lower temperatures than the nest that failed, 2) shading helped lower temperatures, and 3) a big storm lowered sand temperature for approximately one week. We will continue to shade nests as a way to improve leatherback nest survivorship at Wembrak but we need to evaluate the construction of the shade to ensure that it sufficiently reduces the nest temperatures

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INTERNESTING INTERVALS OF HAWKSBILL TURTLES THROUGH SATELLITE TRACKING

Claudio Bellini[1], Erik A. P. Santos[1], Renata Ramos[2], Maria Angela Marcovaldi[3], and Armando J. B. Santos[3]

[1]Centro Tamar-ICMBio, RN, Brazil
[2]Engeo Soluções Integradas
[3]Fundação Pró-TAMAR, Salvador, BA, Brazil

Satellite tracking is revolutionizing our knowledge of the movements and behavior of sea turtles. The increasingly accurate locations obtained with technologies such as Fastloc-GPS are powerful tools for conservation purposes. However, receiving data through satellite telemetry is still a challenge in equatorial regions, mainly for reasons such as satellite coverage, the size of data messages, and rapid surface time frequently the received data arrives fragmented. The recapture of tracked individuals tagged with devices that allow data to be downloaded directly from the tag makes it possible to fill in the gaps of received messages. Such detailed data allow the detection of residence areas, where females spend the quiescence period, and the areas in the vicinity of the nesting beach where they usually stop prior to emerging, as well as movements in between. Here we present downloaded data during internesting intervals (INI) for eight individual hawksbill turtles within a season, and for one individual in two nesting seasons monitored by Projeto TAMAR in Rio Grande do Norte state in northeastern Brazil. The tags used were SPLASH10 with Fastloc GPS by Wildlife Computers, configured to detect events of emergence longer than 20 minutes (houled out), which were related to nesting attempts. Data was analyzed using Q-Gis, and the areas were delineated as Minimum Convex Polygon (MCP) using 95% of the points. A total of 22 complete INI was recorded; three females were tracked for a single INI, one female for two INI, three females for three INI and two females for four INI. The average INI was 15.5 days (13.6 to 18 days, N=22). Eight INI presented one (5) or two (3) prior false crawls detected, with average INI at 16 days (14 to 18 days). Immediately after nesting, females moved to the quiescence areas with an average speed of travel of 0.71 km/h (0.04 to 1.4 km/h), lasting in this movement on average 1.42 days (0.08 to 4.83 days). The quiescence area has an average MCP area of 2,860 m2(32 to 14640 m2). The offshore distance was in average 4.75 km (1.1 to 15.3 km), between the 20 and 50 m isobaths. The average residence time was 11.2 days (4.4 to 13.5 days). The movement to the vicinity of the nesting beach presented an average speed travel of 0.74 km/h (0.007 to 1.6 km/h), spending on average 1.4 days (0.08 to 4.8 days) in this pre-emergence movement. The pre-emergence area had an average offshore distance of 3 km (0.24 to 8 km) and 16,723 m2 (189.6 to 90,842 m2) average MCP area, where the females stayed in average 1.9 days (0.09 to 5.3 days) prior nesting. The tag of the female detected nesting twice developed technical problems, losing data seven days before the second nest. From the three females tracked during three INI, the MCP of quiescence area usually diminished with each return; for one female all the MCPs overlapped, the other two resided first in a different spot from the other next two, which overlapped. It is interesting that, the last two spots almost overlapped with a previous MCP for the same individual turtle in its previous nesting season. For the two females with four INI available, all MCPs overlapped, and while the area diminished gradually with each return for one individual, it fluctuated for the other. These preliminary analyses show the importance of high-resolution location data to improve the identification of key areas and behavior changes during internesting and can further, help in the management and effective conservation.

THE IMPACT OF LUNAR TIDAL VARIATION AND NEARSHORE BATHYMETRY ON SEA TURTLE EMERGENCE IN MIAMI DADE COUNTY, FLORIDA

Faith Benner

Miami Dade County Sea Turtle Conservation Program, Miami, FL, USA

Florida provides vital nesting grounds for three species of sea turtles: loggerheads (*Caretta caretta*), greens (*Chelonia mydas*), and leatherbacks (*Dermochelys coriacea*). This study sought to discern the impact of lunar tidal variation and nearshore bathymetry on emergence location and timing of these three sea turtles in Miami Dade County. Location and timing data of 1,143 sea turtle emergences in Miami Dade County were collected by sea turtle surveyors in the Miami Dade County Sea Turtle Conservation Program during the 2017 sea turtle nesting season. Three lunar factors were tested in relation to sea turtle emergence timing. No relationship existed between the percentage of the moon illuminated and the number of sea turtle emergences on corresponding nights ($p=0.766$), nor was there a relationship between tidal range and the number of sea turtle emergences on corresponding nights ($p=0.481$). The proportion of sea turtle emergences occurring during spring or neap tides was also not significantly different ($p=0.0131$). Nearshore bathymetry was also correlated with sea turtle emergence density across the five beaches in Miami Dade County, using depth at 100m offshore as a proxy for coastal slope. Two beaches, Miami Beach ($p=0.0002$) and Key Biscayne ($p=0.0007$) showed a strong negative relationship between coastal slope and sea turtle emergence density. One beach, Golden Beach, showed only a marginally significant negative relationship between coastal slope and sea turtle emergence density ($p=0.054$). Two beaches, Fisher Island ($p=0.486$) and Haulover Beach ($p=0.714$) showed no relationship between coastal slope and sea turtle emergence density. Sea turtles nesting in Miami Dade County appear to do so independently of the time in the lunar cycle, and, on some beaches, prefer emerging in locations where the coastal slope is larger and more severe. This knowledge of where sea turtles prefer to emerge is useful in allocating conservation resources to ensure that those areas have the highest level of protection possible.

ANALYZING THE DISTRIBUTION AND DENSITY OF MACRO AND MICROPLASTIC DEBRIS ON A LOGGERHEAD (*CARETTA CARETTA*) NESTING BEACH AS A CONTRIBUTING ENVIRONMENTAL FACTOR FOR HATCHING SUCCESS ON JEKYLL ISLAND, GEORGIA IN THE UNITED STATES

Celine Mollet Saint Benoit[1], Christy Visaggi [1], Brian Meyer[1], David Steen[2], and Dajun Dai[1]

[1]*Georgia State University, Atlanta, GA, USA*
[2]*Georgia Sea Turtle Center, Jekyll Island, GA, USA*

Plastics are negatively impacting global ecosystems, with a substantial amount compiling in marine habitats. The most obvious effects from plastics on marine organisms are injuries resulting from entanglement and ingestion, yet smaller plastics accumulate within the sediments of the ocean and coastal habitats. Amassing within the sands, plastics can result in temperature fluctuations and impact sand permeability. Sea turtles, including loggerheads commonly found along the southeastern U.S., may be among organisms impacted by the presence of plastics within beach sands, particularly in regard to nesting habitat quality. This study examines the spatial distribution and possible role plastics may play on a loggerhead nesting beach located on Jekyll Island in southeastern Georgia. Since the 1940s, the island's coast has been developed for lodging and tourist attractions. The progressive human footprint on Jekyll Island and proximal coastal areas would likely result in increased manmade marine debris. In addition to marine debris, the island has had events of light pollution, sea turtle egg poaching, depredation events, nest relocations, and beach erosion, all which may combine to influence sea turtle conservation in the region. In this study, we examined plastic debris as a possible influence on the hatching success of loggerhead populations on Jekyll Island through baseline data collection at the micro- and macro- level. Potential environmental factors were also accounted for to provide a qualitative comparison between the variables. A macroplastic census (n_1=29) was established via quadrat analysis (100cm x 100cm) conducted at every half kilometer of the 14km length of the beach. The Marine Debris Tracker App developed by the NOAA Marine Debris Program and the University of Georgia was also used to document any debris observed while conducting the transect. With the assistance of the Georgia Sea Turtle Center Research Team, sediment samples (n_2=58) were retrieved from within the nest cavity wall, at the time of inventory. A saline solution separation method is underway to remove any possible plastic debris found within the nest cavity sediment. The detected microplastics will be categorized as either spheroids, granules, fibers or plastic films. Additional data regarding other possible environmental factors, such as land use and public beach access points, which may play a role in hatching success, were also collected. This is to provide an encompassing context to sea turtle conservation efforts on the island. Plastics data will be analyzed through spatial analysis utilizing the ESRI software, ArcMap 10.6. Existing trends or shifts over time will detect in part by utilizing long-term data available on nesting and hatching success on the island. Doing so provides an inclusive view of this long-term species and their nesting sites, rather than a single snapshot over one nesting season. Mapping of these data illustrates the areas or zones where plastics may be negatively impacting the hatching success of this species. Given the growing global awareness and concern for the impacts of plastics on sea turtles, establishing baseline data for the role that plastic debris may play on a loggerhead-nesting beach is imperative to ensuring the future reproductive success of this charismatic species.

END OF THE LINE? NESTING PHENOLOGY SHIFTS UNABLE TO MITIGATE ADVERSE IMPACTS OF CLIMATE CHANGE ON WINTER NESTING SEA TURTLES*

Blair Bentley[1], Scott Whiting[2], and Nicola Mitchell[1]

[1]*University of Western Australia, Perth, Australia*
[2]*Department of Biodiversity, Conservation and Attractions, PERTH, Australia*

Understanding how climate change will affect sea turtle nesting beaches is a fundamental consideration for threat abatement and species recovery plans. Increasing ambient temperatures are expected to lead to increased embryonic mortality and wide-scale rookery feminization for all sea turtle species across the globe, threatening population persistence. These effects will vary between species and populations as a consequence of existing environmental heterogeneity, regional differences in the magnitude of climate change impacts, and population-specific thermal thresholds. We employ a population-specific mechanistic modelling approach to assess the impacts of climate change on embryonic mortality and sex ratios at four flatback (*Natator depressus*) sea turtle rookeries. The model provides an overview of rookery outputs over a broad spatial scale at typical nest depths, using temporally robust interpolated climate surfaces. We show that climate change will have the greatest impact on winter nesting populations of *N. depressus* in the tropical north of Western Australia. These rookeries are most susceptible as sand temperatures at nesting depths are generally warmer than other rookeries, and their current nesting phenology does not allow for temporal shifts in nesting to a cooler period of the year. In contrast, summer nesting populations of *N. depressus* appear to be less at risk from increasing ambient temperatures, due in part to their slightly higher thermal thresholds and because they can alter their nesting phenology to avoid suboptimal temperatures. Taken together, our findings demonstrate the need for population-specific models to guide the most appropriate conservation strategy.

EVIDENCE FOR A ROLE OF OLFACTION IN THE TIMING OF MASS-NESTING IN SEA TURTLES*

Vanessa S. Bezy, Kayla M. Goforth, J. Roger Brothers, Catherine M. F. Lohmann, and Kenneth J. Lohmann

University of North Carolina, Chapel Hill, NC, USA

Reproductive synchrony occurs in diverse organisms and can be driven by a variety of mechanisms. Although the mass-nesting of olive ridley sea turtles is one of the world's most impressive displays of reproductive synchrony, little is known about the mechanisms that allow turtles to synchronize their behavior so that thousands emerge to nest at the same time and place. In principle, this behavior might be mediated by a chemical signal (possibly a pheromone) that triggers synchronized nesting. To explore this hypothesis, we conducted an experiment to determine if chemoreception - in particular olfaction - might play a role in the timing of nesting behavior in mass-nesting olive ridleys. Prior to an arribada, gravid females were captured in nearshore waters. The nostrils of each turtle were treated with either an olfactory anesthetic (zinc sulfate) or saline (seawater). We then intercepted the turtles as they emerged to nest during a mass-nesting event that started shortly thereafter. Turtles treated with the olfactory anesthetic nested later than those treated with saline. Although there are several caveats, the effect of olfactory impairment on the timing of nesting is consistent with the possibility that olfactory cues play a role in synchronizing mass nesting.

EVALUATION OF THE SPATIAL AND TEMPORAL DYNAMICS OF ARRIBADA NESTING IN THE KEMP'S RIDLEY USING UNMANNED AERIAL VEHICLES (UAVS) AND GROUND-BASED CAMERAS

Amy Bonka[1], Robby Brannum[1], Zachary Sanders[1], Thane Wibbels[1], Erika Navarro[2], Javier Montano[2], Manuel Rosas[2], Gerardo Marin[2], Hugo Acosta[3], Martha Lopez[3], L. Jaime Pena[2], Patrick Burchfield[2], and Francisco Illescas[4]

[1]*University of Alabama at Birmingham, Birmingham, AL, USA*
[2]*Gladys Porter Zoo, Brownsville, TX, USA*
[3]*CONANP, Ciudad Victoria, Tamaulipas, MX*
[4]*CDEN, Ciudad Madero, Tamaulipas, MX*

The Kemp's ridley sea turtle (*Lepidochelys kempii*) neared extinction in the 1980s, however, due to intense conservation efforts the population has begun to rebound. This rebound has included increasing size of mass nesting events (i.e., arribadas). As the size of the arribadas grows, it is important to understand the dynamics of these mass nesting events, as the dynamics of these mass nesting events have implications for the biology and conservation of this species. In the current study, commercially available UAVs were used to document the dynamics of a relatively large-scale arribada during the 2018 nesting season at Rancho Nuevo, Tamaulipas, Mexico. Two quadcopter UAVs (DJI Phantom 3 Pro, DJI Phantom 4 Pro) were used to survey an arribada nesting area during May 2018. Both quadcopters had 4k video capabilities that recorded to an SD card. The UAVs were flown using the Litchi flight app on an iPad Mini 4 tablet. Videos was analyzed to quantify nesting dynamics during different time periods of the arribada. In addition to the UAVs, StealthCam infrared, time-lapse wildlife cameras were used to document ground-level nesting dynamics at approximately 30 second intervals throughout the arribada. The results demonstrate the utility of using UAVs and wildlife cameras for documenting and evaluating the magnitude and dynamics of relatively large-scale arribadas. This research was conducted as part of the ongoing Kemp's Ridley Bi-National Recovery Program. The authors would like to acknowledge the Bi-National Kemp's Ridley Recovery Program field crews, without whom this research would not be possible. The authors would also like to thank the undergraduate research students at UAB who assisted in video and photo analysis. This work was funded by the Marine Turtle Conservation Fund and UAB.

QUANTIFICATION OF NESTING BEHAVIOR IN THE KEMP'S RIDLEY SEA TURTLE

Robby Brannum[1], Zachary Sanders[1], Thane Wibbels[1], Amy Bonka[1], Gerardo Marin[2], Erika Navarro[2], Manuel Rosas[2], Javier Montano[2], Martha Lopez[2], Hugo H. Acosta-Acosta[2], Fransisco Illescas[2], Luis Jaime Peña[2], and Patrick Burchfield[2]

[1]*University of Alabama, Birmingham, AL, USA*
[2]*Gladys Porter Zoo, Brownsville, TX, USA*

The Kemp's ridley is the only species of sea turtle that typically nests during the day. It has been reported that its nesting process is relatively fast (approximately 50 min) which may in part be due to the Kemp's ridley's relatively small size and its diurnal nesting behavior. In the current study, wildlife cameras were used to capture time-lapse photography of the nesting behavior of numerous Kemp's ridleys during a mass nesting event (arribada). The data were then analyzed to determine the average amounts of time that Kemp's ridleys spend in various behaviors associated with nesting (i.e., digging body pit, digging nest cavity, egg

laying, covering, etc.). The results provide average times spent in each activity as well as the average time for the entire nesting process. Quantitative data of behaviors associated with the nesting process is essential for the accurate estimations of the number of nests produced during high density arribadas.

VARIATION OF CLUTCH SIZE IN THE NORTH ATLANTIC GREEN TURTLE (*CHELONIA MYDAS*)

Renato Saragoça Bruno[1], Jaime Alberto Restrepo Machado[2], and Roldán A. Valverde[1,2]

[1]*Biological Sciences Department, Southeastern Louisiana University, Hammond, LA, USA*
[2]*Sea Turtle Conservancy, Tortuguero, Costa Rica*

For oviparous vertebrates, egg production is an energetically costly task because of yolk investment in growing follicles during vitellogenesis. For species that undertake reproductive migrations, long-distance movements to areas that may not contain adequate food sources complicate the balance of the energy budget. Likely because of these challenges, females of most sea turtle species take multi-year intervals between reproductive seasons to replenish body stores. North Atlantic green turtles (*Chelonia mydas*) graze on sea grass meadows throughout the Caribbean and females migrate to mate and nest every two to three years. Tortuguero National Park (TNP), northeastern Costa Rica, receives the largest nesting aggregation of green turtles in the Atlantic and a smaller number of hawksbill turtles (*Eretmochelys imbricata*). To assess the effects of the time of the season and female size in the number of eggs laid per clutch, we analyzed approximately 60 years of data collected by the Sea Turtle Conservancy (STC) as part of the longest ongoing sea turtle research and conservation effort in the world. From 1955 to 2017, the research personnel of the STC visually counted the number of eggs laid by 7307 *C. mydas* and by 189 *E. imbricata*. Straight carapace length (SCL) and weight were measured for a portion of the sampled individuals. Average clutch size was 110.7 ± 24.744 eggs for *C. mydas* and 163.7 ± 30.206 eggs for *E. imbricata*. SCL ranged from 77 to 123 cm in *C. mydas* (n= 5613) and from 74 to 101 cm in *E. imbricata* (n= 133). The weight of female *C. mydas* ranged from 83 to 192 kg (n= 250) and average Fulton's Body Index was 1.27 ± 0.123 and this measurement significantly correlated with clutch size ($P<0.001$). In *C. mydas* and *E. imbricata*, clutch size correlated positively to female straight carapace length ($P<0.005$). Number of eggs per clutch in *E. imbricata* remained stable, but *C. mydas* clutch size reached its zenith in the middle of the nesting season ($P<0.001$). The results of our study corroborated previous findings for this same population and lead us to reiterate the conclusions that time of the season and size of individuals affect clutch size of *C. mydas*; however, only a small percentage of the variation in clutch size was attributable to female size. Adding to the weight of evidence, we also found that the population trend for *C. mydas* nesting at TNP was to lay more eggs in the middle of the season than at the start or the end. For *E. imbricata*, we achieved results that are in accordance with previous investigations and found a positive relation between female carapace size and number of eggs per clutch; however, a small percentage of the variability in clutch size could be attributed to carapace size. Finally, we believe that further investigation is needed aiming individual variation and age effects in sea turtle clutch size.

THE INFLUENCE OF ELEVATION ON LOGGERHEAD (*CARETTA CARETTA*) HATCHING SUCCESS ON SANIBEL ISLAND, FLORIDA, USA

Jack Brzoza and Kelly Sloan

Sanibel-Captiva Conservation Foundation (SCCF), Sanibel, FL, USA

Florida's beaches are among the most vulnerable in the nation to changes in sea level, and loss of nesting habitat is one of the biggest threats to sea turtles in Southwest Florida. The naturally dynamic nature of beach habitats is accelerated by the increasing frequency of tropical storms, hurricanes, storm surge, flooding, and sea level rise. Current projections indicate that the area around Fort Myers, FL, USA could see sea level rise 2-3 feet in 60-80 years. Such an increase has the potential to significantly change the quality of Florida's beaches and potentially eliminate areas of nesting habitat through erosion and inundation. Beach profiles will likely be altered as well and average sea turtle nest elevations relative to mean sea level could decrease significantly. One method of defense that is commonly used to address beach erosion along the shoreline is artificial beach nourishment. The result is a wider beach with a higher elevation. Given the variability between changes in beach profiles occurring from sea level rise and artificial beach renourishment, representing influences from natural processes and human intervention, the relationship between nest elevation and hatching success becomes increasingly important to understand. This study aims to explore this relationship by between loggerhead (*Caretta caretta*) nest elevation and hatching success within and among nesting seasons on Sanibel Island, FL, USA. The following questions were also addressed: how does the relationship between nest elevations and hatching success of multiple nests laid by a single female change within a single nesting season and between seasons? In an area of beach influenced by erosion and subject to maintenance via mechanical sand placement, is there a difference between the elevation and hatching success of nests prior to and following the renourishment project? A Trimble GPS unit (+/- 1-2 cm accuracy) was used to collect elevation data for loggerhead nests laid in 2016, 2017, and 2018. Additionally, on a two-mile section of beach subjected to sand placement during a dredging project in 2017, average elevation and average hatching success for nests laid on this two-mile area prior to (2016) and following (2018) this project were compared. Finally, in an attempt to eliminate confounding factors influencing hatching success specific to a single nesting season, the elevations and hatching successes of nests laid by a single individual identified with tags were compared. The results of this project will help drive management decisions and conservation efforts within the context of sea level rise.

HATCHERY EMERGENCE SUCCESS DURING THE RAINY SEASON ON THE SOUTHERN NICOYA PENINSULA COSTA RICA*

Candela Buteler[1], Carmen Mejías-Balsalobre[1], Isabel Naranjo[1], Randall Arauz[2,3], and Daniela Rojas-Cañizales[1,4]

[1]*CREMA, Rescue Center for Endangered Marine Species, Costa Rica*
[2]*Fins Attached Marine Research and Conservation, Colorado Springs, CO, USA*
[3]*Migramar, Olema, CA, USA*
[4]*Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV), Maracaibo, Zulia, Venezuela*

Olive ridleys (*Lepidochelys olivacea*) are listed as vulnerable on the IUCN Red List and commonly nest in the Pacific beaches of Costa Rica during the rainy season. Hatcheries are a popular conservation tool to protect species of marine turtles and have been proven to be useful for protecting nests from harvest and natural loss. Nonetheless, the effectiveness of hatchery-based conservation programs relies on the way that they are managed. For this reason, it is important to quantify the hatchery emergence success and assess the variables that affect it. Despite the extensive research on this topic there is still a lack of consensus regarding the primary determinants of hatching and emergence success. Since 1998, a monitoring program has been running in San Miguel beach on the Southern Nicoya Peninsula, previously lead by PRETOMA and by the Rescue Center for Endangered Marine Species (CREMA) in the present. This project monitors and protects sea turtle nests, mainly Olive ridleys, from poaching and predation with the use of a hatchery. The aim of this study is to examine the variables that effect San Miguel´s hatchery emergence success. San Miguel hatchery is roofless and has a rain gauge placed in the middle to record the levels of rain twice a day. During night patrols and morning censuses nests were relocated to the hatchery. The clutches of eggs were counted and collected with latex gloves and carefully transported in sterile fabric bags to the hatchery where they were recounted and buried. Nests were excavated two days after hatchling emergence to quantify the emergence success by relating the total number of emerged hatchlings to the total number of eggs originally deposited in the nest. We compared the emergence success from 2013 to 2017 (2018 will be included at the end of the season) and examined its relationship with the period of incubation, clutch size and average rainfall during the incubation period. A total of 1326 nests were analyzed. The average rainfall during the incubation period (mean of mm ± SD) was significantly different between seasons (2013a=11.71±6.43, n=240; 2014b=14.12±4.12, n=329; 2015c=9.00±2.26, n=247; 2016d=6.98±1.25, n=197; 2017e=8.21±2.79, n=320; different letters are significant with $p<0.05$, ANOVA and LSD Fisher Test). The emergence success (%) was also different between years (2013a=68.33±1.51; 2014b=81.15±1.29; 2015c=75.56±1.48; 2016ac=71.54±1.66; 2017d=86.97±1.30; ANOVA, $p<0.05$; different letters are significant with $p<0.05$, ANOVA and LSD Fisher Test). The linear multiple regression for emergence success versus average rainfall, clutch size and period of incubation was significative (R^2=1, F= 620.49, $p<0.05$). Rainfall and incubation period showed a positive relation; however, clutch size showed a negative relation with the hatching success. A possible explanation for the increase in the emergence success with higher rainfall and smaller clutch size may be related with the temperature, as temperature can be affected and probably reduced by these two factors. However, further research is needed to improve the understanding of the factors affecting the emergence success. Overall, this study shows the importance of understanding different variables that affect the efficiency of hatcheries.

REDUCTION OF ENERGY IN HATCHLINGS OF CARETTA CARETTA IN BOA VISTA, CAPE VERDE RESULTING FROM THEIR RETENTION AFTER EMERGENCE

Stephanie Butera[1], Elton Do Rosario[1], Maria Medina Suarez[1], Ana Liria Loza[2], and J. Pinos Crosas[1]

[1]*Cabo Verde Natura 2000, Boa Vista Island, Cape Verde*
[2]*Universidad de Las Palmas de Gran Canaria, Las Palmas, Spain*

Ecotourism is an attempt to resolve issues between conservationists and the social realm by bringing benefits to both. Ecotourism benefits the social sector by using a region's ecological resources as attractions for tourists. This can also benefit conservationists if the income generated by ecotourism is shared with NGOs and ecological projects. Despite the obvious benefits of ecotourism, if not properly managed, it may lead to the degradation of the resource. In coastal areas where sea turtles nest, they are often used as an attraction for ecotourism, both as adults and as hatchlings. In order to satisfy the demand for hatchlings to release to the sea, tourism companies often work in agreement with NGOs that conserve sea turtle populations so that they supply hatchlings from the beaches or from their hatcheries. In many cases hatchlings are retained for long periods before release, although little is known about the effects of their retention. In Boa Vista local guides create a demand in tourists for hatchlings to release on their beaches. This study investigated the effect that retention has on Loggerhead sea turtle (*Caretta caretta*) hatchlings' ability to run to the sea and their ability to flip themselves over. In order to do this, we surveyed 30 nests, for which time of emergence was known, from the Cabo Verde Natura 2000 hatchery in Ervatão, Boa Vista inside the Reserva Natural das Tartarugas. From these nests 18 hatchlings from each was chosen at random. At emergence each hatchling's carapace length and width was measured and each was weighed. The hatchlings were weighed again 24 hours after emergence and the average start and end weights were compared. Each hatchling was made to perform each of the 2 trials. The running trial consisted of a 1m long sand runway with a red light in the middle of the finishing end to attract the hatchlings. The hatchlings were placed 3 at a time and the time required for each to run to the end of the runway was measured using a stopwatch. After completing this trial the hatchlings were each turned over on their carapace and the time taken to flip back over was recorded, with a maximum of 1 minute. The hatchlings were selected 3 at a time to randomly to perform the trials once at a specific time after emergence. The first 3 were tested immediately after emergence. An hour later another group was tested. After that the remaining hatchlings were tested 3 hours after emergence, 6 hours after emergence, 12 hours after emergence, and 24 hours after emergence. At 24 hours after emergence, the first group was tested again to compare effects of retention on the individual. Retaining hatchlings after emergence reduces their energy level, slowing them down and diminishing their strength. This study may be used to inform local and foreign conservation authorities about the effects that the retention of hatchlings has on their energy reserves and ability to survive in the sea. This information can improve ecotourism management practices to provide a more sustainable model.

NEST PREDATION OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) ON GEORGIA'S BARRIER ISLANDS*

Zachary Butler[1], Mark Dodd[2], and Seth Wenger[1]

[1]*University of Georgia: Odum School of Ecology, Athens, GA, USA*
[2]*Georgia Department of Natural Resources, Brunswick, GA, USA*

Predation of loggerhead sea turtle (*Caretta caretta*) nests by native and non-native species is a significant threat to recovery efforts throughout the species' nesting grounds. In Georgia, USA, nests are threatened by predators including but not limited to: raccoons, feral hogs, armadillos, ghost crabs, snakes, and fire ants. Nesting beaches are patrolled daily at dawn, with surveys occurring below the previous night's tide to ensure that all sea turtle emergences are detected. Daily patrols were conducted for the duration of Georgia's sea turtle nesting season (15 May–1 October) in 2009–2018. The objective of this study was to examine a historical data set provided from beach monitoring efforts since 2009 and compare loggerhead nest losses due to different predators on two of Georgia's barrier islands (Sapelo and Ossabaw Islands). We hypothesized that northern raccoons (*Procyon lotor*) would be the most frequent predator of loggerhead nests, while invasive feral hogs (*Sus scrofa*) would be responsible for the greatest mean egg loss per predation event. We also hypothesized that nine-banded armadillos (*Dasypus novemcinctus*) and Atlantic ghost crabs (*Ocypode quadrata*) would have a low predation effect compared to that of other predators. Our preliminary results show that raccoons have depredated an estimated 9338 eggs, while hogs have predated approximately 8020 eggs across the two islands. Egg losses from other predators were substantially lower: 1350 from ghost crabs, 300 from armadillos, 55 from birds, 15 from kingsnakes, and 12 from fire ants. Ghost crabs were responsible for the highest number of predation events (284), followed by raccoons (242), hogs (120), armadillos (9), fire ants (2), kingsnakes (2), and birds (1). Mean egg loss per predation event was highest for hogs at 66.83 (± 3.57) eggs, and lowest for ghost crabs at 4.75 (± 0.35).

Raccoons and armadillos had comparable mean egg losses per predation event with 38.59 (± 1.99) and 33.33 (±9.56) eggs respectively (mean egg loss was not calculated for birds, kingsnakes, or fire ants due to the low number of predation events). Our results show that despite active management, introduced species such as feral hogs destroy a substantial number of eggs, although native species like raccoons also account for extensive egg loss. In contrast, armadillos (considered an invasive species by the U.S. Department of Fish and Wildlife Services) appear to be a much lower threat. Our results provide a data-driven basis for predator management on Georgia's barrier islands that could have significant implications for sea turtle conservation efforts taking place along the Georgia coast.

POST-HURRICANE NESTING SUMMARY AND MATERNAL EFFECTS ON HATCH SUCCESS OF *DERMOCHELYS CORIACEA* AT SANDY POINT NATIONAL WILDLIFE REFUGE

Carmen Candal[1], Dana DeSousa[1], Claudia Lombard[1], and Kelly Stewart[2]

[1]*US Fish and Wildlife Service, Sandy Point National Wildlife Refuge, Frederiksted, St. Croix, VI, USA*
[2]*The Ocean Foundation, Washington, DC, USA*

Sandy Point National Wildlife Refuge (SPNWR), designated in 1984 and located in the eastern Caribbean Sea on the island of St. Croix, provides critical nesting habitat for threatened and endangered sea turtle species including leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), and green sea turtles (*Chelonia mydas*). Tagging efforts began in 1977, and each year from March-August, researchers, interns, and volunteers conduct nightly surveys to tag nesting female leatherback sea turtles, collect data, collect genetic samples from nesting females and hatchlings, monitor nests during incubation, and excavate nests post-hatch. In 2017, St. Croix was severely impacted by Hurricanes Maria and Irma, causing damage and erosion to the 3.2-km nesting beach at SPNWR. The data collected during the 2018 season is important for us to understand how these hurricanes have affected nesting activity and availability of suitable nesting habitat for the leatherback population. Here, we summarize the 2018 post-hurricane nesting season and examine maternal factors that may influence hatch success, which may play an important role in increasing offspring fitness and species persistence in a future in which sea level rise and increased frequency and intensity of natural disasters are expected. Leatherback nesting began 9 March 2018 and ended approximately 15 August. In total we recorded 130 nests laid by 38 individuals, of which 23 were remigrants while 15 were neophytes. This is a higher proportion of new nesting females at SPNWR, which indicates recruitment of females returning to their natal beach to lay their first nests. We hypothesized that more experienced remigrants would have nests with a higher hatch success than those of neophytes. Clutch size ranged from 35 to 131 yolked eggs (mean=80), and hatch success ranged from 12.66% to 91.18% (mean=46.33%). We found a significant negative correlation between clutch size and hatch success ($F_{1,89}$=15.717, p=0.001, R^2=0.15). The mean hatch success for remigrants (45.84%) and neophytes (46.03%) were not significantly different (ANOVA: $F_{1,77}$=0.002, p=0.964, R^2<.001). However, the nest with the highest hatch success was laid by a remigrant tagged in 2007, and a neophyte laid the nest with the lowest hatch success. We also hypothesized larger females would have a higher hatch success. Average curved carapace length (CCL) for individuals ranged from 141.4 cm to 170.1 cm (mean=155.2 cm). We found no significant relationship between CCL and hatch success (ANOVA: $F_{1,77}$=0.040, p=0.843, R^2<.001). Overall, SPNWR had more nests and nesting individuals in 2018 than in 2017 and a higher proportion of new nesting females (~39%). As stated earlier, the mean hatch success for neophyte nests was 0.19% higher than that of remigrant nests, although of nests with confirmed mothers, neophytes laid 24 and remigrants 67. Our statistical tests did not support our hypotheses about maternal factors influencing hatch success for 2018. Hatch success therefore is a complicated measure influenced by many environmental factors in conjunction with individual characteristics. Continued monitoring may show a more pronounced correlation between maternal factors and hatch success in years with higher nesting numbers. Nonetheless, our evidence of higher hatch success from nests of neophytes and smaller turtles sets a positive trend for the future Sandy Point nesting population.

INCREASE IN NESTING NUMBERS OF OLIVE RIDLEYS IN BRAZIL ALLOWS THE EVALUATION OF SPATIO-TEMPORAL NESTING PATTERNS

Jaqueline C. de Castilhos[1], Augusto César Coelho[1], Éderson L. Fonseca[1], Fábio Lira[1], Ana Carolina Corréa [1], Marilda Weber[1], Alexsandro S. Santos[1], Frederico Tognin[1], João A. de Abreu[1], Maria Angela Marcovaldi[1], and Manjula Tiwari[2]

[1]*Fundação Pró-TAMAR, Salvador, BA, Brazil*
[2]*Marine Turtle Ecology and Assessment Program, NOAA -SWFSC, La Jolla, CA, USA*

Sea turtle conservation in Brazil began with a survey of the entire coastline and islands from 1980 to 1982. First reports indicated that the state of Sergipe was the main nesting site for olive ridleys within Brazil, however the most abundant species was the loggerhead turtle. Interviews with local people, such as fishermen, revealed that virtually all nests were poached, egg consumers had never seen a sea turtle hatchling, and no nesting aggregations, such as arribadas were ever observed or described. Following the establishment of Projeto TAMAR field stations in 1981 along the northeastern coast and regular monitoring of 339 km of nesting beaches since 1991, between the states of Bahia and Sergipe, a 10-fold increase from 252 olive ridley nests in 1991/1992 to 2,606 nests in 2002/2003 was estimated for this area. Here we reevaluate the nesting trend from 1991/1992 to 2013/2014. The increasing trend has continued with more than a 3-fold increase since the last assessment with more than 8,750 nests laid in 2013/2014. In addition, on beaches where records of olive ridley nests were only occasional in the past decade, nesting is now regularly reported. Even though olive ridley nesting is concentrated between October to February, records show that nesting now occurs year-round. After three decades of conservation efforts, the olive ridley is now the most common sea turtle species nesting in the state of Sergipe, as well in the extreme end of northern Bahia. The population recovery is a result of conservation efforts to protect nests and females, reduce bycatch in the shrimp fishery, and raise awareness. Effective conservation of this olive ridley population will depend on a long-term monitoring and research to address the mitigation of threats over time.

EVALUATION OF THE HATCHING SUCCESS OF *LEPIDOCHELYS OLIVACEA* AND ITS RELATIONSHIP TO THE HATCHERIES'S MANAGEMENT IN GUATEMALA

Barbara Lisset, Cumez Cate, Berta Alejandra, and Morales Mérida

San Carlos of Guatemala University, Guatemala City, Guatemala

The *Lepidochelys olivacea*, is the most abundant sea turtle in Guatemala. It is threatened by the collection of eggs, due to the economic needs of the local communities. In this research, the hatching success and its relationship with the management of three hatcheries was evaluated, by comparing the observed practices with recommended practices. The causes of death of neonates and their relationship with the management of the turtle were analyzed. The sex ratio was determined by gonadal identification. It was observed that

there is a discrepancy and misinformation about the most appropriate practices, as well as a lack of management manuals. The causes of death of 297 neonates were identified, which are mainly related to management practices, such as: the extraction of newborns before their emergence, predation by domestic cats, birds and ants, fatigue, dehydration and insolation of newborns. Essential information such as temperature measurement and incubation conditions, were absent. The sex rate found was 100% females. The consequences on populations in the long term are not known. It is suggested to reconsider the turtles as the only conservation method, and it is recommended to implement the management of natural nests in Guatemala.

FORAGING AREA DOES NOT AFFECT NESTING PHENOLOGY OF THE NORTHWEST ATLANTIC LOGGERHEAD TURTLE (*CARETTA CARETTA*)

Simona Ceriani[1,2] and Kate L. Mansfield[2]

[1]*Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, FL, USA*
[2]*University of Central Florida, Department of Biology, Orlando FL, USA*

Stable isotope analysis is an increasingly common tool for marine turtle research and management. Satellite telemetry and isotope values of tissues collected on nesting beaches have been used to identify foraging areas used by loggerheads (*Caretta caretta*) of the Northwest Atlantic (NWA) subpopulation. Previous research demonstrated that loggerheads nesting at the Archie Carr National Wildlife Refuge (ACNWR, Florida, USA) using geographically distinct foraging areas in the Southeast USA and Gulf of Mexico have distinct tissue isotope values. Thus, stable isotope values have been used as a proxy for foraging areas. Loggerheads experience disparate environmental conditions (e.g., temperature regimes which have been found to correlate with the onset of the nesting season) at these foraging areas that may affect nesting phenology. This study aims to investigate whether female's foraging area choice affect nesting phenology. Specifically, do females encountered during early, middle and late season frequent the same foraging areas? A total of 257 individual females were sampled for bulk stable isotope analysis at the ACNWR in 2016 (n=131) and 2017 (n=126) during consistent nighttime tagging efforts across the nesting season (May-August). A skin sample was collected after deposition (or when the female returned to the water in the case of a non-nesting emergence) following standard protocol and preserved in ethanol 70% until analysis. Bulk stable isotope analysis (d13C and d15N) of epidermis tissues was conducted following standard protocols. The nesting season was divided in three segments: early (1 May – 9 June), middle (10 June – 9 July) and late season (10 July – 14 August). To test for significant differences in isotopic values (d13C and d15N) across the nesting season, we used permutational analysis of variance (PERMANOVA). d13C and d15N did not differ among segments of the nesting season (WTS = 2,107, p=0.716). Even though foraging areas used by loggerheads nesting at the ACNWR differ in sea surface temperature and distance to the nesting beach, our results suggest that female's foraging area choice does not affect nesting phenology of this important aggregation which hosts ~14% of the NWA loggerhead subpopulation.

RELATIONSHIP BETWEEN THE SIZE OF THE FEMALE NESTING TURTLE AND THE NUMBER OF EGGS LAID PER NEST BY OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) IN THE AREA OF MULTIPLE USES HAWAII- AUMH, SANTA ROSA, GUATEMALA

Marí-a Contreras-Mérida[1], Alejandra Morales-Mérida[1], and Marc Girondot[2]

[1]*Universidad de San Carlos de Guatemala, Guatemala City, Guatemala*
[2]*Laboratoire d'Ecologie, Systématique, d'Evolution, Université Paris-Sud, AgroParisTech, CNRS, Université, Paris Saclay, Orsay, France*

Sea turtles are known for spending their entire lives in the sea and returning to the land by the time they lay their eggs on the beaches all over the world for them to be incubated. Within this group, there is the species *Lepidochelys olivacea* (Olive ridley), which nests along the Pacific coast in Guatemala. Unfortunately, it is affected negatively by human activity such as overexploitation, alteration of nesting areas or captured, among others. There are no natural nests on the beaches of the Pacific Coast due to egg depredation, so they need to be relocated to hatcheries. There is a lack of information not only of these types of nests but also about the nesting biology of the sea turtles in the country; because of this, we wanted to determine if there was a relationship between the size of the turtle and the number of eggs on each nest in order to generate basic information about this species and have data to impulse conservation and implement the actions needed. Determine the relationship between the size of the nesting Olive ridley and the number of eggs laid in each nest on the beach of the Area of Multiple Uses Hawaii (AUMH in Spanish), Santa Rosa, Guatemala. was a prospective study including 74 nesting females during the months of June to October 2017, through night patrols along 6 kilometers within the AUMH in Santa Rosa Guatemala. The following information was collected: Curved Length and Width of the Carapace (CCL and CCW, respectively), the number of eggs laid, the location of the nest, distance to vegetation and to the high tide line. The data was analyzed using a simple regression and a Spearman Correlation in the statistic program R version 3.4.1. From the 74 nesting females the average size of the carapace in CCL was of 64.8 cm (CI95% from 53 to 70cm) and CCW of 70.7 cm (CI95% from 63.5 to 77cm) and an average number of eggs laid per nest of 92 (CI95% from 59 to 120). We classified the turtles into two categories according to their carapace size into small (<64cm) and large >64cm). We found a direct correlation between the size of the carapace and the number of eggs placed by the Olive ridley. There is a direct correlation between the size of the nesting Olive ridley carapace and the number of eggs they laid in the season.

HISTORIC SEA TURTLE NESTING PATTERNS RELATIVE TO SHORELINE MANAGEMENT AND DEVELOPMENT ON BALD HEAD ISLAND, NORTH CAROLINA

Elizabeth S. Darrow[1], Emily Goetz[1], G. Christopher Shank[1], Olivia Bryson[2], and Adam Silva[2]

[1]*Bald Head Island Conservancy, Bald Head Island, NC, USA*
[2]*University of North Carolina, Wilmington, NC, USA*

The Bald Head Island Conservancy (BHIC) has been collecting data on sea turtle nesting on Bald Head Island, a barrier island at the mouth of the Cape Fear River, for 35 years. During this time, residential development has increased in a controlled manner, but the most of the Island's land cover is still currently maritime forest, marsh, and beach. The Island has three distinct beaches (west, south, and east) that were developed during different timeframes, with homes being constructed bordering east beach in the past 5-10 years. The Village of Bald Head Island strives to "live in harmony with nature" and reduce the impact of

Island residents and visitors on wildlife, but it is possible that beachfront development, including light pollution, may have had an effect on sea turtle nesting behavior. In addition, these three beaches are eroding or accreting at different rates and the Village actively manages shorelines via periodic beach renourishment and construction of a terminal groin in 2015. This project's objective is to use BHIC's 35-year dataset to create an animated map of historic sea turtle nests on Bald Head Island. This map will then be used to examine spatial and historical patterns in site fidelity, and correlate changes in nesting behavior to shoreline change and human population size in a barrier island community undergoing light residential development.

PRE-HURRICANE VS. POST-HURRICANE NEST SUCCESS AND HATCH SUCCESS OF *DERMOCHELYS CORIACEA* AT SANDY POINT NATIONAL WILDLIFE REFUGE

Dana DeSousa[1], Claudia Lombard[2], Carmen Candal[2], Kelly Stewart[3], and Nina Mauney[3]

[1]*Pace University, New York City, NY, USA*
[2]*US Fish and Wildlife Service, Sandy Point National Wildlife Refuge, Frederiksted, St. Croix, VI, USA*
[3]*The Ocean Foundation, Washington, DC, USA*

Sandy Point National Wildlife Refuge is a federally protected and designated nesting area for sea turtles on the U.S. Virgin Island of Saint Croix. Islands in the Caribbean, including Saint Croix, are in the path of hurricanes each year that vary in severity and direction. Hurricane weather events may affect leatherback sea turtle (*Dermochelys coriacea*) nesting and hatch success in the Caribbean. There is very little known about the effects of such types of weather having either positive or negative influence on sea turtle nesting and hatching success. Leatherback nesting season overlaps with hurricane season between 1 June and 30 November annually. Hurricanes Irma and Maria affected the nesting habitat at Sandy Point National Wildlife Refuge in 2017; in particular Hurricane Maria was especially damaging to nesting habitat and removed nearly ten years of sand deposits. The 2017 season resulted in historically low numbers of leatherback nesting throughout the entire Caribbean. The data collected during the 2018 season is being used here to understand how these hurricanes have affected nesting activity and availability of suitable nesting habitat for the leatherback population. The purpose of our study was to examine if there were any apparent weather influences due to changes in beach profiles, sand deposition, or substrate quality on the hatching successes before and after the hurricanes. We hypothesized that the increase in weather severity, which is impacted by global climate change would affect nest success and hatch success negatively. We compared nesting and hatching success from the 2017 nesting season and the 2018 nesting season at Sandy Point. Overall, 2018 saw more nests and nesting individuals as compared to 2017. We measured nest success as the rate of false crawls to nests. The nest success measured was 88.28% for 2018 and 91.91% for 2017. In 2018 we recorded 130 nests laid by 38 individuals. In 2018 we recorded 113 nests laid by 27 individuals. Due to regular annual longshore erosion patterns within the season, it is sometimes necessary to relocate nests to a safer area of the refuge. In 2018, we had 51 nests that needed to be relocated while 79 were left in situ. In 2017, we had 15 nests that needed to be relocated while 98 were left in situ. We defined hatch success as the number of hatched eggs versus total number of yolked eggs in a clutch. Clutch size ranged from 35 to 131 eggs with a mean of 80.24 eggs in 2018. Hatch success ranged from 12.66% to 96.20% with a median of 43.48% and mean of 47.24%. The mean hatch success for relocated nests was 39.59% and in situ nests was 49.02% for all nests in 2018. Although there were fewer nests overall and fewer individuals during the 2017 nesting season, the hatch success of both in situ and relocated nests were higher. In 2017, clutch size ranged from 43 to 117 eggs with a mean of 77.27 eggs. Hatch success ranged from 5.80% to 95.65% with a median of 54.84% and mean of 54.81%. The mean hatch success for relocated nests was 44.44% and in situ nests was 56.74%. Leatherback sea turtles do not nest every season so there is a variable number of individuals nesting every few years. By comparing nesting seasons before and after

major weather events we can better understand the implications of extreme weather events on nesting leatherback sea turtle populations.

A COMPARISON OF THREE TYPES OF PIT TAG SCANNERS USED ON LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*) DURING THE 2018 NESTING SEASON AT SANDY POINT NATIONAL WILDLIFE REFUGE

Emma Dlutkowski[1], Makayla Kelso[2], Claudia Lombard[3], and Kelly Stewart[2]

[1]*Front Range Community College, Fort Collins, CO, USA*
[2]*The Ocean Foundation, Washington, DC, USA*
[3]*US Fish and Wildlife Service, Sandy Point National Wildlife Refuge, Frederiksted, VI, USA*

Sandy Point National Wildlife Refuge was established in 1984 for the purpose of protecting leatherback turtle (*Dermochelys coriacea*) nesting habitat, although leatherbacks have been monitored here since 1977. Nesting turtles are identified to track nesting histories and individual reproductive success. Turtles nesting at Sandy Point are identified with a flipper tag and a Passive Integrated Transponder (PIT) tag. Since 1992, PIT tags have been used to identify individual nesting females due to their long retention times and accuracy. They are more reliable than flipper tags, although flipper tags are still used as a primary identification method. During the 2018 nesting season, three PIT tag scanner models were tested to compare their accuracy in the field. As well, we wanted to determine if we could find a more cost-effective scanner. The nesting season began with the first nest documented on 9 March and lasted until the middle of July with the last nest on 13 July. One hundred sixty-two total *D. coriacea* activities were documented during the course of the nesting season; 130 of these were nests. Thirty-eight individual turtles were identified. Fifteen of the 38 turtles were neophytes, while the other 23 were remigrants. Ten of these turtles (~25%) had only one documented activity at Sandy Point for the season. The other turtles returned for multiple documented activities. One turtle had eight activities, the highest number of activities for an individual during the season. The three PIT tag scanners we tested included an AVID Power Tracker, a Biomark HPR Lite, and a Biomark Pocket Scanner. The AVID Power Tracker has been used consistently in the past on the project, while we were testing the HPR Lite and the Pocket Reader. All of the turtles encountered during the 2018 nesting season were tagged with, or already had, AVID tags. Of the 38 turtles encountered this season, 22 were scanned with the three different scanners. An important consideration when choosing a scanner is its ability to read tags reliably. The HPR Lite and the AVID Power Tracker were able to read all of the tags successfully. The Pocket Reader was successful in reading all but 2.22% of the tags. Another consideration when choosing a scanner is its size, weight, battery life, and cost. The AVID Power Tracker reliably read the tags; however, it is bulky and a bit heavier than the other two scanners. During the season, the AVID Power Tracker had minor problems with battery life, when it sometimes failed unexpectedly. The Pocket Reader and the HPR Lite had longer battery lives. The most economical scanner is the Biomark Pocket Reader at $550; the HPR Lite costs $800, while the AVID Power Tracker costs significantly more. Based on our observations, the Pocket Reader seems to be the best all-round choice for the project, although we recommend scanning all new turtles (neophytes) with multiple scanners.

20-YEAR ASSESSMENT OF MARINE TURTLE NESTING ECOLOGY ON BIOKO ISLAND, EQUATORIAL GUINEA*

Bryan Featherstone[1,2], Dana Venditti[1,2], Juan Cruz Ondo Nze[2], Francisco Mitogo Micha[2], Heidi Rader[1,2], Gail Hearn[1,2], and Mary Katherine Gonder[1,2]

[1]*Drexel University, Philadelphia, PA, USA*
[2]*Bioko Biodiversity Protection Program, Malabo, Equatorial Guinea*

Four species of marine turtles are known to nest on the 19 km of beaches along the southern shores of Bioko Island contained within the Gran Caldera Scientific Reserve (GCSR) in Equatorial Guinea (leatherback, *Dermochelys coriacea*; green, *Chelonia mydas*; olive ridley, *Lepidochelys olivacea*; and hawksbill, *Eretmochelys imbricata*). For 20 years (1998-present) the Bioko Biodiversity Protection Program (BBPP), has recorded nesting marine turtle activity on these beaches in partnership with the National University of Equatorial Guinea (UNGE), the National Institute of Forest Development and Management of Protected Areas (INDEFOR-AP), and Drexel University. Data recorded annually spans the entirety of the nesting season from October through March. After a decline in nesting marine turtle activity in 2008, nesting populations have stabilized during the past 10 years for the two most common nesting species: green and leatherback marine turtles. Over the past 4 years, small fluctuations in nesting activity have occurred with the number of encounters fluctuating from approximately 500 to 3,000. In fact, after stabilizing, green turtle nesting activity has actually increased over the past four years. The number of encounters reached almost 4,000 in the 2017-2018 nesting period, up from approximately 1,500 in the previous season and an average of approximately 1,400 over the past decade. Despite stronger law enforcement resulting from collaboration between BBPP and INDEFOR-AP, illegal take of adult nesting female turtles continues. Development within the village of Ureca, the only village fully contained within the GCSR, and completion of a paved road extending directly to the nesting beaches has allowed unregulated access and development. The BBPP continues to document the increase in these incidences, as well as facilitate the education of both visitors to the GCSR and local guides participating in the exceedingly successful ecotourism entrepreneurial program. In particular, a recent collaboration with the SMART (Spatial Monitoring and Reporting Tool) Partnership has allowed INDEFOR-AP and BBPP biomonitoring teams to assess activities of marine turtle poachers on Bioko's southern beaches and more accurately pinpoint areas in need of increased conservation activities. All research and conservation efforts are made possible with the generous funding provided by the United States Fish and Wildlife Service and support given through UNGE and Drexel.

CHARACTERIZING THE TYPE AND FREQUENCY OF NEST INFESTATION FOR GREEN SEA TURTLE (*CHELONIA MYDAS*) IN TORTUGUERO, COSTA RICA

Maria Gabriela Sandoval Ferrer[1,2], Jaime Restrepo[2], James Hannon[2], and Roldán A. Valverde[2,3]

[1]*Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela, Maracaibo, Venezuela de Ecología General, Centro de Modelado Científico (CMC), La Universidad del Zulia (LUZ), Maracaibo, Venezuela*
[2]*Sea Turtle Conservancy*
[3]*Southeastern Lousiana University, Hammond, LA, USA*

Green sea turtles have rapidly become a subject of scientific research due to their status as an endangered species and the growing global public awareness of their plight, thanks to various conservation programs around the world. However, in order to continue the success of current conservation strategies, it is

necessary to understand the entirety of their life histories, including that of early embryonic development during the nest incubation period. This highlights the need for more detailed research of the factors affecting this vital life stage. It is known that throughout the incubation period, both eggs and hatchlings are vulnerable to various anthropogenic threats and natural predators. At Tortuguero beach, sea turtle nests can be externally disturbed by dogs, armadillos, and raccoons, while internal disturbance and infestation from crabs, ants, maggots, fungus, and bacteria have been documented. Previous studies have highlighted the information gap surrounding internal nest infestation and disturbance. However, at current, a detailed description of the type and rate of internal nest disturbance and infestation, under natural conditions, is unknown for green sea turtles. Tortuguero, Costa Rica, provides the second largest nesting populations of green sea turtles in the world. Therefore, understanding its nesting dynamic provides invaluable information on the potential implications of the global conservation status and regional management of this species. The aim of this study is, therefore, begin to identify the main types and rates of internal nest infestation and disturbance for *C. mydas* in Tortuguero National Park, Costa Rica.We marked and kept track of 240 nests during the 2018 nesting season, to the date 59 nests have been exhumed, on each excavation, we documented the type and rate of infestation present in each clutch. Preliminary results have begun to highlight the main infesters including crabs and maggots as the most frequent ones and the rate of infestation; however, a completion of the entire season is necessary before conclusions can be drawn.

SYNCHRONOUS HATCHING OF LOGGERHEAD SEA TURTLE EMBRYOS

Angela Field[1] and Jessica McGlashan[2]

[1]*Florida Atlantic University, Boca Raton, FL, USA*
[2]*Western Sydney University, Richmond, New South Wales, Australia*

For reptiles, incubation temperature influences embryonic development including metabolic rate, incubation period, and is also important for sex determination in some species. For developing turtle embryos, warmer incubation temperatures accelerate embryogenesis and reduce incubation periods and conversely for cooler temperatures. Egg position and thermal gradients in a nest have the potential to alter developmental rates of embryos and cause asynchronous hatching times. Despite the difference in incubation temperature, synchronous hatching still occurs in many freshwater turtle nests as a result of embryos hatching early, or through metabolic compensation. Synchronous hatching is likely facilitated through embryo-embryo communication. To date there is no recorded information of how sea turtle embryos coordinate hatching behavior. The purpose of our study was to determine if the phenomenon of synchronous hatching occurs in loggerhead sea turtle (*Caretta caretta*) embryos. Sea turtle nests are deep in the sand and result in more constant temperatures throughout the nest compared to freshwater turtles. However, during development, sea turtle embryos produce metabolic heat giving potential for temperature differences throughout the nest. There have been no studies that document the effect metabolic heating that may result in varying incubation rates of clutch mates and therefore lead to asynchronous hatching. We hypothesize that the eggs at the center of the nest will experience warmer incubation temperatures due to metabolic heating compared to eggs at the periphery of the nest. Loggerhead nests collected the morning after deposition from Boca Raton Beach during late July of 2018. We created asynchronous clutch environments by incubating half of a clutch at (32ºC) and the other half at (28ºC) for a period of one week. After one week, the clutch mates were reunited to complete incubation together at the same temperature (28ºC). Incubation period was determined as the time from oviposition to pipping, the first sign of hatching. Once fully emerged from their eggs, morphometric measurements were taken to determine if there were any differences between treatment groups. We found that there were no significant differences in incubation period or hatchling size within asynchronous clutches and between treatment and controls, indicating that

synchronous hatching occurred despite the difference in initial incubation temperature. The behavior of synchronous hatching increases survivorship through enabling synchronous emergence and predator swamping and likely occurs in many species as a result of embryo-embryo communication.

EVALUATING REPRODUCTIVE SENESCENCE IN FEMALE CARIBBEAN HAWKSBILL SEA TURTLES

Alexandra L. Fireman[1,2], Ryan Woodland[1], and Seth P. Stapleton[2,3]

[1]University of Maryland Center for Environmental Science Chesapeake Biological Laboratory, MD, USA
[2]Jumby Bay Hawksbill Project, Long Island, Antigua, West Indies
[3]Dept of Fisheries, Wildlife and Conservation Biology, University of Minnesota, St. Paul, MN, USA

Monitoring sea turtles on nesting beaches is a widely implemented method for studying their reproductive ecology. However, long-term reproductive output and the effects of senescence on sea turtle reproduction are poorly understood. The critically endangered hawksbill sea turtle (*Eretmochelys imbricata*) may provide a unique opportunity to study senescence in marine turtles given their extreme natal homing to nesting beaches. The Jumby Bay Hawksbill Project has monitored a primary nesting beach on Long Island, Antigua, West Indies since 1987 using saturation-tagging methods. These protocols have facilitated collection of individual fecundity data for hundreds of nesting hawksbills. We hypothesized that reproductive tradeoffs may be observable in nesting behavior, with certain age-classes prioritizing a different fecundity metric. To test this, we will analyze nesting data collected from 1992 to 2017 (25 years). We will quantify the reproductive output of females at varying ages using a multiple regression approach to assess the relationship of fecundity metrics (remigration interval and number of clutches per year) with the estimated age of each individual turtle. Preliminary analyses suggest that older turtles have longer remigration intervals but average more clutches per season. This may indicate that sea turtles experience tradeoffs in these reproductive metrics over time. The relationship between age (or reproductive experience) and individual output is not well understood in marine turtles, and this analysis directly addresses that knowledge gap. Understanding how sea turtles of varying age contribute to depleted populations is essential for creating and implementing effective conservation plans to best promote their recovery.

EFFECTS OF IN SITU INCUBATION TEMPERATURES ON HATCHLING LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) MORPHOLOGY, HEALTH INDICES, AND LOCOMOTOR PERFORMANCE

Kelsey A. Fleming[1], Justin R. Perrault[2], Nicole I. Stacy[3], Christina M. Coppenrath[2], and Alison Gainsbury[1]

[1]University of South Florida St. Petersburg, St. Petersburg, FL, US
[2]Loggerhead Marinelife Center, Juno Beach, FL, USA
[3]Department of Comparative, Diagnostic, and Population Medicine, College of Veterinary Medicine, University of Florida, Gainesville, FL, US

Egg incubation temperatures, in addition to an embryo's genetic makeup, have several effects on developing sea turtle embryos, including altered metabolism, immune function, hatching success, incubation length, and locomotor performance. Earth's atmospheric temperature is expected to reach an

increase of 1.5°C between 2030 and 2052 at the current rate, likely impacting embryonic development in sea turtles, and thus influencing their phenotypic responses ultimately leading to the ability of sea turtle populations to reproduce and survive. Several studies examined the effects of "high" and "low" incubation temperatures on sea turtle hatchlings; however, the majority of these studies on hatchling size, locomotor performance, and behavior were conducted on laboratory-reared, relocated nests exposed to constant incubation temperatures, which is inconsistent with temperature variations in their natural nest environment. The Northwest Atlantic subpopulation of loggerheads is the largest nesting population in the Western Hemisphere with approximately 87% of its nesting effort occurring on the peninsular region of Florida. Because of the high number of nesting turtles in this area, and the prospect that these beaches will likely be impacted by climate change, this area is of essential conservation importance. With this study, we examined the impacts of naturally varying in situ incubation temperatures on loggerhead sea turtle hatchling morphology, health indices, and locomotor performance. Data loggers were placed in the middle of each of 15 clutches laid in May, June, and July on Juno Beach, Florida, to record temperature every half hour for the duration of incubation. In total, we collected, weighed, measured, and sampled 144 hatchlings. Seven morphological traits were recorded and scute abnormalities were noted. We then quantified a number of health indices (glucose, hemoglobin, total solids, packed cell volume, and leukogram). Finally, we performed a righting response test in sea water. These nests were excavated after hatching to calculate hatching success and to determine stage of development for those that were found unhatched. Mean incubation temperature ranged from 29.80 ± 0.09°C in May to 33.20 ± 0.17°C in July. The maximum temperature experienced by a nest for 3 consecutive days averaged to 34.60 ± 0.39°C for May, 34.70 ± 1.30°C for June, and 35.30 ± 0.30°C for July. The number of individuals with abnormal scutes were significantly higher in warmer nests. Six hatchlings in May, nine hatchlings in June, and 27 hatchlings in July had abnormal scute patterns. We used a non-parametric Kruskal-Wallis to test for the effects of temperature on morphological traits, health indices, and righting response and identified several significant differences. We found that hatchlings from warmer nests had significantly greater body depth and larger umbilicus widths and lengths. Hatchlings from cooler nests had significantly higher straight carapace lengths and widths, front flipper lengths, and heart rates. Hemoglobin, packed cell volume, total solids, and absolute heterophils, immature heterophils, monocytes, and basophils were significantly higher in hatchlings from warmer nests, suggesting altered hemodynamic balance and potential inflammation. Righting time was also significantly longer in warmer nests. This is the first study to establish baselines for health indices in hatchling loggerheads with concurrent morphology and locomotor evaluation in relation to nest temperatures. The results of this study are crucial in understanding negative effects from increased incubation temperatures on hatchling physiology and development, leading to increased vulnerability to disease and reduced survival. In addition, higher incubation temperatures resulting in smaller body size and slower righting time could potentially decrease the ability to make it to, and survive in, the open ocean. This study demonstrates the anticipated increase in sand temperature due to climate change has the potential to impact hatchling fitness and survival.

FIRST KEMP'S RIDLEY SEA TURTLE (*LEPIDOCHELYS KEMPII*) NEST DOCUMENTED IN NEW YORK, USA

Patricia S. Rafferty[1], Donna J. Shaver[2], Hilary R. Frandsen[2], and Maxine Montello[3]

[1]*National Park Service, Gateway National Recreation Area, Staten Island, NY, USA*
[2]*National Park Service, Padre Island National Seashore, Corpus Christi, TX, USA*
[3]*Riverhead Foundation for Marine Research and Preservation, Riverhead, NY, USA*

We report the first confirmed record of a Kemp's ridley turtle (*Lepidochelys kempii*) nest in New York State. On 12 July 2018, park visitors observed and photographed a sea turtle crawling towards the dunes and excavating a nest chamber on West Beach, on the Rockaway Peninsula, within Gateway National Recreation Area (GATE). Egg deposition was not observed. Biologists were not on scene to verify species of the nesting turtle, but the authors later identified species by examining photographs taken by the citizens that observed the turtle. *L. kempii* nest primarily along the Western Gulf of Mexico Coast in Mexico. In the U.S., nesting is concentrated in Texas. Some nesting also occurs annually in Florida and occasionally on the beaches of other U.S. Gulf and Atlantic states. Prior to this record, the northernmost *L. kempii* nest was documented in Virginia. GATE National Park Service (NPS) staff protected the estimated nest location with a wire cage enclosure, string fencing, and signage. Trail cameras were installed at the site. Biologists from Padre Island National Seashore, Gulf Island National Seashore, Long Island United States Fish and Wildlife Service (USFWS) Field Office, New York State Department of Environmental Conservation (NYSDEC), and the Riverhead Foundation for Marine Research and Preservation (RFMRP) provided technical expertise and/or equipment for monitoring and protection of the nest and hatchlings. On 10 September 2018, the 60th day of in situ incubation, GATE NPS staff documented that the nest had been inundated by high tides. Due to the threat of continued high tides predicted to be produced by Hurricane Florence, the nest was excavated by GATE NPS staff to recover any viable eggs and to release any hatchlings. Egg retrieval occurred after the thermo-sensitive period for sex determination during the middle third of incubation had already occurred. Of 116 deposited eggs, 110 viable eggs were recovered and incubated in polystyrene foam boxes filled with clean sand. Between 25 and 28 September 2018, 96 hatchlings that emerged from these eggs were released at the West Beach nest site. Species was confirmed by examination of hatchlings. Unhatched eggs were collected for on-going genetic and temperature-dependent sex determination studies. This nest represents a significant northward expansion of the nesting range for the species. Due to the length of the incubation period, it is likely that the hatchlings produced from this nest were male. Kemp's ridley nesting has been documented at multiple NPS units and the habitat preserved by the NPS may become increasingly important for the conservation of this species over time, as climate change impacts continue.

COLOR PREFERENCES OF *ERETMOCHELYS IMBRICATA* HATCHLINGS*

Robert Gammariello, Jr.[1,2], Cindy Gerke[2], Lidia Salinas[3], and Stephen G. Dunbar[1,2,3]

[1]*Marine Research Group, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, CA, USA*
[2]*Protective Turtle Ecology Center for Training, Outreach, and Research, Inc. (ProTECTOR, Inc.), Loma Linda, CA, USA*
[3]*Protective Turtle Ecology Center for Training, Outreach, and Research, Honduras (ProTECTOR - Honduras), Tegucigalpa, Honduras*

The hawksbill sea turtle (*Eretmochelys imbricata*) is a critically endangered species of sea turtle with a unique ecological niche. Despite joint efforts of nations worldwide, populations of E. imbricata continue to decline. One factor contributing to their decline is continuing coastal development and light pollution, the latter of which disorients hatchlings, preventing them from reaching the ocean. Previous research on loggerhead (*Caretta caretta*) and green sea turtles (*Chelonia mydas*) has indicated that hatchlings least prefer red light and will orient toward other light sources more readily than to red light. However, this finding has not been tested in other species. If E. imbricata hatchlings do not exhibit the same color preferences as *C. caretta* and *C. mydas*, new lighting procedures may be needed on *E. imbricata* nesting beaches to ensure proper hatchling orientation behavior. This study aimed to determine if *E. imbricata* hatchlings exhibit the same color preferences as *C. caretta* and *C. mydas* hatchlings. Hatchlings were obtained immediately after hatching on Wilmont Bay, Guanaja, Honduras and were kept in a cool, dark room. All experiments were conducted between the hours of 1900 and 0300, when hatchlings typically emerge, and were carried out in a dark room to ensure no interference from other light sources. The 1 m long Y-maze experimental chamber was constructed of 10.2 cm PVC, with the top 2.5 cm removed to view and record video of hatchling movements. The inside of the maze was painted black in order to ensure a uniform stimulus and filled with 2 cm of hatchling natal beach sand for a natural substrate to move across. In order to isolate light as the treatment variable, the experimental chamber was kept on level ground and the orientation of the maze was changed for each trial, ensuring that geomagnetic fields were not a confounding variable. The left-right position of the colored light was also alternated in between trials to control for possible handedness. Hawksbill hatchlings were given a choice between two colors of light (either white, red, or blue) at either end of the two branches in the Y-maze in order to discern their color preference. Due to low nesting numbers, only two nests were included in this study, with 27 haphazardly chosen individuals between the two nests. Hatchlings were tested once without replacement before being released en masse by 0300 hours. Initial results are similar to those for *C. caretta* and *C. mydas*, indicating that *E. imbricata* hatchlings also least prefer red light. All hatchlings tested oriented to blue light over red light (P-value = 0.012). Similarly, all hatchlings tested oriented to white light over red light (P-value = 0.0022). The current red wavelength measures in place for the protection of emerging hatchlings are therefore supported by initial findings of this study. We suggest that urban development close to hawksbill nesting beaches should use red lights during the nesting season in order to minimize hatchling disorientation and mortality.

ESCUDO DE VERAGUAS, HAWKSBILL (ERETMOCHELYS IMBRICATA) NATURAL REFUGE*

Raul García, Roldán A. Valverde, Guillermo Lopez, and Cristina Ordoñez

Sea Turtle Conservancy, Bocas del Toro, Panama

The Sea Turtle Conservancy (STC) was established in Panama in 2003. Since its foundation, the STC has been working in different Caribbean beaches, including a small island called Escudo de Veraguas, which is a 3Km2 island located approximately 20 miles off Chiriquí beach. This island is an important natural refuge that hosts endemic species like the pygmy three-toed sloth (*Bradypus pygmaeus*) and the Green hummingbird (*Amazilia handleyi*), among others. According to data collected in the last three years by the STC, Escudo is one of the nesting sites with greatest number of hawksbill nests on the Caribbean coast of Panama. Due to the characteristics of this island, there are only a few threats for sea turtle egg survival in this beach. Erosion is one of the natural threats to this area and it is a result of adverse storms than can affect nests success. Also, Escudo is a remote island far away from civilization and with difficult access during the most part of the year, which makes the nests in this area less vulnerable to anthropological threats. More than 500 nests per season were counted the lasts three years during the track surveys carried out in the island. After the incubation period, hatching and emergence successes were calculated to estimate hatchling productivity in the island. The preliminary results for the last three years for hawksbill nests show an average hatching and emergence success of around the 73% and 65%, respectively. According to these data, an estimated 100,000 hawksbill hatchlings were produced in those three years. These data reflect the biological importance of Escudo as a nesting beach; however, the category of protection of this island is the lowest in Panama (Landscape Reserve). In the last years Escudo has become more inhabited, the number of buildings around the island has been increasing, as well as the number of people living there and their pets, mainly dogs. Dogs could be a serious threat for nest survival if it is not controlled. Tourism is also increasing in the island and there are more frequent cases in which people camp and make bonfires on top of the nests without even knowing that they are in a nesting area. Garbage is another problem that is present in Escudo and is getting worst every year. The aim of this conservation program is to highlight the importance of Panama's Caribbean as a hawksbill nesting site and also to propose possible conservation strategies to regulate the activities held in Escudo to conserve sea turtle's population and their habitat. In the short term, conservation strategies should begin by raising awareness to protect sea turtles and approach different stakeholders, like residents and tourists who visit or live in the island. In the long term, some of the beaches should have restricted access due to the high number of nests reported (more than 40 nests in beaches with 35m long) and in the best scenario, increasing the protection category of the area.

CHELONIAN VS. PREDATOR: USING BIOSTATISTICAL AND GIS ANALYSES TO DEVELOP A RESEARCH-BASED PREDATOR CONTROL PROGRAM FOR AN ISLAND WHOSE NESTING BEACHES ARE UNDER ATTACK*

Jaynie L. Gaskin[1], Robert Kelly Vance[1], Tara Lopez[2], and Christine Hladik[1]

[1]*Georgia Southern University, Statesboro, GA, USA*
[2]*GSU Sea Turtle Program, St. Catherines Island, GA, USA*

St. Catherines Island, located ~ 42 km south of Savannah on the coast of Georgia, USA has 19 km of loggerhead sea turtle (*Caretta caretta*) nesting habitat monitored from 1989 to the present by a program operated through Georgia Southern University. In 2016 and 2017, St. Catherines Island suffered the highest rate of sea turtle nest predation on the Georgia coast. The number of nests lost to feral hogs (*Sus scrofa*) and raccoons (*Procyon lotor*) more than doubled from 2015 to 2016. During 2017, a total of 126 sea turtle nests were affected and over 60% of nests were completely lost to predators. Sea turtle conservation efforts on St. Catherines Island must evolve to include an aggressive, continuous predator control program. The ultimate goal of this project is to develop a predator control program based on biostatistical and spatial analyses of environmental and nesting variables, and predation. Predation events on St. Catherines Island from 1999-2017 were analyzed using biostatistical and GIS techniques. In ArcGIS, Kernel Density, Optimized HotSpot, and Cluster/Outlier analyses identified high-density areas of nesting and predation. Maps were used to select locations for enhanced nest protection mechanisms and focused predator elimination efforts. The Average Nearest Neighbor and High/Low Clustering analyses determined statistical significance. In SPSS, demographic and frequency analyses identified associations among variables. Results were used to assess effectiveness of predator control mechanisms. Odds ratios and 95% confidence intervals were calculated to investigate all associations. Analysis of data produced statistically significant results used to design, implement, and evaluate a research-based predator control program. This research improved sea turtle conservation efforts on St. Catherines Island, and these methods will be employed to fight future nest predation. This study illustrates the application of biostatistical and spatial analysis in conservation and these results may be relevant to nesting beaches worldwide.

CAN YOU HANDLE THE HEAT? DOES MOISTURE DURING INCUBATION INFLUENCE HEAT TOLERANCE OF EMERGING HATCHLINGS?*

Christopher Gatto[1], Bill Matthews[1], Jeanette Wyneken[2], and Richard Reina[1]

[1]*Monash University, Melbourne, Victoria, Australia*
[2]*Florida Atlantic University, Boca Raton, FL, USA*

Incubation environment can have significant effects on embryonic development in sea turtles. The majority of research has focused on warmer nest temperatures increasing female production. Many studies suggest that increased female production may lead to sea turtle population decline globally. However, recent studies suggest that higher embryonic and hatchling mortality may have a larger effect on population viability than increased feminisation. Examples of mass hatchling mortality as a result of overheating are becoming more and more common. Despite this threat, we know little about what influences hatchling tolerance of extreme temperatures. It is possible that incubation environment influences hatchling heat tolerance post-hatching. Therefore, we incubated eggs at high and low moisture in order to determine how moisture content in sea turtle nests influences hatchling hydration levels and to determine how hydration levels impact hatchling thermal tolerance. Higher sand moisture concentrations during incubation increase differences in water potential between eggs and sand, altering water exchange rates. Higher moisture concentrations increase the intake of water into eggs and could potentially result in hatchlings with higher water content. These hatchlings may be able to tolerate higher temperatures because of their higher water contents. To test this, we collected blood samples from emerging green turtle hatchlings and determined packed cell volume as well as total protein concentrations as indicators of hatchling hydration. We then determined hatchling critical thermal maximum by observing hatchling crawling behaviour at various body temperatures. Data analysis is underway at the time of writing but hatchlings incubated at higher moisture levels appear to have lower packed cell volumes i.e. are more hydrated. Initial results indicated that hatchlings incubated at higher moistures seem to have a lower tolerance for extreme temperatures. Eggs in this study were incubated in natural nests with moisture concentrations maintained by pouring water onto nests, simulating rain. Therefore, the responses of hatchlings in this study reflect the environmental dynamics that occur in natural nests. This study will provide further insight into the incubation conditions that may maximise hatchling

survival during dispersal. It will also provide insight into how altered climates will affect hatchling thermal tolerance into the future.

EFFECTS OF MATERNAL SATURATION TAGGING ON LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) SITE FIDELITY: A COMPARISON OF SOUTHEASTERN NORTH CAROLINA NESTING BEACHES

Emily Goetz[1], Elizabeth S. Darrow[1], G. Christopher Shank[1], Olivia Bryson[2], Matthew H. Godfrey[3], Jacci Hohnstein[4], Campbell J. Nairn[5], Brian Shamblin[5], and Adam Silva[2]

[1]*Bald Head Island Conservancy, Bald Head Island, NC, USA*
[2]*University of North Carolina, Wilmington, NC, USA*
[3]*North Carolina Wildlife Resources Commission*
[4]*Oak Island Parks and Recreation, Oak Island, NC, USA*
[5]*University of Georgia, Athens, GA, USA*

Bald Head Island (BHI), located in southeastern North Carolina, is considered a critical nesting site for the loggerhead sea turtle (*Caretta caretta*). In 1983, nightly beach patrols of the island were initiated by the Bald Head Island Conservancy (BHI Conservancy). In years since, methods of sea turtle data collection have evolved, notably with the implementation of flipper tagging in 1991, followed by PIT tagging and biopsy skin sample collection in 2002. Beginning in 2010, the BHI Conservancy, along with other nesting beaches in North Carolina, South Carolina, and Georgia, has participated in sea turtle egg collection for DNA analysis by the University of Georgia. Through DNA data collection, individual turtles can be identified, and their nesting patterns mapped, linking their nests across state boundaries in the Southeast, even when physical tag information was not observed. Facilitating one of only two current saturation tagging programs in North Carolina, the BHI Conservancy is uniquely situated to examine the potential impacts of motorized patrol, tagging, and hands-on data collection efforts on sea turtle nesting patterns at northern nesting latitudes. Neighboring sea turtle nesting programs, on beaches such as Oak Island, identify sea turtle nests during morning patrols but do not tag or otherwise interact with nesting turtles. We will compare site fidelity between turtles that have nested on Bald Head Island (where staff aim to tag every observed turtle) and Oak Island (where nesting females are not intentionally encountered), with the objective of assessing the influence of hands-on saturation tagging projects on nesting patterns. Site fidelity will be assessed by analyzing genetic data of all nesting turtles on Bald Head Island and Oak Island between 2010 and 2017. Nesting locations of individual turtles, both within each nesting season as well as over multiple nesting years, will be analyzed for historical patterns using a runs test for randomness, and any non-random patterns will be assessed for correlation to changes in turtle protection methods, including tagging efforts. Patterns in site fidelity for both assumed neophytes and experienced nesters will be discussed for both beaches, with the goal of assessing how a turtle's first nesting experience may impact their nesting behavior in future seasons. All analyses will be conducted with the objective of better understanding how hands-on sea turtle management and monitoring efforts may impact or impede nesting efforts.

THE EFFECT OF HIGH NEST TEMPERATURES ON THE GROWTH RATES OF LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) EMBRYOS AND HATCHLINGS

Kaitlin Grell and Sarah Milton

Florida Atlantic University, Boca Raton, FL, USA

All seven species of sea turtle are listed as either endangered or vulnerable on the IUCN Red List. One factor affecting sea turtle vulnerability is global climate change; due to climate change, temperatures have been increasing with each passing year. This is detrimental to sea turtle nests as temperature influences sea turtle embryonic development: besides sex determination, temperature affects the length of the incubation period, hatchling body size, and hatchling locomotor performance. Previous studies have shown that embryos that develop at warmer nest temperatures with shorter incubation periods become smaller, less vigorous hatchlings compared to those that develop at cooler temperatures. However, it is not known if some stages of development are more vulnerable to high temperatures than others. Here we compared embryonic growth rates across developmental stages at cooler and warmer incubation temperatures for loggerhead sea turtle nests laid on the Boca Raton, Florida beach to determine if warmer temperatures reduce growth rate at a specific stage of development compared to cooler temperatures, since temperature could differentially affect initial growth, organogenesis, or the later growth stages of development. HOBO temperature dataloggers were placed in each nest within 12h of deposition, and nest temperatures recorded at 15 min intervals throughout the incubation period. Upon emergence, nests were excavated and the dataloggers removed. Unhatched eggs were collected, and each embryo was staged according to Miller's development Field Key. Once each embryo was staged, they were individually photographed. The carapace length of each embryo was then measured using a digital millimeter scale and analyzed alongside temperature data. Measurements were also taken from a sample of 20 newly hatched hatchling from each analyzed nest upon excavation (hatchling data collected as part of J. Wyneken study). Embryo and hatchling measurements and their corresponding incubation period and temperatures were analyzed to find any correlation between growth rate, stage of development, and temperature. Data recorded from the 2017 nesting season in Boca Raton showed mean incubation temperatures ranging from 30.8°C – 33.61°C, with a maximum temperature of 35.96°C. The mean incubation temperature of early/mid-season nests ranged from 30.8°C – 31.58°C and resulted in a hatchling mean straight carapace length (SCL) of 43.37mm. The mean incubation temperature of late-season nests ranged from 32.08°C – 33.61°C and resulted in hatchlings with an SCL of 41.64mm. This study will further elucidate what effect climate change may have on embryonic development.

AN ASSESSMENT OF SEA TURTLE NESTING TRENDS IN RELATION TO BEACH PRESERVATION PROJECTS IN MIAMI-DADE COUNTY, FLORIDA

Leanne Hauptman[1], L. Teal Kawana[2], Keene Haywood[1], and Maria Estevanez[1]

[1]University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, FL, USA
[2]Miami-Dade County Sea Turtle Conservation Program, Miami, FL, USA

The beaches of Miami-Dade County, Florida are a prevalent nesting site for loggerhead and green sea turtles, however, extensive beach erosion is threatening these critical sea turtle nesting habitats. Beach nourishment projects occur along the beaches of Miami-Dade County to aid in the loss of shorelines. The

projects are completed by transporting offshore or upland sediment onshore. This research examines how loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) sea turtle nesting behaviors relate to monitored project areas within Miami-Dade County. Long term data on nesting response in project areas are essential but studies are scarce. This study aims to correlate different aspects of nesting behavior and nesting frequency in project areas vs non-project areas in Miami-Dade County for the 2017 nesting season. The loggerhead sea turtle and green sea turtle nesting and non-nesting emergence data was obtained from the Miami-Dade County Sea Turtle Conservation Program through work under a Florida Fish and Wildlife Conservation Commission (FWC) marine turtle permit. Nest locations throughout the County were assessed using a Geographic Information System (GIS) geodatabase, to determine if there is a significant difference between the frequency of nesting in project areas compared to the frequency of nesting outside of project areas. The same was completed for non-nesting emergences inside and outside project areas. Nesting success rates in Miami-Dade County were evaluated to find if there is any significant relationship inside and outside project areas. Distances from mean high water (MHW) and distances from dune for each sea turtle emergence were evaluated in order to determine if there are particular ranges of distance with higher occurrence for nests vs non-nesting attempts. Research was also conducted on final digging activity on non-nesting emergences to evaluate for any significant differences between project areas and non-project areas. The results of nesting trends in relation to beach preservation will be presented but are currently being analyzed. Miami-Dade County has never mapped nor researched how sea turtle nesting behaviors respond to project areas, thus making this study a vital component for future studies and conservation efforts.

INCUBATION TEMPERATURE EFFECTS ON LOGGERHEAD (*CARETTA CARETTA*) SEA TURTLE HATCHLING VIGOR*

Chris Henaghan and Sarah Milton

Florida Atlantic University, Boca Raton, FL, USA

Climate change temperature increases will result in higher incubation temperatures; this could lead to thermal stress and decreased vigor in sea turtle hatchlings. This study aimed to quantify temperature-induced differences in performance and examine the potential underlying physiological mechanisms responsible for decreased vigor in loggerhead turtle hatchlings in South Florida. HOBO-U22 temperature probes recorded 2017 nest temperatures on the Boca Raton, FL beach in 9 loggerhead turtle nests at 15min intervals throughout the incubation period. Upon emergence, hatchlings were tested for righting response times, crawling and swimming speed, and swim endurance. Blood was collected from experimental and control hatchlings to quantify corticosterone levels, as differences in stress hormones resulting from increased temperatures may be an underlying mechanism altering hatchling performance. Data were considered statistically significant for $p<0.05$. Nest temperatures ranged from 30.8°C to 33.6°C. The mean temperature in early season nests (laid 5/4 to 6/6) was 31.3°C; hatchlings from these nests had a mean righting score of 4.1 (on a scale of 0-6) and crawled down a 2m ramp at a mean velocity of .054m/s. Hatchlings that incubated later in the season (laid 6/23 to 7/21) had average nest temperatures of 33.18°C, with significantly lower righting scores of 3.2 and crawl speeds of .03m/s. When mean nest incubation temperatures were grouped (30-31°C, 31-32°C, 32-33°C, and 33-34°C) a significant decline in crawling speed and righting response was found in nests incubated at 33-34°C. Further investigation into maximum incubation temperatures revealed that crawling speed significantly declined once nest temperatures rose above 35 or 36°C. Thus, incubation temperatures were negatively correlated with hatchling performance. Blood corticosterone levels were also significantly affected by incubation temperature. Corticosterone levels ranged from 10.56-552.95pg/ml and were found to be significantly greater in hatchlings from cooler nests (30-31°C). Corticosterone levels were also negatively correlated

with the maximum temperatures measured for each nest. A significant decline in corticosterone levels was seen when the maximum incubation temperature rose above 35°C, 35.5°C, or 36°C or mean nest temperatures were over 34°C during the late developmental stages (stages 27-31). The largest significant temperature difference during incubation was seen in one nest with a mean temperature of only 31.46°C, but which experienced mean temperatures of 30.1, 30.2, then 34.2°C during early, middle and late development. Corticosterone levels were only one third those measured with similar mean nest temperatures, but which did not rise above 34°C. This suggests that temperature during the late stages of development may play a critical role in the decline of corticosterone levels. Crawling speed was the only performance measurement found to be significantly positively correlated with corticosterone levels. These results support previous studies on sea turtle hatchlings, with incubation temperature affecting hatching success, righting response, and crawling speed, with hatchlings incubated above 32°C showing decreased vigor. The correlations between corticosterone levels, nest incubation temperatures, and hatchling performance improves our understanding of the underlying physiological mechanisms linking elevated incubation temperatures and sub-lethal physiological effects that may significantly impact hatchling survival in south Florida and elsewhere.

IMPACTS OF A GEOTEXTILE DUNE CORE PROJECT ON SAND CHARACTERISTICS AND SEA TURTLE REPRODUCTIVE SUCCESS

Sarah E. Hirsch, Kimberly S. Rigano, Katelyn M. Fraser, Derek Aoki, Emily Kelly, Gabriella Carvajal, Gabriella LeFevre, Heather Seaman, Kylie Ariotti, Laura Wenk, and Justin R. Perrault

Loggerhead Marinelife Center, Juno Beach, FL, USA

Coastal squeeze, the combined pressures of sea level rise and coastal development, threatens the loss of sea turtle nesting habitat around the world. Florida USA is home to a number of globally important nesting grounds for loggerhead turtles and regionally important nesting grounds for green turtles. Many of these nesting beaches are classified as critically eroding habitat. Geocores are large sand filled geotextile containers buried at the base of the dune and are used to protect homes from the encroaching shoreline, yet little is known about their impacts on sea turtles. A previous analysis of one such structure installed in Juno Beach, Florida suggested that the geocore did not lower loggerhead or green turtle nesting success, although loggerheads were more likely to false crawl when they came within five meters of the engineered dune. That study found no significant differences in the hatching and emergence success of nests laid at the geocore site but, the sample size was limited, washouts were not analyzed, and there was no analysis on how characteristics of the engineered dune may have influenced those parameters. This study expands on the previous one, evaluating sand characteristics of the geocore's reconstructed dune and how these parameters influence hatching success of loggerhead nests. Sand samples were obtained from the bottom of the egg chamber (at time of excavation) for nests at the geocore site as well as a control site located just to the south. Additionally, representative sand samples were collected at three high, mid, and low beach locations at a depth of 45cm (typical loggerhead nest depth) at each site. Hatching success was calculated for each of the sampled nests. The representative sand samples revealed that the sand used to reconstruct the dune ranged in color from brown to grayish brown, had a mean moisture content of 3.38±0.61%, and a mean grain size of 0.81±0.12mm. The high beach samples from the control site ranged in color from brown to grayish brown, had a mean moisture content of 3.88±0.25%, and a mean grain size of 0.88±0.12mm. At both the geocore and control sites, samples obtained from the mid and low beach ranged in color from dark grayish brown to dark gray. Moisture content and grain size increased closer to the waterline for both sites. Preliminary results indicate that the sand from the nests laid at the geocore site had a mean moisture content of 4.23±2.52% and a mean grain size of 0.87±0.15mm. Nests at the control site had a mean moisture content of 4.30±0.81% and a mean grain size of 0.90±0.15mm. Using a student's t-test, there were no significant differences found in moisture content or grain size between nests laid at the control versus the geocore site ($P > 0.05$). This is likely due to the fact that the vast majority of nests laid at the geocore site were located on the open beach, seaward of the engineered dune. When excluding washed out nests, hatching success was 67.68±17.08% at the geocore site and 34.36±31.68% at the control site. When including washed out nests, hatching success dropped to 38.25±36.23% at the geocore site but, was still significantly higher than at the control site (29.31±31.69%, $P = 0.014$). Our results continue to suggest that the geocore minimally impacts sea turtles. We will continue to monitor the area in subsequent years to improve sample size, especially for green turtles which tend to nest higher on the beach and are therefore more likely to lay their nests on the engineered dune. Additionally, we hope to evaluate carbonate content and nest temperatures for nests laid at the geocore site.

INFLUENCE OF ENVIRONMENTAL AND ANTHROPOGENIC ACOUSTIC CUES IN SEA-FINDING OF HATCHLING LEATHERBACK (*DERMOCHELYS CORIACEA*) SEA TURTLES*

Bethany Holtz[1], Kelly Stewart[2], and Wendy E. D. Piniak[3]

[1]*Department of Environmental Studies, Gettysburg College, Gettysburg, PA, USA*
[2]*The Ocean Foundation, Washington, DC, USA*
[3]*Division of Marine Science and Conservation, Nicholas School of the Environment, Duke University Marine Laboratory, Beaufort, NC, USA*

Increased levels of anthropogenic sound have been linked to behavioral and physiological responses in several marine species, highlighting the need for comparable studies examining the impact of sound on sea turtles. Studies of sea turtle behavioral response to sound have been limited to underwater responses to seismic airguns and explosions. As research on the role of naturally occurring terrestrial environmental sounds have not been fully explored, we examined the response of sea turtle hatchlings to natural and anthropogenic noises present on their nesting beaches. While light has been identified as the primary orientation cue used by hatchling sea turtles emerging from the nest, auditory stimuli has the potential to serve as a secondary cue in sea-finding. We measured the behavioral responses of hatchling leatherback sea turtles, *Dermochelys coriacea*, collected from the nesting beach in the Sandy Point National Wildlife Refuge, St. Croix in the presence of recorded beach surf sounds, vehicle traffic, and human conversation. Hatchling leatherbacks are able to detect aerial acoustic sounds between 50 and 1600 Hz and are most sensitive to sounds between 50 and 400 Hz. The highest sound energy produced by beach waves occurs at frequencies <1000 Hz and overlaps with the most sensitive hearing range of hatchling leatherbacks. Also falling within this peak hearing range are human conversation (85-650 Hz) and vehicle traffic (60-8000 Hz), which may mask these natural acoustic cues. We placed hatchlings on a level circular platform surrounded by 36 converging bins of equal length within a light-proof tent. The speaker producing the recorded trial sounds was placed outside the light-proof tent and rotated around the arena in relation to compass bearings of North, South, East and West randomly to avoid any directional bias. We recorded trial sounds directly on or the near nesting beach at St. Croix. We mapped the sound field throughout the arena for each trial sound. We placed a single hatchling in the middle of the arena and waited for up to 5 minutes for it to crawl into one of the surrounding bins. We compared the location of the hatchling's chosen bin to the location of the speaker to determine whether the turtle oriented toward or away from the sound source. We examined the phonotaxic behaviors of the hatchlings at three trial sounds (beach wave sounds 70 dB re: 20 μ Pa, vehicle traffic 70 dB re: 20 μ Pa, and human conversation 68 dB re: 20 μ Pa measured at the hatchling start location). Each trial was video recorded using an infra-red camera to analyze the time taken and path traveled by the turtles to the chosen bin. Leatherback hatchlings exposed to sound (anthropogenic or natural) oriented faster (mean travel time: 51.14 seconds) than those exposed to no sound (mean travel time 60.29 seconds) ($p=0.07$). We plan to calculate the proportion of hatchlings that oriented either positively or negatively in relation to the speaker utilizing circular statistics. Additional research is needed to further examine the biological significance of hatchling hearing and address potential impacts of terrestrial anthropogenic sounds.

BEHAVIORAL AND ECOLOGICAL CORRELATES OF REPRODUCTIVE SUCCESS IN FEMALE LOGGERHEADS (*CARETTA CARETTA*)

Shelby R. Hoover[1], David Addison[2], and Michael Salmon[1]

[1]*Florida Atlantic University, Boca Raton, FL, USA*
[2]*Conservancy of Southwest Florida, Naples, FL, USA*

To understand the reproductive structure of a long-lived species like marine turtles, long-term data are required. The majority of long-term studies on marine turtle reproduction focus on nesting numbers to assess the efficacy of conservation and management efforts. Few studies, however, focus on the variation in reproductive performance of individual females, a necessity for understanding the selection pressures that have shaped female reproductive tactics and life history traits. We are using a long-term data set (1973 – present) that describes the nesting activity and behavior of individual loggerheads nesting at Keewaydin island on the West Coast of Florida, U.S.A. These data include information on approximately 2,000 individuals, of which about 550 were seen multiple times over many years. From these data, we will compare and contrast the number of hatchlings, on average, produced by each female as a measure of her reproductive success (RS). These data will be used to establish a baseline distribution of RS for all of the females over all of the years, against which the traits of individual females, observed repeatedly to establish a pattern, can be compared. Individual female reproductive performance will thus be determined in relation to the population as a whole, with more successful females showing distinctly greater RS and less successful females showing distinctly lower RS than the mean for the population as a whole. We will test the hypotheses that more successful individuals will be those that (i) produce larger clutches during any one breeding period, (ii) are more efficient at accumulating energy reserves and thus show shorter intervals between successive breeding periods, (iii) consistently select the "safest" beach zones as nesting sites to maximize hatchling production, and (iv) are older and therefore more experienced individuals. Our approach promises to reveal which of these variables are most strongly associated with enhanced female RS, and thus will be a powerful tool for understanding the evolutionary forces that have shaped life history traits and reproductive strategies of loggerhead females.

HATCHING SUCCESS RATE OF SEA TURTLES AFTER DEPREDATION

Tori Howard, Gustavo Stahelin, Erin E. Seney, and Kate L. Mansfield

University of Central Florida, Marine Turtle Research Group, Orlando, FL, USA

Predation is a natural process in maintaining ecosystem's function and balance. However, high levels of predation may hamper a species' ability to recover and are of particular concern if predator populations are associated with human presence or activity. Given the threat status of all species of sea turtles, high levels of predation can be concerning from a conservation standpoint. Sea turtles have been considered a keystone species by promoting more productive seagrass beds, preventing sponges from outcompeting slow growing corals, as well as providing nutrients to beach dunes in the form of leftover eggshells and unhatched embryos. Adult turtles have very few natural predators and are at low risk of predation. However, sea turtles are slow-growing, and the early life stages are exceptionally vulnerable to predation. Sea turtle clutches are laid as shallow as 30 cm below the surface and can be sought out by a multitude of predators (e.g., raccoons, Procyon lotor; ghost crabs, *Ocypode quadrata*; bobcats, *Lynx rufus*). Once eggs have been dug up by a predator, the remaining eggs may become more easily available to secondary predators (e.g., birds, snakes). We determined the impact of predation on hatching success of sea turtle clutches and compared the results to undisturbed nests. We examined nests of leatherbacks (*Dermochelys coriacea*), loggerheads (*Caretta caretta*), and green turtles (*Chelonia mydas*) laid on the Brevard County portion of the Archie Carr National Wildlife Refuge (ACNWR), Melbourne Beach, Florida, USA, during the 2016-2018 nesting seasons. This section of beach sees a significant percentage of the total United States and Florida's loggerheads and green turtles nesting (20-30%). For leatherbacks, all nests laid in the study area were marked, monitored, and inventoried. For loggerheads and green turtles, a subset of approximately 130 nests were marked for inventory each year. During the study period, 5 leatherback (93 total monitored, 5%), 38 loggerhead (426, 9%), and 25 green turtle nests (417, 6%) were depredated. Raccoons had the largest impact on sea turtle nests with 46% of the nest depredations, while bobcats, ghost crabs, domestic dogs (*Canis lupus familiaris*), fire ants (*Solenopsis* spp.), and other predators were also present in smaller proportions. Nesting sea turtles also played a role in the disturbance of some of the nests; as the study site is densely populated with nests, some were displaced while the female was digging and/or covering her nest. Nesting green turtles accounted for 11% of all nest disturbances. This analysis will provide researchers key insight as to how much of an impact predators have on sea turtle nests on the ACNWR, and how much of a concern predation is when compared to estimates of nests washed out by storms and other known threats. Managers can use this data to improve protection plans on beaches with similar predators during future nesting seasons. Given the importance of the ACNWR to Florida and the north Atlantic loggerhead and green turtle populations, it is crucial to understand the impact of predators on these species as beach development increases and likely facilitates larger populations of new and existing predators.

ORIENTATION OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) AND KEMP'S RIDLEY (*LEPIDOCHELYS KEMPII*) TURTLE HATCHLINGS TO DIFFERENT COLORED LIGHT*

Janeth Guadalupe De la Cruz-Pino[1], Martha Harfush[2], Daniel Hernández-Baltazar[3], Pablo Pacheco-Cabrera[4,5], and Jorge E. Morales-Mávil[1]

[1]*Laboratorio Biología de la Conducta, Instituto de Neuroetología, Universidad Veracruzana, Xalapa, Veracruz, México*
[2]*Centro Mexicano de la Tortuga, CONANP*
[3]*CONACyT-Instituto de Neuroetología, Universidad Veracruzana*
[4]*Laboratorio de Neurofisiología de la Conducta, Instituto de Neuroetología, UV*
[5]*Instituto de Investigaciones Biomédicas, UNAM*

Hatchling sea turtles emerge from their nests and move rapidly towards the ocean, guided by visual stimulus. During their journey to the sea, hatchlings move away from obstacles, such as vegetation or high dunes, and look for open and illuminated horizons. It has been suggested that light is one of the main stimuli used by hatchlings during orientation. In this study, we tested the response of olive ridley (*Lepidochelys olivacea*) and kemp's ridley (*Lepidochelys kempii*) turtle hatchlings towards different colored light (blue, green, yellow, and red). The trials with kemp's ridley turtles (n=160) were carried at Campamento Tortuguero Santander, Veracruz, Mexico, and the trials with olive ridley turtles were carried at Campamento Tortuguero La Escobilla, Santuario La Escobilla Beach, Oaxaca, Mexico. Our experimental set-up consisted of an arena, 2 m in diameter, with a light stimulus that was placed in the opposite direction of the ocean. We measured the response time (s) and the speed towards the light stimulus (d/s) and the orientation of each hatchling (degrees). Results showed that olive ridley turtles had a longer response time and moved slower in blue light, as compared to the other colored lights, but moved rapidly towards green light. The kemp's ridley turtles showed a longer response time towards green light, as compared to blue, yellow, and red light However, they moved slowly towards red light. Hatchling of olive ridley turtles were oriented significantly towards all four light stmulus ($W = 16.74$, $p = 0.01$), and kemp's ridley turtles were significantly oriented towards the four-light stimulus ($W = 27.56$, $p = 0.01$). The response of positive attraction to lights with shorter wavelengths (blue, green, and yellow) could be related to the fact that sea turtles, for most of their life, see the horizon through the blue ocean filter, which could explain why olive ridley turtles are more sensitive towards short wavelengths. However, the positive orientation response of the kemp's ridley hatchlings to red light could be related to the fact that kemp's ridleys are usually born at dawn, when the sunset turns reddish, which could be a signal to the young when they go towards the sea. The different orientation responses to light stimulus could reflect differences in the habits of sea turtle species.

LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) INCUBATION DYNAMICS ON A FLORIDA PANHANDLE BEACH, USA

Megan S. Lamb

Apalachicola National Estuarine Research Reserve, Florida Dept. of Environmental Protection, FL, USA

Understanding the incubation environment of Loggerhead sea turtle nests (*Caretta caretta*) is important to recognizing challenges faced by this globally threatened species. Loggerhead sex is determined by

incubation temperature, and clutches experience a critical temperature of 29.0°C during the middle third of the incubation period where a clutch produces an equal ratio of male and female hatchlings. Above this temperature, more females are produced, below, more males. There is concern that warming global temperatures may lead to a feminized loggerhead population causing population challenges. This project examines the incubation temperatures of loggerhead nests on Little St. George Island, a barrier island along the Florida panhandle whose nesting females are included in the Northern Gulf of Mexico (NGOM) recovery unit, part of the Northwest Atlantic Ocean Distinct Population Segment (DPS). Clutch and sand control temperatures directly adjacent to nests measured incubation temperatures and metabolic heating occurring in egg clutches. Transects of loggers placed from primary dune crest to just above mean high water line provide a temperature profile of the beach. Together nest temperatures, metabolic heating, and beach transects create a comprehensive picture of the temperatures sea turtle nests currently experience on this beach. This data provides baseline information about the present incubation environment in the NGOM recovery unit and contributes to understanding of global loggerhead populations. Incubation temperatures were recorded in thirty-three nests from 2016-2018, and transect data was collected at a single location in 2016 and six locations in 2017-2018. The average clutch temperature during middle third of incubation was 31.52 (±0.59)°C in 2016, 30.09 (±0.23)°C in 2017, and 30.49 (±0.22)°C in 2018. The temperature of all nests measured fell above the critical temperature of 29.0°C during the middle third of the incubation period. Analysis of variance indicates clutch temperatures were significantly different between all years but not significantly different amongst early, middle, or late season nests within each nesting season. Metabolic heating across all nests averaged 1.78 (±0.20)°C but ranged from 0.30°C to 3.22°C. Transect temperatures indicate warmer temperatures on dune crest with temperatures decreasing towards the water line. Temperatures and trends from crest to water line were similar in all areas of the island.

USING A SCENT-DETECTION DOG FOR SEA TURTLE NEST MONITORING AND CONSERVATION OUTREACH*

Rebekah Lindborg, Blair Witherington[2], J. Rachel Smith[1], and Pepe Peruyero[3]

[1]*Disney's Animal, Science and Environment, Orlando, FL, USA*
[2]*Inwater Research Group, Jensen Beach, FL, USA*
[3]*J&K Canine Academy, Alachua, FL, USA*

Many sea turtle research and conservation tasks on nesting beaches require precise location of eggs within nests. Surveyors can expend a significant amount of time and effort attempting to find the exact clutch location during surveys. Without being present during oviposition, surveyors rely on visual cues to identify nests and find the clutch. Variation in these cues can lead to uncertain nest identification, long search times, errors in positioning nest protection, and failure in re-locating the clutch for determination of hatching success. In this study, we tested the accuracy and efficiency of a 2–3-year-old, 40 lbs terrier mix scent-detection dog for locating sea turtle eggs and examined the use of the dog as a conservation ambassador. The study took place on a 7-km stretch of beach near Disney's Vero Beach Resort® in Florida during the 2017-2018 nesting season. The detection dog was trained to present an alert behavior (sit) at cloacal mucus odor, which was used as an olfactory target to indicate freshly buried eggs. Accuracy was measured as sensitivity and specificity of nest identification at crawls (nests or abandoned attempts) and as the horizontal distance between alert and clutch locations. Sensitivity was the ability of the scent-detection dog to not alert at abandoned nest attempts. Specificity was the ability of the scent-detection dog to alert at nests. Efficiency was measured by clutch search time and the number of holes dug. We collected data both for a detection dog team (including the dog handler) and for human surveyors using only visual nest appraisal. The detection dog correctly identified nests (sensitivity, correct positive) and abandoned attempts (specificity, correct negatives) 100% of the time (n=557). Comparing the alert location of the detection dog (n=525) to the initial guess made by a human surveyor (n=218), the detection dog correctly alerted at the clutch location at a rate of 84.1%, while the human surveyors were correct 69.1% of occurrences. In addition to accuracy and efficiency comparisons of surveyors and the detection dog, we also tested one method that could be used to deploy a scent-detection dog in a real-world scenario for sea turtle nest monitoring after the accuracy of the dog had been assessed. This method involved trusting the dog's alert location and marking the nest without digging down to confirm the clutch location. With this method, less effort was spent searching for the eggs during nest inventories two months after oviposition, with an average search time of 76 seconds and an average of one hole dug to locate the clutch (n=36). Using the detection dog as a conservation ambassador, we reached a total of 12,686 people through social media and in-person beach encounters.

CONSEQUENCES OF FLIPPER AMPUTATIONS IN SURVIVAL, GROWTH AND REPRODUCTION OF LOGGERHEAD TURTLES*

Adolfo Marco Llorente[1], Andrés Saez-Guerra[2], and Samir Martins[3]

[1]Doñana Biological Station, CSIC, Seville, Spain
[2]University Pablo de Olavide, Seville, Spain
[3]BIOS.CV, Sal Rei, Boa Vista, Cabo Verde

Fisheries bycatch, entanglement on ghost nests or plastic debris and predators, cause severe damages in marine turtles, ranging from flipper amputations to their death. In fact, amputations are the most common defect that female sea turtles acquire in life. However, little is known about the frequency of these amputations, as well as their influence for the life history of sea turtles. Here, we have evaluated the influence of flipper amputation on the threatened loggerhead turtle population of the Eastern Atlantic. A long-term study has been conducted on adult females of this population on several high-density nesting beaches of Cape Verde. Daily night surveys were conducted for the nesting season: several thousands of adult female turtles were observed and individually tagged and identified. Biometric data of adults was taken selectively. Many adult females with one or multiple amputations of the rear or front flipper were found nesting on the beaches. The influence of the different level of amputation on turtle size and reproduction are showed and discussed. Data of 5892 females were surveyed from 2005 to 2017, of which 16% had at least one partial flipper amputation and 2.4 % were found with complete flipper amputations. The mean no. of false crawls and failed nesting attempts were bigger amidst adult females with, at least, one amputated flipper. The higher the amputation rate, the greater the impact. More nests were found from amputated females, though this result does not necessarily indicate more fecundity. Due to their physicallimitations, amputated females may have higher nest site fidelity. Non-amputated females may move longer distances from one nest to the next, leaving in some cases the study area. Furthermore, nesting success was bigger amidst non-amputated females. Amputated females did more false crawls which entail an energy waste and an extra effort because they must perform more inshore incursions per nest. This can be applied too for failed nesting attempts which also cause that amputated females must excavate more nests and move to further points on the beach. Predation and poaching risks could be higher for amputated females. Female poaching on the beach is still a severe threat for females in Cape Verde. The cause of these constraints could be the important physical limitation of amputated females. Furthermore, part of these differences may be caused by a possible greater ease of being observed during surveys. The largest number of nests in amputated adults supports the reduction mobility hypothesis and once again suggests an obligatory nesting site fidelity for these turtles. It may also indicate longer remigration intervals, compensating this factor by laying amputated females more nests per breeding season than non-amputated females. Despite amputations can cause a high mortality and reduce turtle fitness, many partially and totally amputated turtles can successfully nest on the beach and can survive throughout different nesting seasons, indicating that the effort on recovery centers to rescue and release these animals is worthwhile and has to be reinforced.

DOES MOISTURE AFFECT THE TEMPERATURE-SEX RATIO RESPONSE CURVE?*

Alexandra Lolavar

Florida Atlantic University, Boca Raton, FL, USA

All species of sea turtles exhibit a cooler male/warmer female temperature-sex ratio response. The impact of temperature on hatchling sex makes nest conditions during incubation and the factors that affect these conditions particularly important. Field and experimental studies on loggerhead sea turtle sex ratios suggest that increased sand moisture impacts sea turtle sex ratios with, and perhaps beyond, a cooling effect. Current sex ratio predictions rely on the embryonic response to temperature only and may inaccurately estimate sex ratios especially during periods of heavy rainfall when sand moisture increases. Our study updates the established pivotal temperature and transitional range of temperatures (TRT) for the loggerhead sea turtle population in Boca Raton, Florida. We examine how varying sand moisture impacts the embryo's response to temperature. In 2016-2018, we collected loggerhead sea turtle (*Caretta caretta*) eggs and transferred them into Styrofoam™ boxes. Across three seasons, we incubated groups of eggs at temperatures of 28.0°C, 28.5°C, 29.0°C, 30.0°C, 31.0°C, 31.5°C, 32.0°C, and 33.0°C. The groups of eggs were incubated in one of three volumetric moisture contents: low, medium/average, or high. Temperatures inside the masses of eggs were recorded throughout incubation and the volumetric moisture content of each nest box was monitored at egg level. When the hatchlings emerged, they were transported to the Florida Atlantic University Marine Laboratory where they were raised for 2–3 months and underwent laparoscopic examination of the gonads and gonadal ducts to identify sex. We calculated temperature-specific sex ratio response curves at each moisture level to identify the TRTs and pivotal temperatures. At each temperature, slopes of the response curves for eggs differed with moisture level. The TRT was narrowest for eggs incubated in high moisture. Eggs incubated in higher sand moisture produced more males than eggs incubated at the same temperatures but at lower sand moisture. The results of this study are an important because they significantly clarify the nature of sea turtle embryos' responses to temperature under different moisture conditions and provide experimental data to help explain the poor match between the lab TSD curves and the results obtained in nature. Changing precipitation patterns associated with global climate change may impact nest moisture content, which can subsequently affect how developing embryos respond to increasing temperatures. Thus, a clear idea of moisture's role will be essential in assessing possible impacts on sea turtle biology.

PREDICTING THE IMPACTS OF CURRENT DEVELOPMENT ON FUTURE COASTAL SQUEEZE FOR NESTING SEA TURTLES IN US NATIONAL PARKS*

Marta P. Lyons[1], Riley Gillette[1], Annette Spivy[2], John F. Weishampel[1], and Betsy Von Holle[1]

[1]*University of Central Florida, Orlando FL, USA*
[2]*University of Maryland, MD, USA*

The southeastern United States coastline is expected to experience substantial sea level rise and already has extensive development close to the shoreline. The combination of rising sea level on one side and stationary hard structures on the other side can result in what is called "coastal squeeze," inhibiting the inland migration of beaches. Barrier islands on the east coast of the United States represent key nesting habitat for *Caretta caretta* and *Chelonia mydas* and have a history of mixed use, with protected natural areas and human development. Barrier islands with greater human development may experience more nesting area loss as a result of coastal squeeze, as compared to those with limited human development where beaches can migrate inland with rising shorelines. We tested how much existing infrastructure would limit beach movement, and thus nesting area, by comparing projected nesting beach loss among four southeastern National Parks with differing levels of human infrastructure. We looked at Cape Hatteras (CAHA), Cape Lookout (CALO), Cumberland Island (CUIS) and Canaveral (CANA) National Seashores. In order to estimate the amount of nesting beach that will potentially be lost with moving shorelines, we used more than a decade of nesting data to quantify the area that encompasses the middle 95% of where females place nests in relation to the distance from the shoreline. We then calculated changes to this area based on projected future shoreline for 2100 with sea level rise. We quantified changes to nesting area based on the assumption that the beach would migrate with the shoreline and females would nest within the same distance from shoreline that they are currently nesting. We considered any area inland of roads or intersecting with buildings and private inholdings as inaccessible. We show that *Caretta caretta* and *Chelonia mydas* are using slightly different areas of the beach among parks, and the physical width of the beach is reflected in the distance from mean high tide line where females are currently nesting. Contrary to our hypothesis, parks with more impervious surfaces were not predicted to lose more nesting area compared to parks with currently limited infrastructure in proximity to beaches. CUIS, which has relatively pristine beaches undisturbed by permanent hard structures, had the highest percent of beach loss by 2100 (7% lost) for C. caretta nesting area, while CAHA, with the most human infrastructure had 4% predicted loss and CANA, with substantial infrastructure, is only predicted to lose 1% of nesting area by 2100. CALO, which has limited infrastructure had a 3% predicted beach loss. Overall, we did not find that parks with greater human infrastructure near beaches are at a greater risk for nesting area loss from coastal squeeze. The majority of current roads and other infrastructure will still not intersect with nesting beaches in 2100. Though we saw some evidence of loss of beach area due to coastal squeeze between rising sea level and hard structures at US National Seashores much of the decrease in nesting area was due to overall changes to barrier island shape.

EVALUATING FINE-SCALE NEST SITE SELECTION PREFERENCES OF NEOPHYTE AND REMIGRANT LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)

Sarah E. Martin[1], Brian M. Shamblin[1], Mark G. Dodd[2], Joseph B. Pfaller[3], Kristina L. Williams[3], Kate Tweedy[4], and Campbell Joseph Nairn[1]

[1]*University of Georgia, Athens, GA, USA*
[2]*Georgia Department of Natural Resources, Brunswick, GA, USA*
[3]*Caretta Research Project, Savannah, GA, USA*
[4]*Little Saint Simons Ecological Advisory Council, Little St. Simons Island, GA, USA*

Fine-scale nest site selection (NSS) affects hatching and emergence success in addition to potentially impacting hatchling sex ratios and fitness. Previous studies have demonstrated individual repeatability of NSS preferences, raising concerns about the potential for altering gene pools through relaxed selection on females that consistently nest in poor sites. Previous studies of loggerhead turtle (*Caretta caretta*) NSS suggested that neophytes (newly recruited nesters) and remigrants (returning females) may exhibit different NSS preferences, with neophytes tending to nest lower on the beach profile. NSS variation attributable to previous nesting experience has implications for interpreting individual repeatability and clutch relocation practices. In the case of our previous study conducted in 2012, low nest site fidelity and long remigration intervals may have confounded the classification of neophytes. The goals of this study are to estimate individual repeatability of clutch elevation and distance to the spring high tide line (DSHTL) and 2) to assess potential differences in NSS preferences and repeatability between neophytes and remigrants. Additionally, we will compare NSS preferences of related individuals to determine if it is feasible to generate preliminary assessments of heritability. We conducted this study on four Georgia barrier islands: Wassaw, Ossabaw, Sapelo, and Little St. Simons Island during the 2018-nesting season. We collected body pit depths (from the sand surface to the top of the clutch) as well as egg chamber depths to incorporate these data into elevation measured using a real-time kinematic (RTK) GPS unit. We will analyze these NSS metrics following assignment of clutches to individual females and these females to experience groups via genetic tagging using 16 microsatellite loci. The relative importance of each beach, individual female preferences, and previous nesting experience in determining variation in elevation and DSHTL will be examined. This study will provide further insight into repeatability of individual preferences in NSS and how these may vary between neophyte and remigrant nesters. Preliminary data on the repeatability of behavior among relatives may inform the potential for heritability of NSS preferences. These data have implications for the potential for relaxed selection pressure via the common management practice of relocating clutches deemed doomed by tidal inundation and erosion.

NORTH PACIFIC OF NICARAGUA: THRIVING FOR THE RECOVERY OF THE HAWKSBILL TURTLE OF THE EASTERN PACIFIC OCEAN

Jorge Martinez[1], Velkis Gadea[1], Eduardo Altamirano[1], Maria Alejandra Rivera[1], Jorge Lezama[1], José Urteaga[2], Perla Torrez[3], Mike Liles[3], Alexander Gaos[3], and David Melero[3]

[1]*Fauna & Flora International, Cambridge, England*
[2]*Emmett Interdisciplinary Program in Environment and Resources, Stanford University, Stanford, CA, USA*
[3]*Eastern Pacific Hawksbill Initiative, San Diego, CA, USA*

The Eastern Pacific hawksbill turtle is one of the most threatened sea turtle populations in the world. In 2010, as part of the Eastern Pacific Hawksbill Initiative (ICAPO), Fauna & Flora International (FFI) and local partners began conservation efforts in the Estero Padre Ramos Natural Reserve, Nicaragua. In 2012, FFI discovered a second nesting site at the Estero Aserradores, located 30 km south of Estero Padre Ramos and, in 2014, we launched a conservation project in this area. In this presentation, we update the nesting beach monitoring and nest protection results up to 2018. Sea turtle monitoring is conducted through a mix of technics that includes night patrols on the densest nesting areas, a reward system offered to eggs collectors that share information on nesting events, and boat surveys of the estuary shore. Most of the hawksbill clutches are protected by relocating them into hatcheries; however, some nests (~ 10%) are protected in situ. For each nesting event, we collect information on the nest location and nest characteristics (e.g., clutch size, nest depth, and width). In addition, when it is possible, we measure nesting females (CCL, CWL), and tag them, using Iconel and PIT tags. The hatcheries are managed following standard procedures which include the excavation of 100% of the nests after 3 days of the first emersion or estimated due date and the release of hatchling in locations near the original nesting sites. Across nine years of conservation, we have protected 1668 hawksbill nests, tagged 319 females, and release of 148,344 hatchlings. The poaching rate of hawksbill nests decreased from nearly 100% to less than 4%. In 2018, we recorded 275 clutches in both areas Padre Ramos and Aserradores. These results suggest that these areas host over 40% of the known hawksbill nesting within the Eastern Pacific. In addition, we have also recorded exchange of females between these two sites, and nesting areas in El Salvador. These results render Aserradores and Padre Ramos as the largest hawksbill nesting aggregation in the Pacific of Nicaragua, and one of the most important in the entire Eastern Pacific region.

THE EFFECT OF MOISTURE ON GREEN SEA TURTLE (*CHELONIA MYDAS*) HATCHLING FITNESS AND SUCCESS

Bill L. Matthews, Christopher R. Gatto, and Richard D. Reina

Monash University, Clayton, Victoria 3800, Australia

While the effects of temperature on embryonic development of sea turtles have been well studied over recent years, our understanding of moisture, another important environmental variable, is quite limited. We know that moisture decreases nest temperature through evaporative and direct cooling during rainfall, but what affects does moisture have on hatchling success, phenotype and fitness? To answer this question, we incubated 40 green sea turtle (*Chelonia mydas*) nests in a beach hatchery under high (~8%) and low (~4%) moisture concentrations for the duration of embryonic development. Half of the nests also had temperature sensors to observe any effect of moisture on nest temperature. As hatchlings emerged, we took mass and morphological measurements and then measured hatchling locomotion performance through crawling speed and swimming tests during the frenzy period. Nests were also excavated to observe hatching and emergence success, as well as the stages of embryonic death of unsuccessful eggs. High moisture concentrations significantly increased the duration of the incubation period and decreased the nest temperature. Moisture had no effect on hatching success, emergence success, stage of embryonic death, hatchling phenotype, crawling speed or initial swim strength. However, hatchlings from high moisture nests performed significantly worse in later swimming tests, suggesting poorer swimming endurance. This study is the first-time fitness tests have been conducted on hatchlings incubated in hatchery conditions under altered moisture regimes. The results show that high moisture conditions decrease the performance of hatchlings during the frenzy period, possibly reducing their chances of post hatching survival. The effect of moisture on temperature also highlights the importance of including rainfall patterns in predictions of future climate change effects on sea turtle populations.

SPATIAL DISTRIBUTION OF NATURAL AND RELOCATED LEATHERBACK NESTS AT SANDY POINT NATIONAL WILDLIFE REFUGE, ST. CROIX USVI

Nina Mauney[1], Claudia Lombard[2], Dana DeSousa[3], and Kelly Stewart[1]

[1]*The Ocean Foundation, Washington, DC, USA*
[2]*US Fish and Wildlife Service Sandy Point National Wildlife Refuge, Frederiksted, St. Croix, VI, USA*
[3]*Pace University, New York City, NY, USA*

The Sandy Point National Wildlife Refuge (SPNWR), located on the southwestern tip of St. Croix, USVI, is a critically important sea turtle nesting area that was specifically designated for protection of leatherback sea turtle (*Dermochelys coriacea*) nesting habitat in 1984. Since its designation, it has become an important site for leatherback research, monitoring, and management. The conditions that influence nesting habitat favorability relate to the basic geography of the beach; its peninsular shape creates three distinct environments. The north side is large and sandy, the western portion has a highly changing morphology due to longshore current erosion, and the southeastern stretch is often covered in dried seagrass and algae and experiences some annual erosion. Due to the dynamic nature of certain sections of the SPNWR beach profile, washout during nest incubation poses a significant threat to leatherback hatch success. As such, nest relocation based on a knowledge of past erosion patterns is an integral tool in leatherback conservation and management and increasing hatchling production through nest relocation is one of the principal goals of the Comprehensive Conservation Plan for SPNWR. The goal of this study was to determine the distribution of natural and relocated leatherback sea turtle nests at the refuge during the 2018 leatherback nesting season, and to examine trends in nest washout to provide recommendations for future management. To address these questions, we conducted nighttime nesting patrols to encounter nesting females and triangulate nest positions with respect to standardized beach marker stakes. Clutches were relocated when they were laid too close to the high-water mark or were on the western beach. We then did hatchling emergence surveys to determine the fate of each natural and relocated nest by beach zone marker. Global Positioning System coordinates were collected and processed in ESRI's ArcGIS. Throughout the 2018 season, 28 of 130 total nests were relocated. Preliminary results suggest a higher prevalence of both nest relocations and washouts on the western side of the beach. Results from this study could inform future relocation decisions. By looking at the nest distribution patterns over several years and the hatching success of all nests by beach zone, we can identify the best sections of beach on the refuge to place future threatened egg clutches. Analysis of several nesting seasons is necessary to determine long-term historical trends in nest relocation and beach erosion.

CLASH OF THE TURTLES: DOES GREEN SEA TURTLE NESTING ACTIVITY IMPACT LOGGERHEAD TURTLE NEST SITE SELECTION?

Adrienne McCracken, Sarah E. Hirsch, Jennifer D. Reilly, and Justin R. Perrault

Loggerhead Marinelife Center, Juno Beach, FL, USA

The state of Florida is considered a globally significant nesting site for loggerhead sea turtles (*Caretta caretta*), with a cluster of five counties along the southeastern coastline of the state hosting ~75% of the state's nesting activity. Palm Beach County alone annually hosts ~10% of the world's loggerhead nests. Green sea turtles (*Chelonia mydas*) also frequently nest in Florida and follow biennial nesting trends (i.e., high nesting year followed by a low nesting year), with record-breaking nest counts in 2013, 2015, and again in 2017. Green turtles tend to create large pits of displaced sand during the nesting process, altering the topography of the beach. These pits can measure one meter in both diameter and depth and can persist for weeks on the nesting beach, creating an obstacle for other nesting turtles. The two species' nesting seasons overlap annually, with the highest percentage of overlap occurring from mid-June to early July. Using nesting activity data from 2013–2017, we analyzed loggerhead turtle nesting success (i.e., the ratio of nests to false nesting attempts) and percentage of beach utilization for both successful nesting and false nesting attempts (i.e., false crawls) along 15.25 km of beach in northern Palm Beach County. Beach utilization was calculated by measuring the distance the turtle traveled from the high water line and comparing that to the total beach width (i.e., from the high water line to the vegetation line). Our objectives were to determine (1) if loggerhead beach utilization decreased with increasing green turtle nesting activity at a high-density nesting site in Palm Beach County, Florida and (2) if loggerhead turtles were more likely to false crawl if they encountered a green turtle body pit. Using linear regression analysis, no significant relationships between loggerhead turtle beach utilization and green turtle nesting density was observed. However, loggerhead turtles were more likely to false crawl if they encountered a green turtle body pit ($P<0.001$). Loggerhead nesting success was 15.67% when a green turtle body pit was encountered, whereas nesting success was 59.33% when they crawled over unobstructed beach. As the southwestern Atlantic green turtle population continues to recover, it is possible that interspecific competition between the two species will increase; however, our results suggest that currently, interspecific competition for space is not an issue on Palm Beach County beaches.

INVESTIGATING SYNCHRONOUS HATCHING IN THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*)*

Jessica McGlashan and Angela Field

Florida Atlantic University, Boca Raton, FL, USA

Turtles exhibit remarkable synchrony in both hatching and emergence of young from the nest. Synchronous hatching is where neonates hatch at or around the same time and is important to ensure synchronous emergence. Synchronous emergence is when large groups of hatchlings depart the nest together, and this behaviour is thought to increase survivorship through predator swamping. Egg position and thermal gradients in a nest alter developmental rates of embryos and has the potential to cause asynchronous hatching times. Despite the difference in incubation temperature, synchronous hatching still occurs. Embryo-embryo communication is thought to be the mechanisms that enables synchronous hatching, either by stimulating eggs to hatch early or through metabolic compensation during embryogenesis. To determine the importance of embryonic communication for synchronous hatching we incubated eggs of loggerhead turtles (*Caretta caretta*) in both isolated and grouped conditions and compared incubation period. All eggs were incubated at a constant temperature of 28°C and incubation period was recorded from oviposition date to pipping date. We found a significant difference in incubation period between eggs incubated in isolation compared to eggs incubated in groups, indicating that group formation is important for hatching synchrony. Comparisons of morphometric measurements show there was no difference in hatchling size due to incubation conditions. Synchronous hatching is not a passive action, it is driven by embryo-embryo communication in the nest. It is not clear how embryos are communicating, but it is apparent that group formation during incubation is important for facilitating synchronous hatching.

RELATIONSHIPS BETWEEN HUMAN DEVELOPMENT AND DEPREDATION OF LOGGERHEAD AND GREEN SEA TURTLE NESTS

Mitchell Meads, Gustavo Stahelin, Kate L. Mansfield, and Erin E. Seney

University of Central Florida Marine Turtle Research Group, Orlando FL, USA

Global population rise inherently results in increased human development in coastal areas across the globe. As coastal towns transform into coastal cities, constant human activity causes disturbances that affect local species and ecosystems. These may include water, air, and light pollution, harvest or removal of local plant and animal species, competition for beach space, and alteration of habitat or resource selection. The effects of such disturbances are far-reaching ecologically and can have compounding impacts on many different species. Although sea turtles dig deep egg chambers and camouflage their clutches, eggs are commonly predated by armadillos (*Dasypus* spp.), coyotes (*Canis latrans*), raccoons (*Procyon lotor*), ghost crabs (*Ocypode* spp.), and bobcats (*Lynx rufus*). Some of these species, such as raccoons, are highly associated with human activity. The objective of this study was to compare the frequency of loggerhead sea turtle (*Caretta caretta*) and green sea turtle (*Chelonia mydas*) nest depredations to the level of human development on 21 kilometers of the Brevard County portion of the Archie Carr National Wildlife Refuge along the east coast of central Florida from 2016 to 2018. During daily morning sea turtle nesting surveys, we collected information on predator and prey species, location of the depredation, and estimated number of eggs destroyed per observed depredation event. Out of the 38,783 loggerhead nests laid in the study period, a total of 940 disturbed loggerhead nests were observed and an estimated 24,124 eggs were

destroyed. Out of the 18,458 green turtle nests, 483 disturbed nests were observed, and an estimated 14,457 eggs destroyed. Predator species for these depredations included raccoons, bobcats, ghost crabs, and even domestic dogs (*Canis lupis familiaris*). To characterize human development, we used satellite imagery to create a relative index of development for each half kilometer of the study site. This index considered the potential maximum level of human development based on the estimated capacity of each property. The capacity of each property was defined as the geographical size of each property measured in square meters, and the estimated number of beds available in each private home, condominium, or hotel. This index was used to determine if there were spatial relationships between the level of human development and depredations. Our results suggest that sea turtle eggs can encounter more threats of predation in anthropogenic areas. Information from this research could alter management strategies for sea turtle rookeries around the globe to help combat ecological effects of urban sprawl.

A 5-YEAR REVIEW OF SEA TURTLE NESTING ACTIVITIES ON BUCK ISLAND, ST CROIX, USVI

Natalie Monnier, Jessica Stuczynski, Danielle Alvarez, Allison Del Gizzi, Laura Palma, Nathaniel Hanna Holloway, Clayton Pollock, and Zandy Hillis-Starr

National Park Service, Buck Island Reef National Monument, St. Croix, USA

Buck Island, a small uninhabited island off the northeast coast of St. Croix, USVI, is an index nesting beach for the critically endangered Hawksbill (*Eretmochelys imbricata*) and endangered Green (*Chelonia mydas*) turtle in the Caribbean. The Buck Island Sea Turtle Research Program (BISTRP), managed by the National Park Service Division of Resource Management, has monitored this index beach for nesting female turtles annually since 1988. Presented here is a 5-year review highlighting research findings and nesting activity trends from 2014-2018. Since 2014, a total of 1,319 hawksbill and 1,084 green turtle nesting activities occurred on Buck Island beaches - 777 of which resulted in confirmed nests. The 2018 nesting season had the highest number of activities on record since 2014, aligning with the cyclical nesting trends commonly observed in these sea turtle species. Research from the past five years has revealed that 2018 was the first-year green turtle nesting activities outnumbered that of hawksbills, despite there being more individual hawksbill turtles coming up on the beach. Such trends may be indicating a shift in nesting dynamics at Buck Island. In total, 105 untagged females were observed on the beach since the 2014 field season (74 hawksbill, 30 green, and 1 loggerhead), indicating that recruitment to Buck Island beaches is still occurring nearly 30 years after initial monitoring began. Relationships between nesting habitat type and hatch success will also be explored to determine which areas of the beach are most suitable for nesting. These results suggest that Buck Island continues to be an important nesting habitat for both hawksbill and green turtles in the Caribbean. Continued monitoring in future years will provide a greater understanding of sea turtle nesting ecology and help inform important conservation and management decisions to ensure species survivorship.

THE EFFICIENCY OF PHENOLOGICAL SHIFTS TO BUFFER THE EFFECTS OF WARMING TEMPERATURES ON HATCHING SUCCESS AND SEX RATIO OF LOGGERHEAD SEA TURTLES*

Jonathan Monsinjon[1], Jeanette Wyneken[2], Kirt Rusenko[3], Milagros Lopez[4], Alexsandro S. Santos[4], Maria A.G. dei Marcovaldi[4], Paulo Lara[4], Mariana M.P.B. Fuentes[5], Yakup Kaska[6], Jenny Tucek[6], Ronel Nel[7], Kristina L. Williams[8], Anne Marie LeBlanc[9], David C. Rostal[9], Jean-Michel Guillon[1], and Marc Girondot[1]

[1]*Laboratoire d'Ecologie, Systématique, d'Evolution, Université Paris-Sud, AgroParisTech, CNRS, Université, Paris Saclay, 91405 Orsay, France*
[2]*Department of Biological Sciences, Florida Atlantic University, Boca Raton, FL, USA*
[3]*Gumbo Limbo Nature Center, 1801 N Ocean Blvd, Boca Raton, FL, USA*
[4]Fundação Pró-TAMAR*, Rua Rubens Guelli, 134 sala 307, Salvador, Bahia, Brazil*
[5]*Department of Earth, Ocean and Atmospheric Science, Florida State University, North Woodward Avenue, Tallahassee, FL, USA*
[6]*Pamukkale University, Sea Turtle Research Centre (DEKAMER), Denizli, Turkey*
[7]*Department of Zoology, Nelson Mandela University, Port Elizabeth 6031, South Africa*
[8]*Caretta Research Project, Savannah, GA, USA*
[9]*Department of Biology, Georgia Southern University, Statesboro, GA, USA*

Shifts in nesting phenology, by initiating reproductive events earlier, in response to warming temperatures is one of the most striking effects of climatic changes currently observed in wild populations. Sea turtles are oviparous reptiles with temperature-dependent sex determination and their nesting phenology is related to environmental temperatures. These long-lived and late maturing organisms have high degree of site fidelity, which may constrain their ability to shift spatially to keep within similar thermal conditions in the future. Therefore, shifting the nesting season could be the most effective short-term response to buffer warming impacts at nesting beaches. Here we calculated the phenological shifts required in the future to keep producing a hatching success and a sex ratio that lie within the ranges currently experienced by several loggerhead populations across a wide range of latitudes. We found that temperature-induced phenological shifts may not help all populations to keep pace with warming temperatures.

THE EFFECT OF TRANSLOCATION TIME ON THE HATCHERY EMERGENCE SUCCESS OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) TURTLES IN PLAYA BEJUCO, COSTA RICA

Aki Nisbet[1,2], Carmen Mejías-Balsalobre[1], Isabel Naranjo[1], Randall Arauz[3,4], and Daniela Rojas-Cañizales[5]

[1]*Dalhousie University, Halifax, Nova Scotia, Canada*
[2]*CREMA, Rescue Center for Endangered Marine Species, Costa Rica*
[3]*Fins Attached Marine Research and Conservation, Colorado Springs, CO, USA*
[4]*Migramar, Olema, CA, USA*
[5]*Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV), Maracaibo, Zulia, Venezuela*

The relocation of eggs and establishment of hatcheries is a common strategy for marine turtle conservation on nesting beaches, especially in areas where the eggs face a number of threats such as egg extraction, animal predation and environmental pressures. This is the case of Bejuco beach, a 3.5 km long beach located in the Southern Nicoya Peninsula, Costa Rica, where Olive ridley (*Lepidochelys olivacea*) turtles commonly nest. Bejuco beach faces both heavy predation and poaching meaning that without the relocation of Olive ridley eggs, the survival rate would be greatly reduced. For this reason, the Rescue Center for Endangered Marine Species (CREMA) manages a hatchery on this beach, as well as a nesting sea turtle monitoring program. Previous studies have shown that if a hatchery is managed correctly, there is no significant difference in hatching success for in situ and relocated nests caused by translocation. However, there are known risks associated with the relocation of marine turtle eggs. Movement-induced mortality of turtle eggs has been documented and a time period of 0-6 hours after oviposition was described as the best time for the collection and relocation of eggs. The purpose of this ongoing study is to determine whether small differences in in the relocation of Olive ridley turtle eggs within the ‘safe period’ have a significant impact on emerging success. The data analyzed for this study comes from October to December 2018. The study site is a frequent nesting beach for Olive ridley turtles with nightly 4-hour monitoring patrols based on the avoidance of the highest and lowest tides to maximize sea turtle encounters. When a nest is discovered during a patrol, the eggs are counted and collected with latex gloves and carefully carried in fabric bags until the end of the patrol where they are then recounted and buried in the hatchery. The time when the nesting turtle is discovered is recorded and as well as the time when the eggs are relocated to the hatchery. The nests considered for this study are only those where the turtle was encountered, as with the rest of the nesting events, there is no way of determining the time when the nesting occurred. After the incubation period, approximately 45-50 days, the number of hatchlings that emerged from the nest is recorded twice. The emerging success is determined by dividing the number of emerged hatchlings by the number of eggs. The translocation time is grouped into 20-minute intervals. The groups are 0-20 mins, 20-40 mins, 40-60 mins, 60-80 mins, 80-100 mins, 100-120 mins, 120-140 mins, 140-160 mins, 160-180 mins, and 180+ mins. The average emerging success for each of the time intervals is also calculated. Using Minitab, an ANOVA test will be performed to determine whether there are significant differences in emerging success between time periods. There are currently no results as research is ongoing, however previous observations suggest that a translocation time of 180+ mins has a detrimental effect on the emerging success at Bejuco beach. The information from this study could be important in modifying patrolling protocols to decrease the translocation time of eggs to ultimately increase the emerging success in hatcheries.

INJURY PREVALENCE AMONG NESTING LOGGERHEAD SEA TURTLES IN THE NORTHERN RECOVERY UNIT

Breanna Ondich

Georgia Sea Turtle Center, Jekyll Island, GA, USA

Turtle populations are susceptible to declines following the mortality of sexually mature females. The most frequently reported negative impacts to sea turtles in the state of Georgia include boat strikes, fisheries-related injuries, and disease. Observations from sea turtle stranding reports suggest that Loggerhead Sea Turtles (*Caretta caretta*) in the Northern Recovery Unit experience a variety of both natural (shark bites) and anthropogenic (boat strike, fishing gear entanglement) injuries that may result in additive mortality; however, our understanding of these potential threats is hindered by their diffuse nature and the inherent difficulties in sampling free-ranging and highly mobile animals. Due to ongoing efforts to mark and recapture female Loggerhead Sea Turtles nesting on Wassaw and Jekyll Island, Georgia, we have had the opportunity to spend decades assessing injury rates on this demographically important segment of the population. In this study we categorize baseline prevalence of major injuries on Loggerhead Sea Turtles and make inferences regarding conservation implications in light of global change. Future research may use the information we compile here to model whether the prevalence of injury we observed is sufficient to cause population declines, given some conservative assumptions regarding survival.

THE EFFECTS OF HURRICANES ON THE INCUBATION LENGTH OF LOGGERHEAD, GREEN, AND LEATHERBACK SEA TURTLES

Alexis Peterson

Nova Southeastern University, Fort Lauderdale-Davie, FL, USA

The current warming of the earth has been linked to an increase in intensity and frequency of tropical cyclones. Cyclones include depressions, storms, and hurricanes. These increasingly intense hurricanes are having a huge impact on sea turtle populations in a multitude of ways, primarily on the impacting of nests. Inundation, washouts, and erosion/ accretion associated with hurricanes are all factors that have been found to decrease nest emergence success rates. Aside from hatching success and mortality rates, hurricanes may also affect incubation lengths. For loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) sea turtles, the average incubation length is between 45 and 60 days. A shortened incubation length could be critical, as underdeveloped hatchlings will have an even lower odds of reaching adulthood than those hatchlings that have had the full length of time to develop. This study explores the relationship between major hurricanes that came within 200 nautical miles of Broward County, Florida and the length of incubation for loggerhead, green, and leatherback (*Dermochelys coriacea*) sea turtles on nesting beaches, with findings offered in the presentation. Data collected from the past 18 years will be statistically analyzed, relationships or correlations expanded upon, and hurricane factors that may be influencing the incubation length explored.

ONE BEACH AMONGST MANY: HOW DOES WEAK NEST SITE FIDELITY AFFECT DEMOGRAPHIC RATES?

Sara M. Weaver[1], Brian M. Shamblin[2], Kristina L. Williams[1], Mark G. Dodd[3], Matthew H. Godfrey[4], DuBose B. Griffin[5], Michelle Pate[5], Campbell J. Nairn[2], and Joseph B. Pfaller[1,6]

[1]*Caretta Research Project, Savannah, GA, USA*
[2]*Daniel B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA, USA*
[3]*Georgia Department of Natural Resources, Brunswick, GA, USA*
[4]*North Carolina Wildlife Resources Commission, Beaufort, NC, USA*
[5]*South Carolina Department of Natural Resources, Charleston, SC, USA*
[6]*Archie Carr Center for Sea Turtle Research, University of Florida, Gainesville, FL USA*

Assessments of sea turtle populations frequently rely on data collected from females at nesting beaches to estimate important demographic rates such as recruitment and productivity. The accuracy of these estimates is therefore critical for evaluating population status and developing effective management strategies. However, logistical difficulties frequently limit the geographic area of saturation tagging projects, causing the survey area to be smaller than the nesting area as defined by the degree of nest site fidelity. If nest site fidelity is weak relative to survey area, then demographic rates may be vulnerable to biases. We tested this hypothesis by comparing demographic estimates generated from nesting events of loggerhead turtles collected at one focal beach (Wassaw Island, Georgia USA) with estimates generated from the same group of turtles, but with all other nesting events from adjacent beaches in Georgia, South Carolina and North Carolina included. We found that estimates of annual recruitment at the focal beach were biased: ~30% of putative first-time nesters at the focal beach had nested on a different beach in a previous season. Estimates of clutch frequency and number of breeding seasons were biased low and skewed to the left but estimates for remigration interval and internesting interval were not significantly different. Our results show how weak fidelity to a focal study site can affect demographic estimates in sea turtle populations and highlight the need to reconsider estimates in other populations that might be vulnerable to similar biases.

NESTING FEMALES CRAWLING INTO THE BEACH: ALWAYS TO LAY EGGS?*

Jose Luis Crespo Picazo[1], Vicente Marco Cabedo[1], Eduardo Belda[2], Jesús Tomás[3], Sara Abalo Morla[2], Ohiana Revuelta[3], Juan Eymar[4], and Daniel García Párraga[1]

[1] *Fundación Oceanogràfic, Ciutat de les Arts i les Ciències, Avanqua L'Oceanogràfic, Valéncia, Spain*
[2] *Institut d'Investigació per a la Gestió Integrada de Zones Costaneres, Universitat Politècnica de València, Spain*
[3]*Unidad de Zoología Marina, Institut Cavanilles de Biodiversitat i Biología Evolutiva, Universitat de València, Spain*
[4]*Conselleria d´Agricultura, Medi Ambient, Canvi Climátic i Desenvolupament Rural, Generalitat Valenciana, Spain*

During recent years Mediterranean Spanish coast has experienced an increase of nesting events by loggerhead sea turtles (*Caretta caretta*). These events are still being studied to improve our knowledge. Until now, this fact has been hypothesized as a possible species mechanism in a respond to ongoing environmental changes; therefore, it could be a colonization process of new suitable habitats. In this

scenario, during the season of 2018 three nesting females were detected at night crawling into the beach and digging their nest. All three turtles were observed in their tries to dig an egg chamber and after pulling out with no apparent reason turtles were stopped before reaching the sea for general health assessment and tagging. Females were satellite tagged, identified with flipper and PIT tag and sampled for genetic analysis. Additionally, a complete health assessment including external physical check, blood sample and coelomic ultrasound examination was performed. Ultrasound showed no eggs presence in the coleomic cavity of two females despite being cycling where ovarian images indicated follicle groups in different maturation stages: third one presented coelomic cavity plenty of mature eggs. Satellite tracking shown turtles movements compatible with nesting activity two days after in the female with mature eggs and several days after tagging and before the common inter-nesting interval described for this species in the other two. These two turtles exposed themselves out of water and dug the nest with no mature eggs to be laid. Biometrics, hematology and biochemistry results, reproductive hormone profile, genetics and tracking movements are provided to discuss such behavior and its role in sea turtle nesting behavior.

NESTING ECOLOGY OF THE SEA TURTLES AT CAYO SERRANA ISLAND AND CAYO SERRANILLA ISLAND, SEAFLOWER BIOSPHERE RESERVE, CARIBBEAN OF COLOMBIA

Cristian Ramirez-Gallego and Karla G. Barrientos-Muñoz

Fundación Tortugas del Mar, Envigado, Antioquia, Colombia

In Colombia, there are five of the seven living species of sea turtles, all of them under some risk of extinction. Of these, four are in the Colombian Caribbean and three have been reported in the Seaflower Biosphere Reserve (SBR). However, since 1998 no studies have been conducted on sea turtles in SBR ignoring the current status of these species. Due to this lack of knowledge, research initiatives that assess the current status of sea turtles in the area, become highly relevant to contribute to the current conservation efforts in the Greater Caribbean. We conducted an analysis of the nesting ecology of the sea turtles as well as, an approach to their threats in the Cayo Serrana Island and Cayo Serranilla Island in 2016 and 2017 respectively. A systematic diurnal and nocturnal sea turtle monitoring in the beaches of Cayo Serrana Island and Cayo Serranilla Island for the interception of nesting females, identification of clutches, hatchlings, determine hatching success and size of the females and hatchlings in the area were carried out. This project was carried out within the framework of the III and IV Seaflower Scientific Expeditions, and represents the first comprehensive study at the national level with sea turtles in the northernmost area of the Colombian Caribbean, providing novel information on the distribution, abundance and nesting ecology of sea turtles, as well as, identification of sea turtle species in foraging areas around of both islands. At Cayo Serrana Island, three species were confirmed by sighting in the area: the loggerhead turtle (*Caretta caretta*), hawksbill turtle (*Eretmochelys imbricata*) and green turtle (*Chelonia mydas*). The loggerhead and hawksbill used beaches of Cayo Serrana as nesting area with five and 20 nests respectively, and the hawksbill and green turtle were present in foraging areas around of the Island. Meanwhile, at Cayo Serranilla Island, which included: Beacon Cay, Sand Cay, Middle Cay and East Cay. A total of 141 nests were confirmed for the green turtle (*C. mydas*) (78 nests), the hawksbill turtle (*E. imbricata*) (58 nests) and loggerhead turtle (*C. caretta*) (5 nests). Furthermore, we confirm that the marine habitats of Cayo Serranilla Island are used as feeding grounds by the presence of juvenile, sub-adult and adults of the hawksbill turtle and the green turtle. Our records allow us to confirm, that Cayo Serrana Island is currently the main nesting site of the loggerhead turtle in the Colombian Caribbean, whereas that Cayo Serranilla Island is currently the main nesting site for the green turtle and possibly for the hawksbill turtle throughout the Colombian territory. Therefore, our results are a valuable contribution to knowledge and demonstrate the relevance that should

be of carried out monitoring and research studies to long-term on these nesting colonies of the Seaflower Biosphere Reserve, in order to strengthen the management and conservation of these species, which contribute turtles to region-wide assemblages.

EVALUATION OF THREE INCUBATION METHODS REGULARLY ADOPTED BY SEA TURTLE HATCHERIES IN THE PACIFIC COAST OF NICARAGUA

Heydi Salazar[1], Daniela Padilla[1], José Urteaga[2], Velkiss Gadea[1], and Juan Berroteran[1]

[1]Fauna & Flora International, Cambridge, England
[2]Emmett Interdisciplinary Programs in Environment and Resources, Stanford University, Stanford, CA, USA

During the last decade the number of sea turtle hatchery has increased considerably in the Pacific coast of Nicaragua. Much of these conservation projects are carried out by private initiatives and organizations that do not necessarily have sufficient technical training to properly handle hatchery. During the first half of the 2000's most sea turtle hatcheries consisted on enclosed sections of beach and nests were placed mimicking natural nests. However, parallel to the increase in the number of hatcheries, we have observed the proliferation of the use of a technique of incubation consisting of placing the nests on sandbags. Hatchery managers in charge of projects that use these bags argue that this technique is more effective in the production of sea turtle hatchlings; however, we have not been able to find scientific evidence supporting or even examining these assertions. In this study, we performed a field experiment where we evaluated the performance of three technics (i.e., sandbags vs. floor of the hatcheries) on the incubation of sea turtle nests. The present study was conducted on Veracruz de Acayo beach, located in Rio Escalante Chacocente the wildlife refuge. Between November of 2017 and 2018 February, a total of 75 nests of olive ridley turtle *Lepidochelys olivacea* nests were relocated in a hatchery and randomly assigned to one of three incubation treatments: 1) nests relocated on the floor of hatchery, 2) nests relocated in 100 liters bags; and (3) nests relocated in 200 liters bags. In order to compare the performance of the three treatments, we looked at four outcome variables per nest: 1) the emersion success, 2) the hatch success, 3) the incubation time length, and 4) the hatchlings vitality (as the time the hatchling crawls a linear meter). In addition, differences in standard morphometric measurements (LRC, ARC, weight) were analyzed. As control, we considered the clutch size, and the average temperature and humidity for each of the three thirds of the incubation period. In our presentation we synthesize the results of this experiment and share some recommendations for future steps.

DIFFERENCES IN SAND TEMPERATURES BETWEEN IN SITU, BEACH HATCHERY AND BOX NURSERY INCUBATION METHODS AT BOCA DE TOMATES BEACH, JALISCO, MEXICO*

Katherine Comer Santos[1], Kylie Blattman[1], Antonio Ramirez Guillen[2], and Catherine E. Hart[3]

[1]*The Science Exchange Sea Turtle Internship Program*
[2]*Campamento Tortuguero Boca de Tomates, Puerto Vallarta, Jalisco*
[3]*Grupo Tortuguero de las Californias, A.C. and Investigación, Capacitación y Soluciones Ambientales y Sociales A.C.*

Boca de Tomates nesting beach in Jalisco, Mexico is a distinctive site; it is the highest density olive ridley (*Lepidochelys olivacea*) nesting beach in Puerto Vallarta despite suffering from poaching, erosion, and hot, dark sands during the peak nesting season June through November. The beach is 2.5km in length and is backed by the Boca Negra mangrove lagoon and Puerto Vallarta International Airport which has a high accuracy weather station. Conservation activities by the Red Tortuguero, A.C. nonprofit group include relocation of nests to1) a shaded beach hatchery and 2) Styrofoam boxes stored inside a tented incubation room. During the study period in 2017 we also chose an in situ location where a female nested on the beach to represent “natural” sand temperatures. An intern in The Science Exchange Program placed a hobo pendant thermometer in each location in sand at nest depth (45cm) with no eggs. We found significant differences in sand temperatures between locations (mean temperatures = in box nursery: 31.49ºC; beach hatchery: 30.83ºC; and in situ: 34.13ºC (ANOVA $p<.001$)). Eight hobos were placed by University of Chapingo students in nests with eggs except for an in situ site, and these were not significantly different in terms of sand temperatures (mean temperatures= in box nursery: 32.05ºC; beach hatchery: 32.08ºC; and in situ: 32.28ºC (ANOVA $p=.09$)). Despite presenting the lowest mean nest temperature when eggs were present, the box nursery had greater diurnal variations in temperatures (+/- 10.7ºC) and was the only incubation method where temperatures exceeded upper lethal temperature limits for olive ridley turtle embryos on multiple occasions (>°C). Hatching success was higher in the beach hatchery (92%) compared to the box nursery (88%) but it was not significantly different. A multiple regression model using local weather data showed wind, sea surface temperature, air temperature, and air humidity could be important variables to monitor in the future as predictors of beach hatchery sand temperatures. Despite more variable temperatures being produced in the box nursery incubation technique, and unknown consequences on hatchling health and fitness, this method may become more necessary as higher sea levels and more destructive storms due to climate change erode nesting beaches. Therefore, studies of the two methods used at successful projects such as Boca de Tomates should continue in order to find and implement best management practices before climate change impacts intensify here and at other sites around the world.

EXPLORING MARINE TURTLE NEST SELECTION USING A BAYESIAN APPROACH*

Kristen A Nelson Sella[1], Nathaniel G. Plant[2], Joseph W. Long[3], Simona A. Ceriani[4], Nicole A. Desjardin[5], Maura C. Kraus[6], and Mariana M. P. B. Fuentes[1]

[1]*Florida State University, Department of Earth, Ocean and Atmospheric Science, Tallahassee, FL, USA*
[2]*St. Petersburg Coastal and Marine Science Center, U.S. Geological Survey, St. Petersburg, FL, USA*
[3]*Department of Earth and Ocean Sciences, University of North Carolina, Wilmington, Wilmington, NC, USA*
[4]*Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, St. Petersburg, FL, USA*
[5]*Ecological Associates, Inc., Jensen Beach, FL, USA*
[6]*Collier County Parks and Recreation, Naples, FL, USA*

Sandy oceanic beaches are important to the reproductive cycle of marine turtles as they exit the ocean to deposit their eggs in sand. Extensive research has been done to determine how and why marine turtles choose their nesting beach and what is needed for a beach to provide suitable nesting habitat. Previous research has shown that beach topography, accessibility, sand characteristics, inundation risk, and disturbance levels influence whether a beach is suitable for nesting. Although general habitat characteristics important for turtle nesting are known, specific patterns that lead to nesting site selection are less clear. Understanding marine turtle nest site selection is important to forecast how their habitat will be impacted by coastal development, restoration, storms, and sea level rise. Bayesian network models have been used to understand patterns in nest site selection of beach nesting birds such as piping plovers (*Charadrius melodus*) by looking at multiple landscape characteristics associated with nesting sites. This probabilistic model approach can be used to quantify nesting habitat of other species, such as marine turtles. In order to develop a Bayesian network model of marine turtle nesting, sites on Florida's Atlantic and Gulf of Mexico coasts were examined for eight years. Study sites were chosen for their relatively low disturbance levels as well as the availability of biological and elevation data (e.g., GPS locations for nests (n = 7141) and non-nesting emergences (n = 8534), lidar surveys) for multiple corresponding years: 2007, 2010, and 2015 (west coast) and 2004, 2006, 2007, 2009, and 2016 (east coast). The lidar data were used to determine an approximate distance to dune toe, distance to dune crest, distance to water line, elevation, and slope for each of the nests or non-nesting emergences (taken at the apex of the crawl). These parameters were then used to develop a Bayesian network model to link these morphological features of the nesting beach with the probability of the presence or absence of a marine turtle nest. Maps were developed to quantify nesting habitat at these locations. Future applications of these models can examine the potential impact of sea level rise (SLR) on marine turtle nesting habitat as well as understand how that habitat may be impacted by the presence of coastal modifications such as beach armoring, which can limit the available extent of nesting habitat if it causes beach narrowing. A decrease in available nesting habitat may impact the reproductive output of these species which is an important factor in their recovery.

DOES FLIPPER DAMAGE AFFECT LOGGERHEAD NEST PLACEMENT AND REPRODUCTIVE SUCCESS?

Sarah Shaver, Jake Kelley, Chris Long, Gustavo Stahelin, Erin E. Seney, and Kate L. Mansfield

Marine Turtle Research Group, Department of Biology, University of Central Florida, Orlando, FL, USA

Predation, fishery interactions, and boat strikes are major contributors to sea turtle mortality. Many predation events and human encounters can cause non-lethal injuries, but the impact of these injuries on sea turtle reproductive output is unknown. One way that non-lethal injuries could be detrimental to fitness is through impacts on nest site selection and nest digging; turtles with flipper injuries may nest in areas of the beach more susceptible to wash-outs and nest inundation. Nests most at risk are those laid lower on the beach and closer to the high tide line. We used data from a long-term nighttime nesting beach monitoring program at the Archie Carr National Wildlife Refuge (ACNWR), Florida, USA to determine the frequency of flipper damage in nesting loggerhead turtles (*Caretta caretta*) and assessed the impacts of non-lethal injuries on nesting by comparing nest placement and reproductive success between turtles with and without flipper damage. From 1982-2018, the University of Central Florida Marine Turtle Research Group (UCFMTRG) documented an annual average of 11,592 loggerhead nests in the 21-km Brevard County portion of the ACNWR. Over this same time period, UCFMTRG researchers intercepted nesting loggerheads at over 15,000 emergences and documented nest location, reproductive success of the nest, and flipper damage when present. We selected nests for which we recorded nest placement (distance to high tide line and dune), and categorized turtles into four groups: no damage, minor damage, major damage, and loss of flipper use/missing flipper. We used linear mixed effect models to compare the nest location and reproductive success of 244 nests laid by turtles with flipper damage and 966 nests for which we did not record any flipper damage. Our analyses suggest that loggerheads with major flipper damage nested closer to the high tide line than turtles with no flipper damage, possibly affecting the reproductive output of turtles with major flipper damage. With the potential for increasing boat strikes and other human interactions that cause flipper damage to increase, it will be important to monitor how flipper damage is affecting populations.

AN EXPERIMENTAL STUDY ON THE EFFECTS OF PARENTAL IDENTITY ON EMBRYO SIZE, INCUBATION DURATION, HATCHING SUCCESS AND HATCHLING SIZE IN LOGGERHEAD TURTLES (*CARETTA CARETTA*)

Boris M. Tezak, Mikaela Arena, Samantha Mueller, Taylor Snyder, and Itzel Sifuentes-Romero

Florida Atlantic University, Boca Raton, FL, USA

For turtles, the incubation environment experienced during embryonic development plays critical roles in many biological processes. Due to the inevitability of the changing climate, it is critical to understand the effects that the incubation environment has on developing turtles. As a result, many studies focus on the effects of different environmental conditions on a number of developmental processes and hatchling phenotype. Previous studies found that temperature and moisture strongly affect at least hatching success, hatchling size, incubation duration, and hatchling sex. In addition to environmental conditions, it is also critical to assess how development and the resulting hatchling might be influenced by variation due to parental origin. In this study we investigate parental influence on embryo size, incubation duration, hatching success, hatchling size, and hatchling mass. Eggs from single clutches laid by six female loggerhead sea turtles (*Caretta caretta*) were evenly distributed into six experimental nests on the beach. Experimental

nests were designed to be at one of three moisture conditions (wet, moderately wet, or ambient) at either shaded ("cool") or unshaded ("hot") nest sites. Six eggs per experimental nest were harvested at 5 different developmental stages to assess differences in embryo growth; the remaining eggs were allowed to hatch and hatchling size (SCL, SCW, HW) and weight were collected. Interestingly, we found that the original clutch (defined as maternal identity) did not have an effect on early developmental rate but it did correlate with incubation duration. In addition, maternal identity also had a strong effect on hatching success and hatchling size. Our results highlight the importance of parental influence on the timing developmental events. Understanding background sources of variation in developmental responses to incubation conditions is fundamental when interpreting the impacts of environmental conditions on sea turtle development.

A BROAD SPATIAL AND TEMPORAL ANALYSIS OF MAMMALIAN PREDATION ON LOGGERHEAD NESTS IN THE STATE OF FLORIDA (USA)*

Luciano S. Soares, Beth Brost, Erin Leone, and Simona A. Ceriani

Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, FL, USA

Florida hosts ~90% of all loggerhead nests laid in the USA. The Florida loggerhead nesting aggregation is comprised of seven genetically distinct management units (MU): Northwest (NW), Central-west (CW), Southwest (SW), Dry Tortugas, Southeast (SE), Central-east (CE), and Northeast (NE). The Florida Fish and Wildlife Conservation Commission coordinates monitoring of sea turtle nesting activity through an extensive network of permit holders covering 1349 km on 226 beaches. Turtles on nesting beaches are exposed to several threats such as beach erosion, coastal armoring, light pollution and predation. Predation is part of the natural system and sea turtles' highly reproductive output compensates for its impacts to a certain level. The U.S. Recovery Plan for the Northwest Atlantic loggerhead population advises that ecologically sound predator control programs be implemented to ensure that the annual rate of mammalian predation on nests (under U.S. jurisdiction) is 10% or below within each recovery unit (RU) based on standardized surveys. Several predators are known to impact loggerhead nests but so far studies have been limited spatially and/or temporally; thus, the extent of predation impact at the population-level has not been determined. The objectives of this study were to identify loggerhead nest predators and the rate of mammalian predation throughout a broad geographic area and time. We analyzed 44,700 records collected using a standardized protocol from 45 beaches encompassing six loggerhead MUs between 2002 and 2017. Five MUs (NE, CE, SE, SW, CW) constitute the Peninsular Florida RU, while the NW MU is part of the Northern Gulf of Mexico RU. Data were available for 16 beaches (2002-2017), and 29 additional beaches (n=45 total) from 2012 to 2017. For the 16 beaches (n= 27,602), the average annual mammalian nest predation rate (avgANMPR) was 10.60% (sd= 2.2%, range: 6.04% - 14.76%). Overall the most common predator was the raccoon. For the 45 beaches, between 2012-2017 (n=30,932), the avgANMPR was 15.23% (sd= 3.27%, range:12.22% - 19.87%). The most common predator was the raccoon, followed by canines (coyotes and dogs). Three of the six MUs experienced predation levels above 10%; however, nest protection techniques (e.g., screening, caging, predator control) are implemented only on a few beaches affected by significant levels of predation. Predation could pose a threat to loggerheads in Florida, especially for Western MUs. Further analysis on the strategies used to mitigate predation and evaluation of their efficacy will be carried out and used to inform implementation of appropriate and targeted protection at the beach-level.

PAST, PRESENT, AND FUTURE: NESTING ECOLOGY AND THE RESILIENCE OF THE HAWAIIAN GREEN SEA TURTLE TO CLIMATIC EVENTS*

Marylou K. Staman[1,2], Jan Willem Staman[1,2], Alexandra S. Reininger[2], Shawn K. K. Murakawa[2], Summer L. Martin[2], Alexander R. Gaos[1,2], Lindsey N. Bull[1,2], Shandell M. Brunson[2], George H. Balazs[2], Camryn D. Allen[1,2], and T. Todd Jones[2]

[1]*Joint Institute for Marine and Atmospheric Research, University of Hawai'I at Mānoa, Honolulu, HI, USA*
[2]*Marine Turtle Biology & Assessment Program, Protected Species Division, Pacific Islands Fisheries Science Center, NOAA Fisheries, Honolulu, HI, USA*

Residing in the most geographically isolated island chain on the planet, the Hawaiian green sea turtle population was recently designated as a Distinct Population Segment (DPS) under the U.S. Endangered Species Act. One of 11 global DPSs, the Central North Pacific population offers unique research opportunities as a "closed" population, with almost no movement of individuals into or out of the region. For 45 years, the population's primary nesting habitat on the islets of French Frigate Shoals (FFS) in the Northwestern Hawaiian Islands has been monitored by NOAA Fisheries' Marine Turtle Biology and Assessment Program. This long-term tagging study has produced a wealth of information about the status and trends of Hawai'i's nesting females. For example, the data indicate that approximately 96% of the population nests at FFS, with >50% occurring on the islet called East Island ("East"), and a 5.4% annual increase in nesting female abundance on East over several decades. There remains, however, limited data to assess this population's resilience to the potential effects of climate change. Currently, our research foci are hatching success, incubation temperature (for hatchling sex-ratio), genetic sampling (for operational sex-ratio), and satellite telemetry with fine scale habitat use (for foraging connectivity). For three years we extended the length of the field seasons to allow saturation tagging of nesting females and excavation of nests (264 nests were excavated on East from 2017-2018 - a dramatic increase compared to published data from only 40 nests excavated prior to 2017). Emergence success remained similar to previous years (2017-2018: 71.3%, 95% CI [68.9, 73.9]; 1974-1975: 70.8%) and mean hatching success potentially increased during the recent nesting seasons (2017-2018: 79.9%, 95% CI [77.4, 82.3]; 1974-1975: 76.7%). The new data revealed large inter-annual and monthly variability in incubation periods and temperatures. This finding highlights the importance of monitoring the environmental parameters within and between seasons at this relatively high-latitude nesting site, especially considering recent ENSO events and climatic impacts. Perhaps most crucial, in light of the recent loss of East to a hurricane, was the increased monitoring of inter-island movements within FFS. In 2017 and 2018, 58 and 34 females, respectively, were tagged while basking on one island and later observed nesting on a different island. Furthermore, at least 34 of the 2017 females and 16 of the 2018 females were observed nesting at both of the primary nesting sites in FFS. Several females were observed moving between islands within a 24-hour period. While many questions remain about the resilience of this population to the loss of one of their primary nesting islands and whether other islets have the capacity to support larger numbers of nesting females, our evidence that nesting females already possess the "map" of available nesting habitat in FFS is encouraging. Future research studies include (1) pivotal nest temperatures to better predict population feminization from forecasting models and (2) male migratory ecology and paternity to elucidate breeding sex ratios for Hawai'i's principal rookery.

OVERCOMING INVASION OF IPOMOEA SP. ROOTS IN LEATHERBACK TURTLE NESTS

Yairus Swabra[1], Johni Mau[1], Deasy Lontoh[1], Fitryanti Pakiding[1], and Manjula Tiwari[2]

[1]Lembaga Penelitian dan Pengabdian kepada Masyarakat Universitas Papua, Manokwari 98314, Papua Barat
[2]Marine Turtle Ecology and Assessment Program, NOAA-SWFSC, La Jolla, CA, USA

Wermon beach in the Bird's Head Peninsula of Papua, Indonesia, is one the last two most important beaches in the Pacific for leatherbacks with an estimated 1200 nests laid in 2017. The State University of Papua's (UNIPA) turtle monitoring program aims to quantify nesting activity as well as increase hatchling production. Hatchling production at Wermon is impeded by high waves during December and January, invasion of Ipomoea sp. roots into nests, and predation. Starting in the 2016, the UNIPA team began noticing widespread distribution of Ipomoea sp. and its devastating effects. The roots wrapped around all the eggs in the nest and effectively sucked the nutrients out of them. During the October 2016 to March 2017 nesting season, nearly all nests that did not get washed away by the high waves failed to hatch because of Ipomoea sp. roots. The UNIPA team has been trying out three different methods to overcome the invasion: 1) relocating nests into natural hatcheries located at the edge of the vegetation line, 2) relocating nests into an area where Ipomoea sp. was previously cleared, and 3) clearing the area surrounding nests that were laid in the midst of Ipomoea sp. mat (clearing radius of five meters). Average hatching success of nests in the hatcheries was greatest, followed by that of the nests relocated to cleared areas. In the in-situ nests where surrounding areas were cleared of Ipomoea sp., the average hatching success was the lowest. Although nests relocated into hatcheries have the greatest hatching success, it is not the ideal solution because the amount of areas above the high tide mark where hatcheries can be built is highly limited. This experiment is still ongoing, but we likely need to combine more than one method to increase hatching success of leatherback nests in Wermon.

USING BLOOD SAMPLES TO IDENTIFY THE SEX OF HATCHLING LOGGERHEAD SEA TURTLES*

Boris M. Tezak, Itzel Sifuentes-Romero, Sarah Milton, and Jeanette Wyneken

Florida Atlantic University, Boca Raton, FL, USA

Marine turtles exhibit temperature dependent sex determination (TSD). In TSD species, the differentiation of gonads into ovaries or testes appears to depend on egg incubation temperature during a critical period of embryonic development. The pattern of temperature-dependent sex determination in sea turtles is hot female/cool male. Because sex determination in turtles is so closely linked to environmental conditions, the most common concern associated with climate change is that marine turtles will be at a higher risk of extinction if sex ratios become dramatically female-biased. These concerns highlight the importance of identifying current and historical sex ratios at sea turtle nesting beaches. Timely and robust estimation of hatchling sex ratios at rookeries remains imprecise due to the lack of sexual dimorphism in young marine turtles and delayed sexual maturity. Most common sex ratio estimations are indirect, based on nest temperatures, air and sea surface temperatures, incubation duration and estimated thermosensitive period durations. However, accuracy of these proxies is unknown. Methodological limitations greatly contribute to this data gap. The lack of a simple, nonlethal technique to verify the sex of hatchlings is at the foundation of this problem. This study describes a new 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 in hatchling blood samples. The presence of these proteins was then compared to the results from laparoscopic or histological procedures to validate this approach. The finding of a sex-specific marker in hatchling turtle blood samples is key to large scale measurement and verification of naturally occurring sea turtle sex ratios; a crucial step in assessing the impacts of climate change on imperiled turtle demographics.

CHARACTERIZING THE EFFECTS OF GROUNDWATER ON SOIL MOISTURE AND TEMPERATURE OF LOGGERHEAD SEA TURTLE NESTS ON SANIBEL ISLAND, FLORIDA

Courtney M. Thomson, Kelly A. Sloan, A.J. Martignette, and Jeanette Wyneken

[1]*Sanibel-Captiva Conservation Foundation, Sanibel, FL, USA*
[2]*Florida Atlantic University, Boca Raton, FL, USA*

Incubation temperature is a key variable that affects the development of loggerhead (*Caretta caretta*) sea turtle embryos. Recent research suggests that additional environmental factors, such as moisture, can also play a significant role in both sea turtle hatching success and sex determination. Understanding the dynamics among these factors is becoming increasingly important considering the predicted increases in global temperatures and changes in storm patterns. Sanibel Island, located in Lee County off of the coast of Fort Myers, Florida, USA provides approximately 21 kilometers of nesting habitat for an average of 400 (2009-2018) loggerhead sea turtle nests annually. Previous research suggests that Sanibel beaches produce more males than would be expected based on local incubation temperatures alone. Sanibel also has significant groundwater flows, with major known discharge areas on the east end of the island. We hypothesized that the groundwater could impact the nest temperature and/or moisture to alter hatching success and hatchling sex ratios. To quantify these effects, sensors measuring groundwater level, soil moisture, and nest temperature at 15-minute intervals were installed in nine in-situ loggerhead nests. Rain gauges were installed adjacent to two nests to evaluate the influence of rainfall. Analyses suggest a significant negative relationship between groundwater depth and nest incubation temperature. In addition, groundwater positively affected soil moisture, but appears to vary significantly among individual nests likely as a function of rainfall.

STATUS OF THE REPRODUCTIVE SUCCESS AND POTENTIAL OVERABUNDANCE OF FEMALE HATCHLINGS AT CUBA'S LARGEST GREEN TURTLE NESTING AREA*

Julia Azanza Ricardo

Instituto Superior de TecnologÃa y Ciencias Aplicadas, Cuba

Cayo Largo is the main nesting site for green turtles and loggerheads in Cuba. Although there has been monitoring of the nesting for more than 15 years, it has not been systematic. On the other hand, no information about incubation temperatures in that area is available, even when there is an incubation area functioning. Due to the contribution of this nesting area to regional marine turtle populations it is vital to determine the percentage of females that are produced in those beaches. To do so we established an experiment to determine spatial and temporal variation on incubation temperature. Sensors were placed inside the incubation chamber of naturally incubated nests (7) and artificially incubated (11 in 2018 and 5

in 2017). Hatchling emergence success was compared between nests naturally incubated and those moved to the artificial incubation area. Results indicate a clear positive trend in nesting in the area. However, natural disturbances in the nesting beaches leads to the movement of some nests to an artificial incubation area which compromises the emergence success which is on average 30 % lower than in the natural areas. At the same time, incubation temperature in the incubation area is almost 2 degrees higher than in natural incubated nests. All sampled nests during July and August had mean incubation temperatures above 30 °C or even higher than 32 °C in the case of the incubation area. These values of temperatures are indicating possible high levels of female production. Since Cayo Largo is the largest green turtle nesting population in Cuba this could be adding large numbers of female recruits to the Cuban archipelago and other nesting areas in the Caribbean. Therefore, further and urgent studies are needed to actually determine how the female production in this important nesting area is.

A GLOBAL SYNTHESIS OF SEA TURTLE LIFE HISTORY DATA FOR DEMOGRAPHIC STUDIES: A CASE STUDY IN THE LOGGERHEAD SEA TURTLE

Mathew VanBemmel[1], Matthew Ramirez[1], Brandon Chasco[1], Alexia Kenney[2], Julia Nina-Marie Hart[1], Natasha Nemyre[1], Susan Piacenza[2], Martha Rincon-Diaz[1], and Selina Heppell[1]

[1]*Oregon State University, Corvallis, OR, USA*
[2]*University of Western Florida, Pensacola, FL, USA*

Sea turtle population assessments require an understanding of sea turtle demographic rates, both their means and variances, to accurately model population dynamics. However, many population assessments are limited by insufficient demographic data and more research needs to be conducted. Our main objective is to develop species- and region-specific demographic rate estimates that can be used for population modeling through a global meta-analysis of sea turtle demographic studies. We also outline pitfalls we encountered while performing the meta-analysis and provide recommendations for improved data reporting in publications. To demonstrate our study, we present data on loggerhead sea turtle clutch size and nester size, two closely related demographic parameters with varying amounts of published data globally. We conducted a literature search to compile studies that reported data for the following demographic parameters: clutch size, clutch frequency, hatching success, remigration interval or breeding probability, hatchling sex ratio, and size of (first time) nesting females. Potential sources were identified from online literature databases (e.g., Web of Science, Sea Turtle Online Bibliography), sea turtle books, theses and dissertations, pertinent global and regional journals and newsletters, and paper reference lists. From this search, we have compiled more than 900 data sources, 300 of which pertain to loggerhead sea turtles. The Regional Management Unit (RMU) framework developed by Wallace et al. (2010) is being used to bin data for each demographic rate by region for each species. Region-and species-specific weighted mean and variance estimates are being calculated for each parameter using random effects models that account for within and between study variation. Hierarchical models and correlation analyses will be used to compare parameter estimates among RMUs. Resulting metadata will be made publicly available for use by regional natural resource managers and to parameterize demographic models for population assessment. During the data extraction step of this project, we encountered inconsistencies in data reporting that prevented many papers from being included in the meta-analysis (e.g., incorrect geographic coordinates listed, no sample size, measure of variability not reported). To ensure broadest possible use of published data, we recommend reporting sample size, a measure of variability, and the type of measure of variability (e.d., SD, SE, CV) used for each reported mean value. We also suggest recording study location to the closest second if using the degree, minute, second format or three decimals if using the decimal degree format.

THE INFLUENCE OF "LEAVE NO TRACE" ORDINANCES ON SEA TURTLE NESTING SUCCESS

Matthew Ware and Mariana M.P.B. Fuentes

Florida State University Marine Turtle Research, Ecology, and Conservation Group, Tallahassee, FL, USA

Sandy beach ecosystems provide valuable ecosystem services to coastal communities such as storm protection, tourism, wildlife viewing, and habitat for protected species. Threats to these services include coastal development, erosion, and sea level rise. In addition to coastal armoring, artificial lighting, human activity, and abandoned beach equipment or debris can further reduce the availability of optimal beach habitat for sea turtles. "Leave No Trace" ordinances and product bans are being used to combat several of these threats, particularly the issue of marine debris. In the case of Baldwin County, Alabama, a "Leave No Trace" ordinance was implemented in 2016 within the city limits of Gulf Shores and Orange Beach. Nesting success and the percentage of obstructed crawls were evaluated both pre- and post-ordinance implementation and between ordinance and non-ordinance beaches using crawl data from the 2011 to 2018 nesting seasons. Enforcement of the "Leave No Trace" ordinance did not improve nesting success in Alabama. The presence of obstructions during a crawl was not a significant component when evaluating nesting success. However, obstructed crawls did decrease by 18% at "Leave No Trace" beaches and increase by 46% at a neighboring non-ordinance beach, relative to pre-ordinance levels. Sea turtle nest site selection is highly variable, and a female turtle may abandon her nesting attempt at any time for reasons beyond obstructions. Improvements in nesting success may not be immediate as enforcement of, and cultural changes associated with, the new ordinance require time. With time and compliance, fewer enforcement patrols will be needed - reducing the potential deterrent effect of nighttime human activity and coastal zone management costs.

RARE SIGHTINGS OF CRITICALLY ENDANGERED EAST PACIFIC HAWSKBILL TURTLES (*ERETMOCHELYS IMBRICATA*), NESTING ON COSTA RICA'S SOUTHERN NICOYA PENINSULA

Emily Grace Webster[1], Daniela Rojas-Cañizales,[1], Carmen Mejías -Balsalobre[1], Daniel Arauz[1], Isabel Naranjo[1], and Randall Arauz[2,3]

[1]*CREMA, Rescue Center for Endangered Marine Species, Costa Rica*
[2]*Fins Attached Marine Research and Conservation, Colorado Springs, CO, USA*
[3]*Migramar, Olema, CA, USA*

The state of the critically endangered Hawksbill turtle (*Eretmochelys imbricata*) is of particular concern in the Eastern Pacific. Prior to 2008, little was known about Eastern Pacific Hawksbills, and the population was listed by the IUCN as of global-scale "critical research and conservation needs". It is estimated that a population of less than 500 individuals nest between Mexico and Peru, with most nesting activity occurring in rookeries in El Salvador and Nicaragua. While being an important site for individuals to feed and grow, encounters with nesting Hawksbills are extremely rare in Costa Rica's Pacific. Where data is available, nesting is sporadic, with most beaches reporting fewer than four nests deposited per year. Since 2015, The Rescue Center for Endangered Marine Species (CREMA) primarily monitors nesting of Olive Ridley turtles (*Lepidochelys olivacea*) on four adjacent beaches in Costa Rica's Southern Nicoya Peninsula (previously

monitored by PRETOMA). The organisation also records incidental nesting of Green (*Chelonia mydas*), Leatherback (*Dermochelys coriacea*), and recently, Hawksbill females. Of the four beaches, Playa San Miguel (1998-2018) is the longest running CREMA project, followed by Corozalito, which opened in 2008. This study summarises data from sightings of Hawksbills that successfully nested on CREMA beaches from 1998 until 2018, reporting on the locations and timing of nesting events, clutch sizes and emerging success. Historical records of encounters with successful Hawkbill nesters exist for PRETOMA projects, namely Caña Blanca (one in 1999), Punta Banco (one in 2002), and Playa Caletas (two in 2005, six in 2007, and one remigrant in 2018). In 21 years of field studies, three sightings were recorded on two CREMA nesting beaches: two on Corozalito Beach in 2015, including a remigrant from Camaronal, and one on San Miguel Beach in 2018. All three sightings occurred between late June and mid-July. In each case, the female was tagged for future identification and biometric data was collected. Clutch size ranged from 91 to 127 eggs. The Corazolito nests were left in situ; the first was not found for exhumation, and the second had an emerging success of 55%. The nest deposited on San Miguel was relocated to a hatchery and had an emerging success rate of 89%. Hawksbill females are known for short migrations, and their presence in Costa Rica's Pacific brings to light the importance of this area as a nesting habitat, even for a small number of individuals. This study represents the first report of nesting Hawksbill encounters at CREMA beaches, contributing to an information deficient, but growing knowledge base. Developing a deeper understanding of the Eastern Pacific Hawksbill population is essential in light of its conservation status.

DO ARRIBADA EVENTS AFFECT SOLITARY NESTING ACTIVITY OF OLIVE RIDLEYS (*LEPIDOCHELYS OLIVACEA*) ON ADJACENT BEACHES IN COSTA RICA'S SOUTHERN NICOYA PENINSULA*

Emily Grace Webster[1], Daniela Rojas-Cañizales[1], Carmen Mejías-Balsalobre[1], Isabel Naranjo[1], and Randall Arauz

[1]CREMA, Rescue Center for Endangered Marine Species, Costa Rica
[2]Fins Attached Marine Research and Conservation, Colorado Springs, CO, USA
[3]Migramar, Olema, CA, USA

Early studies of Olive Ridley marine turtles (*Lepidochelys olivacea*), suggest that discrete populations exclusively perform one of two nesting behaviours: solitary or aggregate (arribada) nesting. More recently, evidence points to a mixed strategy, with no genetic or physiological differences existing between solitary and arribada nesters. The Rescue Center for Endangered Marine Species (CREMA) monitors Olive Ridley nesting on four geographically adjacent beaches in the Southern Nicoya Peninsula, Costa Rica: Corozalito, Bejuco, San Miguel and Costa de Oro. On all, females nest solitarily. There is also sporadic arribada activity on the northernmost beach, Corozalito. Although small, Corazalito arribadas have been occurring with increasing frequency and regularity in recent years. CREMA conducts flipper tagging and nesting activity surveys throughout the nesting season on all four beaches. Access to these projects, including one on which both nesting strategies manifest, provides an opportunity to draw links between these strategies. This study aims to determine if such links exist, and specifically, whether arribada events affect nesting activity on solitary beaches. We revised the CREMA database from three years (2016-2018) of arribada nesting in Corozalito, and solitary nesting in Bejuco, San Miguel, and Costa de Oro to extract daily counts of nesting events at each beach. We compared the solitary nest counts before, during and after arribadas with linear models, testing for lagged effects. We also compared the number of nesting turtles at solitary beaches over time, in relation to distance from the arribada beach. Finally, we reviewed tag recapture records for the same years, calculating the number of females encountered successively exhibiting both solitary and arribada nesting. Preliminary observations from nesting activity surveys reveal that a peak occurs in the number of nesting events at Bejuco, between one and five days before the arribada. Solitary activity at all

four beaches gradually declines to zero throughout and after the arribada. This relationship is most pronounced on the beaches nearest to Corozalito: Bejuco and San Miguel, and when the mass nesting exceeds 5000 individuals. Tag recaptures from 2016 and 2017 also suggest that the solitary and arribada beaches studied by CREMA are connected, with individuals moving according to conditional reproductive behaviours. In 2016, of 120 total recaptures, 38 (31.67%) were solitary-tagged turtles found in Corozalito arribadas, 16 of which were tagged in Bejuco, San Miguel and Costa de Oro. In 2017, of 194 total recaptures, 39 (20.10%) were solitary-tagged turtles encountered nesting in Corozalito arribadas, 20 of which were tagged on the neighbouring beaches. In 2018, two small arribadas have occurred on Corozalito. We are continuing to collect data for the present year. This study sheds light on the complex nesting dynamic of Olive Ridley turtles in the Eastern Pacific, by demonstrating connectivity between nesting beaches linked to a conditional reproductive strategy. In practical terms, these findings enable CREMA participants to anticipate potential arribada events when peaks in solitary nesting occur. They are also essential for understanding the variable behavior of solitary nesting beaches in future years, particularly in light of the changing dynamics of Corozalito arribadas.

ADVANCING KNOWLEDGE OF TANZANIA'S NESTING GREEN TURTLE POPULATION*

Lindsey West

Sea Sense, Dar es Salaam, Tanzania

Between 450 and 500 green turtle (*Chelonia mydas*) nests are recorded annually in Tanzania. More than half of those nests are laid in Juani, a tiny island off the east coast of Mafia Island in central coastal Tanzania. In 2001, a community-based nest monitoring and protection programme was established in Mafia Island. Community Conservation Officers patrol nesting beaches on a daily basis throughout the year to monitor nesting activity. Nests at risk of poaching, predation or tidal inundation are relocated to a safer area. Nests are monitored throughout the incubation period and Conservation Officers conduct post hatching excavations to calculate hatching and emergence success. Since the programme began, 2,227 nests have been monitored and protected in Juani Island and more than 172,000 hatchlings have safely reached the sea. In 2011, after 10 years of nest monitoring, analyses of nesting data confirmed that there was a significant increase in the number of nests laid annually in Juani Island. Despite this upward trend in nest numbers, the size of the nesting population remained unknown. It is widely acknowledged that monitoring of nest counts alone does not provide accurate enough information to generate true abundance estimates or to evaluate the effectiveness of local protection measures. To address this knowledge gap, in 2012, monitoring was intensified during the peak nesting months of April and May. Hourly night foot patrols were conducted between 19:00 and 06:00 hours for 62 nights at four beaches in Juani Island where most nesting is concentrated. The curved carapace length (CCL) and curved carapace width (CCW) of each turtle were measured and the turtle was examined for the presence of existing tags. If not already tagged, individually numbered titanium tags (TZ series) were applied between the first and second scale along the posterior edges of the front flippers. The intensive monitoring programme has been repeated every year during the peak nesting season in Juani Island since 2012. The mark-recapture method has generated information on inter-nesting durations, clutch frequencies and re-migration intervals and produced a preliminary population estimate of 41 – 72 individuals. Between 2012 and 2018, the number of females nesting in the peak season ranged from 13 – 33 individuals. High levels of inter-annual variability in numbers of nesting females are a reflection of varied re-migration intervals. Re-migration intervals ranged from one to four years. Annual variability in nesting numbers highlights the importance of long-term datasets when estimating sea turtle population sizes and assessing the effectiveness of local protection measures. While an eight-year dataset is considered short for species with long generation times, reducing reliance on nest counts as a metric for population size has been an important step forward. The intensive monitoring programme has ensured that efforts to evaluate the success of the sea turtle conservation programme in Juani Island are more scientifically robust which in turn has helped to improve the credibility of community-based approaches to sea turtle conservation amongst decision makers in Tanzania.

EVALUATION OF IN-WATER MOVEMENTS AND ARRIBADA NESTING BEHAVIOR OF KEMP'S RIDLEY SEA TURTLES USING PREPROGRAMMED UAV SURVEYS DURING THE 2018 NESTING SEASON*

Thane Wibbels[1], Erika Navarro[2], Manuel Rosas[2], Jose Gerardo Marine[2], Javier Montano[2], Martha Lopez[3], Hugo Acosta[3], Amy Bonka[1], Francisco Illescas[4], Luis Jaime Pena[2], and Patrick Burchfield[2]

[1]University of Alabama, Birmingham, AL, USA
[2]Gladys Porter Zoo, Brownsville, TX, USA
[3]CONANP, Ciudad Victoria, MX
[4]CDEN, Tampico, MX

The Kemp's ridley (*Lepidochelys kempii*) exhibits pan-specific migration behavior followed by mass nesting behavior (i.e., arribada behavior). In the current study, UAV-based aerial surveys using preprogrammed flight plans were used at the Kemp's ridley sea turtle's primary nesting beach at Rancho Nuevo, MX. Several different commercially available UAVs were used in the study using preprogrammed flight plans. Over 200 missions were flown during the 2018 nesting season. The results indicate that turtles gradually moved closer to shore several days prior to arribada nesting, and some relatively large in-water aggregations were recorded. The locations of the in-water aggregations as well as the locations of the arribada nesting was variable. The results also indicate that several days immediately prior to arribada nesting, turtles could move very close to shore and aggregate in waters adjacent to shore including the surf zone. The in-water as well as nesting behavior suggest that the turtles may be using specific aggregation cues and/or nesting cues. (e.g., social, environmental, etc.) to select aggregation and nesting locations. Collectively the results provide basic insight on migratory and arribada nesting behaviors in the Kemp's ridley sea turtle. These results are from ongoing research conducted as part of the Kemp's Ridley Bi-National Recovery Program. The authors would like to acknowledge the Bi-National Kemp's Ridley Recovery Program field crews, without whom this research would not be possible. The authors would also like to thank the undergraduate research students at UAB who assisted in video and photo analysis. This work was funded by the Marine Turtle Conservation Fund and UAB.

POPULATION BIOLOGY

MULTI-DECADAL OSCILLATIONS IN RECONSTRUCTED COASTAL SOIL TEMPERATURES IN THE SOUTHEAST U.S. IN THE PAST CENTURY: ARE FEARS OF MALE-LIMITED SEA TURTLE POPULATIONS SUBSTANTIATED?

Michael D. Arendt[1], David S. Wethey[2], Ryan R. Rykaczewski[2], Roger H. Sawyer[2], David W. Owens[3], and Joseph M. Quattro[2]

[1]*South Carolina DNR, Columbia, SA, USA*
[2]*University of South Carolina, Columbia, SC, USA*
[3]*College of Charleston (retired), Charleston, SC, USA*

Sea turtle sex is determined by the incubation environment during critical development periods in terrestrial nests; thus, these taxa are particularly vulnerable to predicted global climate change. Contemporary studies emphasize the potential increased female cohort bias and/or decreased hatchling production and survival under the assumption of a warmer climate, but none have considered the possibility of non-linear future climate trajectories. In the present study we investigate historical coastal soil temperatures (and moisture content) in the southeast U.S. from two recently completed global climate reconstructions: 1960–2013 (JRA-55) and 1900–2013 (ERA-20C). Nine spatial locations that encompassed 95% of the nesting range of loggerhead sea turtles (*Caretta caretta*) in the NW Atlantic Ocean were evaluated with respect to daily theoretical incubation duration, computed as a degree day threshold, during a typical nesting season (1 May to 2 September). Spatial clustering of four areas north and five areas south (to west) of a zoogeographic barrier (Cape Canaveral, FL) was observed, and four temporally-distinct incubation duration phases were noted for all nine areas since 1900. Shorter incubation duration phases were significantly (<0.001) correlated with warm phases of the Atlantic Multi-decadal Oscillation (AMO) and conversely, longer incubation duration with cool phases of the AMO. Consequently, recent reports of increased female hatchling production are auto-correlated with a steady transition of the AMO away from a cold phase peak in 1974 and achieving an initial warm phase peak in 1998. Annual index variability for the past two decades is consistent with the previous warm phase (1926 to 1962); thus, if historical periodicity persists, transition back to the cool phase is anticipated by the mid 2030's. As such, the ensuing decade promises to be an exciting period of discovery in the increasingly heated debate surrounding future impacts to numerous taxa in changing global climate. Therefore, broad monitoring of sea turtle sex rations on terrestrial beaches and on foraging grounds is advisable.

RE-VISITING LEATHERBACK SEA TURTLE AGE AND GROWTH

Larisa Avens[1], Lisa R. Goshe[1], and George Zug[2]

[1]NOAA National Marine Fisheries Service, Southeast Fisheries Science Center, Beaufort Laboratory, Beaufort, NC, 28516 USA
[2]Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington DC, 20013 USA

Although data characterizing somatic growth patterns and the ages and sizes at which organisms mature are fundamental to understanding population dynamics and potential effects of management actions, collecting such data remains difficult for all sea turtle species. Leatherbacks present particular challenges due to prevalence of foraging and migratory habitat use in remote, open-ocean areas and unusual physiological characteristics. In the absence of the capacity for direct observation in the wild, inference must be made through indirect approaches. Early estimates of 2-4 yr to maturation from short-term captive growth studies combined with anatomical observations contrast with estimates of 12-20 yr yielded by recent, longer-term captive growth observations and genetic inference of generation times. Initial skeletal growth mark analysis (skeletochronology) of lateral edges of scleral ossicles from the eyes of leatherbacks that died prior to 1996 in the eastern Pacific (EPAC) yielded mean estimates of 13-14 yr to reach adult sizes. However, later skeletochronological analysis of western North Atlantic (NWA) samples collected 2001-2006 found greater growth mark retention and clarity at scleral ossicle tips. Analysis of marks from this alternate location yielded age ranges associated with minimum and mean initial size of nesting NWA females as 16-22 and 24.5-29 yr. While the skeletochronology studies offered insight into how old adult-sized leatherback sea turtles might be at the time they died, data describing ages and sizes specifically at the time of maturation are still lacking. And as leatherback age and growth data overall are limited in scope and estimates range widely, usefulness of available information is constrained. To address this data gap, we re-analyzed scleral ossicles from earlier studies to apply recent refinements in skeletochronological analysis. Specifically, we (1) developed an approach for proportional back-calculation of prior carapace lengths from scleral ossicle growth mark measurements, (2) identified indicators of maturation from abrupt decreases in growth mark spacing (i.e., "rapprochement"), and (3) used these approaches to generate updated estimates of ages at maturation and allow regional comparison between NWA and EPAC, albeit on different time frames. Back-calculation generated curved carapace length (CCL)-at-age trajectories for individual turtles. Generalized Additive Mixed Models (GAMMs) were applied to characterize mean CCL-at-age relationships and 95% credible intervals for each population. Somatic growth rates during the first year of life were found to be very rapid, comparable to captive growth data. For example, earlier growth models fit to captive NWA juvenile data predicted 2.8 yr at ~70 cm SCL and estimates from the current study were 3 (NWA) and 5 (EPAC) years at 73 cm CCL. From the "rapprochement" growth mark denoting maturation, NWA minimum maturation CCL of 112.8 cm corresponded with age estimates of 12-13 years (95% CI 10.5-13.5 years) and mean maturation CCL of 129.2 cm was associated with age estimates of 19-19.5 yr (95% CI 17-21.5 yr). For EPAC samples, rapprochement was associated with minimum maturation CCL and ages of 110.7 cm and 11.5-12 years (95% CI 10-14 years) and mean maturation CCL and ages of 129.7 cm and 17-20 years (95% CI 17-24 years). Reproductive longevity calculated using the number of growth marks deposited following rapprochement ranged from 3-22 yr (NWA) and 3-18 yr (EPAC). These updated estimates of age at maturation from skeletochronological analysis of scleral ossicle tips are lower than those previously proposed and more comparable to those predicted from fitting growth curves to recent, long-term captive growth data. Furthermore, estimates of reproductive longevity presented here are consistent with ranges observed from tagging studies. Together, these results indicate that application of the refined skeletochronological approach described here may offer opportunities to increase understanding of leatherback age and growth.

FORAGING GREEN TURTLES MAPPING BY DRONE

Katia Ballorain[1], Romain Dambreville[2], Claire Jean[3], Marc Lennon[4], Jean-Christophe Zufferey[5], David Corman[6], Gwénaël Duclos[2], and Stéphane Ciccione[1,3]

[1]*CEDTM, La Réunion, France*
[2]*Wipsea, Cesson-Sévigné, France*
[3]*Kelonia, La Réunion, France*
[4]*Actimar, Brest, France*
[5]*Sensefly, Switzerland*
[6]*AFB*

Environmental education is an important tool to transform people's attitudes and behaviors towards the environment. However, designing effective environmental education programs is a challenging task for small conservation projects that face limited resources and heterogeneous social contexts. Previous research suggests that in order to be effective, education programs need to be fun, culturally sound, and participatory. One way to achieve these characteristics is to articulate environmental education messaging with cultural expressions such as music and theater. Following this logic, during 2018, in collaboration with community groups, we developed the puppet show "Trip to the Center of the Carapace". This show was presented to families of the coastal communities of the Pacific coast of Nicaragua located near some of the most important nesting beaches of Hawksbill (*Eretmochelys imbricata*), Leatherback (*Dermochelys coriacea*), Olive Ridley (*Lepidochelys olivacea*) and Green turtle (*Chelonia mydas*). During 2018, we presented the puppet show in 14 communities, reaching an audience ranging from 100 to 200 people per event. In most of these communities, the direct use of turtles is one of the most important stressors. For example, a sizeable number of local people actively engage in the illegal extraction of turtle eggs and the trade of hawksbill jewelry. In addition, the by catch of turtles prevails in various sites at different levels. Thus, the puppet show script was incepted with content related to the following themes: a) current legislation on marine turtles in Nicaragua, b) ecological and economic importance to society at local and regional level, and c) responsible fishing. In addition to the thematic content, through the dramatic storyline, the show seeks to create awareness based on emotions, incentivizing dialogue, the exchange of experiences, and strengthening the audience's empathy towards the turtles. Ultimately, the show aims to empower the community as protagonists in the protection of sea turtles. To evaluate the effect of the play, we designed a survey aiming to measure attitudes and perceptions towards turtles before and after the exposition to the puppet show. We conducted the pre and post surveys to a sample of 30 people (15 children and 15 adults) attending the show, totaling 420. In this presentation, we synthesize the participatory process conducted for the development of the show, its implementation and its evaluation, our lessons learned and recommendations for future steps. Participation in this symposium is supported by donors, organizations and institutions in my country as well sponsors, partners and committee from the ISTS.

SEA TURTLES AS AN ANIMAL MODEL FOR DETERMINING HOME RANGE USING CITIZEN-SCIENCE SIGHTINGS

Dustin S. Baumbach[1,2], Edward C. Anger[3], and Stephen G. Dunbar[1,2,4]

[1]*Marine Research Group, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, CA 92350*
[2]*Protective Turtle Ecology Center for Training, Outreach, and Research, Inc. (ProTECTOR, Inc.), Loma Linda, CA 92350*
[3]*ScubaTed, West End, Roatan, Honduras*
[4]*Protective Turtle Ecology Center for Training, Outreach, and Research, Inc.–Honduras (ProTECTOR, Inc.–Honduras), Tegucigalpa, Honduras*

Sea turtle home ranges have previously been determined by attaching radio or sonic transmitters to turtles then manually monitoring their spatial location. However, dive tourists frequently observe sea turtles during dives around the world and may be a potential source of data collection for monitoring sea turtle locations. We describe the use of citizen-science sightings, coupled with photo identification, to determine home ranges for individual hawksbill sea turtles in the Sandy Bay West End Marine Reserve (SBWEMR), Roatan, Honduras. We conducted in-water counts of the sponge, *Geodia neptuniiin*, in three different zones (Zone 1 = West Bay, Zone 2 = West End, Zone 3 = Sandy Bay) within the SBWEMR to determine abundance of sponge in areas where turtles were sighted. This sponge was chosen for in-water counts because it was determined to be a common hawksbill prey item. We collected sea turtle sighting locations by dive site for the island of Roatan using a web-based map and from the Turtles Uniting Researchers and Tourists (TURT) smartphone application. Each hawksbill location record contained at least two photographs of the head that we used in a photo ID system to identify individual turtles. We then mapped individual hawksbills with 10 or more separate sightings in ArcGIS Pro and used the minimum bounding geometry with convex hull tool to estimate a home range for each individual. All hawksbill home ranges were mapped together to determine if any home ranges overlapped. We conducted Kruskal-Wallis H tests with Mann-Whitney U post-hoc pairwise comparisons to determine if the number of sponges differed between each of the three zones. Sponge counts in zone 1 (X^2= 4.45, df = 1, p = 0.035, n^2= 0.34) and zone 2 (X^2= 4.49, df = 1, p = 0.034, n^2= 0.28) significantly differed when compared to zone 3. We identified four individual hawksbills with 10 or more sightings (RMP T047, RMP T048, RMP T077, RMP T078) and determined that RMP T048, RMP T077, and RMP T078 had home ranges of less than 1 km^2, whereas RMP T047 had a home range of 1.44 km^2. Hawksbills with home ranges of less than 1 km^2 were mainly sighted in zones 1 and 2, whereas RMP T047 was also sighted in zone 3. We compared SBWEMR hawksbill home ranges to a previous study conducted outside the marine reserve in which researchers used radio transmitters to track juvenile hawksbills. That study found that juvenile hawksbills also had home ranges of less than 1 km^2 outside the reserve, presenting similar results to those of the current study. We suggest that one reason hawksbills had small home ranges may be the high abundance of sponge prey within zones 1 and 2. In our study, we additionally demonstrate that citizen-science sightings data can be used in conjunction with radio tracking to determine sea turtle home ranges. Additionally, this method may be applied to any animal with a home range, providing a cost-effective method for conservation managers to collect large amounts of data for home range analysis.

TINY NESTERS IN THE GULF OF MEXICO: SMALL LOGGERHEADS (CARETTA CARETTA) NESTING IN FLORIDA AND ALABAMA

Allison M. Benscoter[1], Brian J. Smith[2], and Kristen M. Hart[1]

[1]*U.S. Geological Survey, Fort Lauderdale, FL, USA*
[2]*Cherokee Nation Technologies, USA*

Sea turtle population models rely on accurate estimates of key demographic parameters, including age at maturity, duration of life stages, and clutch size. These factors have been identified as critical for population persistence based on ecological models. For small populations, demographic parameters estimated from either larger population models or theoretical modeling efforts may not apply. In the Gulf of Mexico, we sampled, tagged, and satellite-tracked individuals from three sites that represent different segments of Northwest Atlantic loggerhead sea turtles (*Caretta caretta*): Dry Tortugas National Park (DRTO), Everglades National Park (ENP), and Gulf Shores, Alabama (AL). The nesting sub-populations at DRTO in the Northern Gulf each represent an individual recovery unit; DRTO is the smallest (~330 females) nesting subpopulation followed by the second smallest in the Northern Gulf (~430 females). Here we present summary data on turtle size, frequency of occurrence of "tiny" (i.e., <87 cm curved carapace length [CCL]) turtles in our datasets, timing of their captures, and foraging sites determined through satellite tracking. In our long-term (2011–2018) capture-mark-recapture (CMR) and satellite tagging research in these sites, we regularly encounter small nesters less than the reported minimum adult female size of 87 cm (curved carapace length – CCL). In all three sites, the proportion of "tiny" nesters was 0.12, and did not differ across years. The CCL ranged from 74.0–86.9 cm for "tiny" nesters, which nested between 9 May and 31 July across all sites, the same range of dates as the nesters >87 cm CCL. The greatest proportion of "tiny" nesters was observed at ENP (0.26), followed by DRTO (0.13), and AL (0.09). All of the satellite-tagged "tiny" nesters had foraging sites in the Gulf of Mexico, ranging from the Florida Keys, north along the Florida peninsula, and in the northern Gulf of Mexico. Our results have implications for interpretation of interim stranding limits as well as understanding population projections for these small recovery units, which currently consider females <87 cm CCL as non-nesters. Further analysis of regional nester sizes can improve our current population projection models and identify the key vital rates for loggerhead recovery.

DIFFERENTIAL EMIGRATION FROM FORAGING GROUNDS REVEALED BY DISTRIBUTIONAL REGRESSION ANALYSES OF GREEN TURTLE SOMATIC GROWTH DYNAMICS

Karen A. Bjorndal[1], Alan B. Bolten[1], and Milani Chaloupka[2]

[1]*Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, Gainesville, FL USA*
[2]*Ecological Modelling Services Pty Ltd, PO Box 6150, University of Queensland, St Lucia, QLD 4067, Australia*

Many studies of sea turtle somatic growth have been conducted based on a number of analytical approaches. Sea turtle growth rates are characterized by high variation, much of which remains unexplained. This

heterogeneity might be a function of important predictors or covariates leading to further insights into sea turtle growth dynamics. Understanding the drivers of variation in growth rates is ever more critical as sea turtle populations recover, increasing density-dependent effects; as marine resources upon which sea turtles depend are degraded; and as climate change affects ecosystem processes. As models are improved, sources of this variation are better understood and predictions of the effects of climate change, emerging diseases, and population abundance, among other factors, are enhanced. All previous sea turtle growth models of which we are aware have focused on the mean or expected growth rate. In recent years, distributional regression or "going beyond the mean" – in which modelling is not restricted to the mean of the response variable, but extended to other summary parameters of the response distribution (e.g., variance, skewness and kurtosis) – has received greater emphasis. This approach models both the response mean and variance as a function of potentially informative covariates and can yield important new insights. We use distributional regression models fitted in a Bayesian framework with Student-t likelihood to evaluate green turtle somatic growth dynamics for both the mean and variance of the growth response as a function of potentially informative covariates. We analyze a 39-year (1979-2017) dataset from a capture-mark-recapture study of green turtles in the southern Bahamas. The distributional regression model (GAMMLSS) has an improved fit to the growth data in comparison to the mean-response-only model (GAMM). The better fit indicates the advantage of modeling both the mean and variance of the response distribution. We address the cues that stimulate green turtles to emigrate from foraging grounds during developmental migrations. These cues are key for understanding movement patterns and resource use, particularly as green turtle populations are increasing. By testing predictions based on inspection of variance plots, we reveal novel insights on the importance of differential growth rates by green turtles within a size class as cues for emigration. With increasing body size, variance in growth rates decreases because turtles that leave the study site at smaller sizes grow more slowly than do turtles that leave at larger sizes. In addition, with increasing population density, variance in growth rates decreases because, among large turtles, slower growing individuals emigrate sooner at higher densities. Drivers of differential emigration have received little attention in demographic studies of sea turtle foraging aggregations and will be more important as sea turtle populations recover and population densities on foraging grounds increase. Future conservation and management of increasing green turtle populations depend on improved understanding of resource use, sustainability of grazing, and cues for emigration. Distributional regression is a powerful analytical approach for these studies.

A SUDDEN DECLINE IN REMIGRANT NESTING FOR A POPULATION OF HAWKSBILL SEA TURTLES AT JUMBY BAY, ANTIGUA, WEST INDIES

Elizabeth Brammer-Robbins[1], Andrew S. Maurer[1,2], and Seth P. Stapleton[1,3]

[1]*Jumby Bay Hawksbill Project, Antigua, West Indies*
[2]*North Carolina State University, Raleigh, NC, USA*
[3]*University of Minnesota, St. Paul, MN, USA*

Long-term sea turtle population monitoring programs are crucial for understanding sea turtle demography and reproductive output and are important for informing conservation efforts. The Jumby Bay Hawksbill Project, initiated in 1987, monitors a hawksbill sea turtle (*Eretmochelys imbricata*) rookery on Pasture Beach, Long Island, located off the northern coast of Antigua, West Indies. Data have been collected through consistent saturation tagging protocols since the onset of monitoring on Long Island (also known as Jumby Bay). After more than a decade of relative stability in the annual nesting cohort (averaging 30 nesters per year), the population exhibited strong growth and more than doubled to an average of ~70 nesters per year by 2010, reaching a peak of 89 individuals in 2014. However, during the 2016 season, we documented a decrease in nesting activity, with only 55 individuals recorded, and observed even fewer (38) in 2018. In contrast, 2017 was a strong year with 79 nesting individuals. Given the relative stability in recruitment of neophytes at Jumby Bay, we are exploring other possible drivers of these declines, potentially associated with a decrease in remigration or an increase in nesting on peripheral islands. Our hypotheses include: (1) the high regional influx of sargassum seaweed deterring or physically blocking turtles from our nesting beach; (2) long-term deterioration of reef health, potentially associated with coral bleaching events, and subsequent effects on reproductive output; and (3) acute declines in available foraging habitat related to two catastrophic hurricanes in 2017 that impacted the sites where much of our nesting population forages, causing some individuals to forego nesting in 2018. Moving forward, comparing data with other regional monitoring projects will help determine if the apparent decrease in nesting is a broader phenomenon or unique to the Jumby Bay population. Future monitoring will be key to assessing whether this is a short-term anomaly or reflective of longer-term conservation challenges. In addition, revisiting demographic models will allow us to robustly test hypotheses about potential reductions in survival and breeding probability and/or increases in transience.

SEA TURTLE NESTING TRENDS AND MONITORING IN BROWARD COUNTY, FLORIDA

Derek Burkholder, Curtis Slagle, Samantha McCorkle, and Glenn Goodwin

Nova Southeastern University, Halmos College of Natural Sciences and Oceanography, Davie, FL

The Broward County Sea Turtle Conservation Program (BCSTCP) was initiated in 1981 and has since documented annual sea turtle nesting activity along 21.6 miles of Broward County coastline from March 1st to October 31st. The primary role of the program is to identify and classify sea turtle crawls as either nesting emergences or non-nesting emergences (false crawls), document nest and emergence success, respond to and document sea turtle strandings, and conduct public education seminars. Broward County has consistently documented nesting behaviors from three of the seven sea turtle species: Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*), and Leatherback (*Dermochelys coriacea*). Nesting activity for each species varies in both abundance and seasonality. Leatherbacks nest early in season, March through June, and account for less than 1% of all sea turtle nesting in Broward County. Greens nest later in season, June through September, and account for 1-5% of all sea turtle nesting in Broward County. Loggerheads nest mid-season, April through August, and account for more than 95% of all nesting in Broward County. Broward County is considered a medium-density nesting area according to the Florida Fish and Wildlife Conservation Commission (FWC). Here we present seasonal sea turtle nesting trends, and nesting and emergence success. Nesting activity in recent seasons has achieved record breaking nesting numbers with the 2017 season resulting in the highest number of documented sea turtle nests in Broward County (7927 emergences documented, 3587 of which were nests and 4340 being false crawls). These values include nesting activity documented by staff of Dr. Von D. Mizell-Eula Johnson State Park which is located in Broward County but is not monitored by the BCSTCP. Overall nesting activity has been increasing for all species since the program's inception. Leatherback nesting has an average increase of 0.67 nests per year. Green nesting has an average increase of 9.60 nests per year while loggerhead nesting has an average increase of 35.98 nests per year from 1981 - present. These historical nesting trends demonstrate a potential recovery of these species which range from threatened to endangered according to the International Union for the Conservation of Nature (IUCN). Future seasons will reveal if these trends remain persistent and if so, how these elevated nesting numbers will be impacted by concerning changes to our climate.

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

Manuel Fernando Manzano Cervantes

MACM490530

Tecolutla, is a small place in Veracruz state, Mexico, its population is 7 thousand 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 biologist 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 see (in 2017, more than 92,000 were released), without any help, only his own conscience and his love for nature. Year by year he worked awaring the population and little by little he was developing protection techniques to recover this very endangered species. In 2000, "vida milenaria", the non-governmental organization was established legally, to continue working and in the same year the protected area was extended. Actually 35 kilometers in 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 aware 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 achieving 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 so threatened. In 2013, we released more than 92,000 turtle hatchlings, specially the lora turtle (*Lepidochelys kempii*), as well as the green and white ones (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata*). In this moment, 12 men and women are working together to protect the turtles that are threatened in Tecolutla, Veracruz, Mexico.

JUVENILE GREEN TURTLE ASSESSMENT AT THE PARANAGUA ESTUARINE COMPLEX, SOUTHERN BRAZIL

Camila Domit[1,2], Daphne Wrobel[3], Mariana Fuentes[4], Robin Loose[2], Ana Paula Loureiro Bracarense[5], Tawane Nunes[1,2], Gabriela Velez-Rubio[6], Isabela Domiciano[5], Bruna Canal[2], Liana Rosa[1,2], and Stephane Moura[1,2]

[1]*Laboratório de Ecologia e Conservação, Centro de Estudos do Mar (CEM/UFPR), Universidade Federal do Paraná. Pontal do Paraná, PR, Brazil*
[2]*Associação MarBrasil - Projeto REBIMAR, Brazil*
[3]*RRDM - FURG Programa de Monitoramento da Biodiversidade Aquática na Área Ambiental I / Associação MarBrasil - projeto REBIMAR, Brazil*
[4]*Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, Florida USA*
[5]*Laboratório de Patologia Animal, Universidade Estadual de Londrina, Londrina, Parana, Brazil*
[6]*Projeto Karumbe, Uruguay*

Efforts to monitor and assess the biological and health parameters of juvenile *Chelonia mydas* are important to increase the scientific knowledge and to support the management and protection actions of this species´ habitat. The health assessment associated with mark-recapture methods can provide important data on health parameters variation, residence patterns and population dynamics. Both methods have been applied off Paraná coast, in the Paranaguá estuarine complex, a world heritage site. Between 2014 and 2018 a green turtle intentional capture program was conducted in the area (n=7 expeditions, ~45 days in the water), particularly around two rocky estuarine islands: Mel and Cobras Islands. Two different nets with 30 cm stretched mesh openings were used to capture the turtles: a passive capture gill net with 50m length; and an active capture gill net with 20m length. All turtles captured were taken onboard for clinical examination and general procedures. Each individual was photographed, tagged with two metal tags (National Band and Tag CO) provided by TAMAR-ICMBio Centre, weighed and had its curved carapace length (CCL) and width (CCW) measured. Additionally, blood samples were taken from the occipital sinus for hematological and biochemical analyses. After the procedures, turtles were released near the same area they were captured. Including only the animals marked and recaptured in the two last seasons, an abundance estimate was conducted, applying the "Jolly-Seber" model, for open populations, which considers the number of animals entering or leaving the population (i.e., births, deaths and migrations). Overall, 205 individuals were captured, being all juveniles (CCL <80cm). In Mel Island, 13 turtles were captured, two were recaptured in the following capture events in the same year (2018). In Cobras Island, 192 turtles were caught, from which 47 were recaptures: 32 (70%) had already been captured in other events on the same seasons and 14 (30%) from previous seasons. One individual was originally tagged in Ubatuba Municipal District, São Paulo State, by TAMAR in two years before. The body mass ranged from 2 to 34.70 kg (8.04±4.45); body score ranged from bad 2% (n=4) to great 0.5% (n=1), being good 79% (n=162) the most frequent; 42% (N=88) had tumors suggestive of fibropapillomatosis (FP). From 49 turtles that had their tumor score determined, 65.31% (n=32) were moderately affected, 20.41% (n=10) lightly affected and 14.29% (n=7) heavily affected. The CCL ranged from 30.60 to 63.20 cm (39.93±6.00); and CCW ranged from 25.70 to 59.00 cm (36.69±5.64). The turtles' population estimates were 205 individuals (CI: 171-263; 0.11 CV). Paraná coast is considered an important juvenile foraging ground for *C. mydas*. The results presented here suggest that turtles stay in the same area for at least three months before starting to migrate, highlighting the relevance of this area for this species. General physical examination (i.e., body mass, body condition and presence of tumors) indicate that environmental degradation may affect the turtles' health, immunocompromising the individuals. However, data from biochemical and hematological analyses might serve as better indicators of their health. This study is the first to implement the mark-recapture method to estimate abundance of *C. mydas* at the Paraná coast and is supporting the proposal of a new state conservation unit around Cobras Island with the main goal of green turtle conservation. Nevertheless, continuous monitoring of abundance is required to understand the population dynamics, habitat use and potential impacts that might cause population declines.

MODELING SEA TURTLE HATCHLING DISPERSAL AND JUVENILE SURVIVAL IN A VARIABLE ENVIRONMENT

Morgan DuBois and Susan Piacenza

University of West Florida, Pensacola, FL, USA

Sea turtle hatchlings rely on oceanic currents to carry them offshore away from neritic predators and spend "the lost years" drifting around ocean basins. A progressively warmer and more variable climate along with rising sea levels is expected to impact hatchling and pelagic stages of sea turtle populations by influencing sex ratios, inundating nesting beaches, and ultimately decreasing survivorship. In El Nino years, nesting abundance often is unexpectedly low, and thus hatchling yields are reduced, but little has been done to evaluate how hatchlings and juveniles fair in years of extreme weather as they drift. Modeling juvenile drift during past years with unfavorable conditions may help us to understand how they will survive as weather becomes more extreme under the influence of climate change. The purpose of this study is to use a drift model to better estimate juvenile sea turtle survival in the North Atlantic under given conditions, such as highly variable year-to-year conditions and bad weather events, and to use those estimates to add juvenile survival parameters to an existing agent-based model. We predict that the ability to more accurately parameterize juvenile survival in an agent-based model will not only make the model more accurate, but will also allow for experimentation with different sources for juvenile mortality such as climate variability and extremes, bycatch, and oil spills. Understanding how extreme events may have affected juvenile turtles in the past can be extrapolated to predict future vulnerabilities and population-level effects. Juvenile dispersal will be simulated in the particle-tracking model ICHTHYOP, which may be combined with the general ocean circulation model HYCOM to provide background conditions for particle drift. We will compare turtle dispersal under normal and variable climate regimes to determine if different patterns of dispersal are present, and then to infer survival depending on if turtles encounter deleterious environmental conditions (e.g., extremely cold water). We will calculate juvenile survival, under varying climate conditions, and use that data to improve how juvenile survival is modeled in an existing agent-based model (GSTABM). The GSTABM simulates individual behaviors and variability in life history, as well as environmental influences on survival and reproduction. We will explore how differences in juvenile survival, related to varying climate, influence important model outputs, such as nester recruitment, adult abundance, and population trend. In order to protect mobile and cryptic pelagic stage juveniles, knowledge of their movements, distributions, and threats is paramount. However, there generally is lack of knowledge regarding the lost years of green sea turtles, though recent scientific advancements have occurred. Development of a spatially explicit agent-based model that integrates ocean circulation models will be useful to draw an accurate picture of how juvenile oceanic survival can influence sea turtle populations. This information can used to guide spatial management and to assist in limiting fisheries interactions with small juveniles.

ESTIMATING THE NUMBER OF NESTING FEMALES USING BAYESIAN HIERARCHICAL JOLLY-SEBER MODEL FOR GREEN SEA TURTLES (*CHELONIA MYDAS*) IN THE OGASAWARA ISLANDS, JAPAN

Daisuke Endo[1], Satomi Kondo[2], and Toshihide Kitakado[1]

[1]Tokyo University of Marine Science and Technology, Tokyo, Japan
[2]Everlasting Nature of ASIA, Japan

Ogasawara islands are known as one of the largest rookeries of green sea turtles in the North Pacific. Field surveys, such as counting the number of nests and individual identification via tag attachment, have been conducted by the Certified NPO Everlasting Nature of ASIA(ELNA) for understanding their ecology. These surveys revealed that the number of nests has been increasing in recent years. However, the actual dynamics of number of adult females has not been understood yet because adult females usually do not participate in the breeding annually and nesting occurs several times within the season. The aim of this study is to develop the method of estimating number of adult females with Mark-Recapture(M-R) datasets from tagging survey for better understanding of the dynamics of mature female population. The methodology is based on the Jolly-Seber (JS) model, which enables us to estimate the number of individuals and other biological parameters by expressing the recruitment of individuals. We extended the JS model to Bayesian hierarchical models to take into account stochastic remigration intervals and applied the models to datasets in Omura Beach, Ogasawara islands from 2001. The estimation was performed with a Markov chain Monte Carlo (MCMC) method. The simplest model showed that the number of adult females nesting at Omura Beach in 2016 were estimated at 2,223 (95% CI=1,758-2,739), which was around 8 times greater than the number of nests at this beach in 2016 (275 nests were observed). Moreover, annual survival probability and detection probability were estimated 0.93 (95% CI=0.88-0.96) and 0.04 (95% CI=0.03-0.05), respectively. In this study, we estimated the number of females which nest in Omura beach. The Ogasawara islands have more than 40 nesting beaches. Given that the nesting is also confirmed at the other beaches. It means that there is need to consider the selectivity of nesting beach of sea turtles for understanding overall population size. For this purpose, we are planning to develop into an analysis that takes spatial distribution into account.

PILOT STUDY TO EVALUATE THE EFFICACY OF TANGLE NETTING FOR SEA TURTLES IN HIGH DYNAMIC ESTUARIANE HABITATS

Christopher A. Evans, Michael D. Arendt, and Jeffrey A. Schwenter

South Carolina Department of Natural Resources, Marine Resources Division, Charleston, SC 29412, USA

Since 2000, the SCDNR has managed a coastal trawl survey to monitor the distribution, relative abundance, demographic structure, and health of sea turtles between north Florida and South Carolina; however, this region is devoid of complementary estuarine data sets. The large spatial gap in estuarine sea turtle data sets can be attributed to the high tidal flow in this region relative to central Florida and the sounds of North Carolina where estuarine sampling has been conducted in the form of tangle netting. To assess the potential to expand spatial sampling to estuarine waters adjacent to the coastal trawl survey, a pilot study tangle net survey was initiated in the Charleston Harbor in August 2018 near the mouth of James Island Creek (32.759°N, -79.944°W) where green sea turtles (*Chelonia mydas*) commonly occur in other SCDNR surveys. Both ends of the net (76 m long) were anchored (18lb Danforth, 1m of chain) consistent with traditional tangle netting. However, in contrast to traditional net 'tending' in predominantly low flow/wind environments, the entire net (lead line to float line; 3 m tall) was systematically lifted out of the water and spread across the beam of the vessel as it passively moved in the direction of the wind/current in waters 1 to 4 m deep. A total of 31 net tending efforts (14.5 hours total soak) were completed on six sampling dates between 7 and 30 August, with a median tending time of 12 minutes (range = 6 to 34 minutes). No sea turtles were captured, but 130 Elasmobranch specimens (94% cownose rays, *Rhinoptera bonasus*) were captured suggesting successful gear operation. Historic rainfall prior to sampling decreased salinity to 20 to 23 ppt, unusually low for this area which may have altered sea turtle distribution patterns. All biological specimens were captured across four harbor net set locations (18 sets) compared to 13 sets conducted at two locations inside of the tidal creek. Despite the lack of sea turtle captures, results from the 2018 pilot study were encouraging and this effort will be repeated at this location and potentially other estuarine locations in South Carolina during spring and summer 2019.

ENVIRONMENTAL DNA-BASED DETECTION OF MARINE TURTLE SPECIES AND THEIR CHHV5 VIRAL PATHOGEN FROM SEAWATER

Jessica Farrell[1,2], Liam Whitmore[3], Kelsey Yetsko[1], Rachel Thomas[1], Catherine Eastman[1], Paul Linser[1], Lawrence Wood[4], Cody Mott[5], Mark Martindale[1], and David Duffy[1,3]

[1]The Whitney Laboratory for Marine Bioscience, Sea Turtle Hospital, University of Florida, St. Augustine, FL 32080, USA
[2]Department of Biology, University of Florida, Gainesville, FL 32611, USA
[3]Department of Biological Sciences, University of Limerick, Limerick, V94 T9PX Ireland
[4]Florida Hawksbill Project, National Save the Sea Turtle Foundation, 4419 West Tradewinds Ave., Lauderdale by the Sea, Fl. 33308
[5]Inwater Research Group Inc., 4160 NE Hyline Dr., Jensen Beach, FL 34957

Earth's rapidly declining biodiversity is a major challenge of the 21st century and needs addressing swiftly to avoid the 6th mass extinction event. To estimate global biodiversity loss and coordinate efficient conservation efforts, accurate biological monitoring is required to calculate species abundance and their population sizes. However, current methods for monitoring elusive and endangered species, particularly aquatic species, can be ineffective and impractical. Through recent advances in biological monitoring and DNA sequencing, the field of environmental DNA (eDNA) has developed rapidly. Organismal DNA accumulates in the surrounding habitat in the form of shedding skin, mucus or feces. Such eDNA can be collected from environmental samples including seawater. Environmental DNA-approaches have the potential to provide valuable insight into the ecology of many aquatic organisms. While this new field of biological monitoring has enabled scientists to monitor a diverse range of species, it is especially applicable to elusive or endangered species such as marine turtles. We have developed eDNA-based approaches for the detection of several sea turtle species and their viral pathogen chelonid herpesvirus 5 (ChHV5) from seawater samples. ChHV5 is thought to be a key trigger of fibropapillomatosis (FP), a virulent tumor disease of increasing threat to marine turtle populations worldwide. Fibropapillomatosis reached epizootic (animal epidemic) proportions in *Chelonia mydas* in the 1980s and is now present in all seven sea turtle species. We have successfully recorded the previously undocumented growth and post-surgical regrowth rates of FP tumors in *Chelonia mydas* patients at the University of Florida's Whitney Laboratory for Marine Bioscience Sea Turtle Hospital, providing baseline information to better understand the disease, potential growth accelerating factors, and to determine potential therapeutic treatments. Additionally, in combination with ChHV5 DNA detection techniques applied to blood, tissue and seawater (eDNA), these growth baselines enable us to track ChHV5 virus activity in individual patients and how it influences the proliferation of tumor growth and the occurrence of viral shedding into the environment. With the application of novel environmental DNA and qPCR approaches, we have successfully detected the presence of *Chelonia mydas*, *Caretta caretta* and ChHV5 DNA from seawater within patient tanks. Over time, FP-afflicted patients experience fluctuations in ChHV5 activity, altering tumor growth rates and viral shedding levels. We therefore aim to combine patient-specific tumor growth profiling with the quantification of environmental ChHV5 viral shedding to gain an insight into the nature of transmission of this herpesvirus. Application of this eDNA technology can also be used to measure and monitor wildlife population and biodiversity changes spatially and temporally, as well as the environmental range and abundance of wildlife pathogens including ChHV5. We employed eDNA approaches coupled with qPCR to detect marine turtle species and their tumor-associated virus in rehabilitation settings and their natural habitats. These results can be used to optimize the detection and monitoring of vulnerable wild sea turtle populations. The environmental detection of sea turtles and their viral pathogens will increase our knowledge on FP transmission dynamics, a disease which is detrimentally impacting marine turtles in rehabilitation facilities and the wild.

EVERY ARROW IN THE QUIVER: USING A SUITE OF TRADITIONAL AND INNOVATIVE TOOLS TO UNRAVEL THE MYSTERY OF ENDANGERED HAWKSBILL TURTLES IN HAWAI'I

Alexander Gaos[1], Lauren Kurpita[2], Kelly Peebles[2], Hannah Bernard[3], Luke Sundquist[3], Cheryl King[4], Joy Browning[5], Irene Kelly[6], Skippy Hau[7], George Balazs[8], Shandell Brunson[9], Summer Martin[9], Shawn Murakawa[9], Erin LaCasella[10], Peter Dutton[10], and T. Todd Jones[9]

[1]JIMAR-NOAA Fisheries, Pacific Islands Fisheries Science Center, Protected Species Division, Marine Turtle Biology & Assessment Program, HI, USA
[2]Hawai'i Island Hawksbill Turtle Recovery Project (HIHTRP), Hawaii National Park, HI, USA
[3]Hawaii Wildlife Fund, HI, USA
[4]Hawaiian Hawksbill Conservation, HI, USA
[5]US Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, HI, USA
[6]NOAA Fisheries, Pacific Islands Regional Office, Protected Resources Division, HI, USA
[7]Department of Land and Natural Resources, HI, USA
[8]Golden Honu Services of Oceania, HI, USA
[9]NOAA Fisheries, Pacific Islands Fisheries Science Center, Protected Species Division, Marine Turtle Biology & Assessment Program, HI, USA
[10]NOAA Fisheries, Southwest Fisheries Science Center, Marine Mammal and Turtle Division, CA, USA

The conservation of extremely small wildlife populations is a common and high-priority management issue around the world. The hawksbill turtle (*Eretmochelys imbricata*) is a globally endangered species that is extremely rare in Hawaii (U.S.A.). Over the past three decades, a consortium of federal, state, and non-governmental partners, collectively referred to here as the Hawaiian hawksbill network, has implemented a diverse suite of research and management tools to better understand the status and conservation needs of hawksbills in Hawaii. These efforts, which include nest monitoring and protection, in-water surveys, satellite telemetry, hatchling dispersal modeling, and genetic studies, have led to the discovery of several intriguing findings. Our current knowledge indicates <15 females nest annually around the archipelago, and despite protection for more than 30 years, their nesting numbers have not increased. Satellite telemetry research has demonstrated that nesting females undergo limited post-nesting migrations and primarily remain in nearshore Hawaiian waters. Similarly, hatchling dispersal models suggest hawksbills may spend their early development period (i.e., "lost years") in waters relatively close to the Hawaiian Islands, although empirical evidence of this pattern remains lacking. Nonetheless, results of genetic analyses indicate hawksbills nesting in Hawaii represent a distinct genetic stock that is unique from populations in other parts of the world. Combined, these findings suggest Hawaiian hawksbills represent a distinct management unit, with individuals spending most or all of their lives in relatively close proximity to the archipelago. Conservation of marine turtles often requires the collaboration of government authorities from multiple states or nations over large ocean regions; however, conservation efforts in the state of Hawaii can protect the entire life cycle of the Hawaiian hawksbill population. These findings also suggest that addressing local threats to hawksbills foraging in Hawaiian waters has major conservation value for nearby rookeries, and hence the local population. A 30-year stranding and nesting database has identified several important threats to the species, including loss of nests to non-native predators and mortality of both juvenile and adult turtles to nearshore hook-and-line fisheries. The Hawaiian hawksbill network will continue to collaboratively implement innovative research tools to investigate new and emerging questions, including whether additional hawksbill nesting beaches exist around the Hawaiian archipelago, how hatchlings disperse after emergence, and how climate change may impact hatching success and population sex ratios.

WHAT IS THE OUTCOME FOR MARINE TURTLE CONSERVATION FACE TO CLIMATE CHANGE?

Alain Gibudi, Ly Baila, Antchlome Hatete, Fumungongo Tasha Berenice, and Abdou Felly Ali

PROTOMAC, Libreville, Gabon

The world of conservation today is confronted with several problems from different origins, different natures, different forms, intensity, etc. Working in the conservation of marine ecosystems becomes a real challenge in this case. A major element causing all these disturbances not only in the field of conservation of the environment but also in other areas of life is: Climate change. This climate change, of which man is the natural originator, has become the cross-cutting issue, the challenge to be met to see to what extent environmental conservation activities of course including other areas get organized other. In our field of marine turtle conservation, where we work things seem a bit more complicated. For several years, we have been working on the conservation of marine ecosystems, especially on marine turtles, an emblematic species. Climate change, which manifests itself in a number of ways, including rising sea levels, is a major problem and constitutes a major impediment to sea turtle conservation activities on beaches. Because of this phenomenon of rise of the water provokes in places coastal erosions, of disappearance of the nesting beaches. Thus, the collection of data such as counting traces, or the identification of females become difficult. The beaches being for the marine turtles the natural device to ensure the incubation of the eggs their disappearance makes not only the work of conservation difficult but even worse makes the species more and more vulnerable. The work that we will present here as a poster is the results of the monitoring activities on sea turtles that came to nest on the beaches of Central Africa over a period of 10 years from 2000 to 2010. Compared to the work carried out by 2011 to 2016, on the same beaches affected by the disappearance some land due to the rise of the oceans. This work has been taken into account only the trace count data. This allows us to estimate the geographical distribution, density and attendance. The comparative tables over several years clearly show how the ratings are affected by the movements of water, or how the beaches disappear in places, the formations of new spaces or the setbacks of certain beaches. We will discuss the results and challenges we face.

3D OCF-ECF-TIME TABLE PERMITS TO ESTIMATE TRUE CLUTCH FREQUENCY

Marc Girondot

Université Paris Sud, Orsay, France

The regularity of interesting periods in marine turtles has been used by Frazer and Richardson (1985) to propose to build 2D tables with Observed Clutch Frequency (OCF) and Estimated Clutch Frequency (ECF) with OCF being the number of times a female was observed nesting during the season and ECF being the number of times it has supposed to nest based on its first and last record on the beach and the number of days between each clutch. This idea was very powerful, but it suffers two problems: It supposes a perfect regularity of the internesting period and all nests deposited before the first observation and after the last observation cannot be inferred using this method. I propose two models to resolve these limitations. First an individual-focused model permits to estimate, even when few observations are available, the interesting period as well as the probability to abort a nesting process and the number of days before a new attempt will be done. Second, an extension of the OCF-ECF method will be described in which the OCF and ECF tables are calculated after grouping the females seen for the first time during each internesting period of the nesting season. The exact probabilities associated with each OCF-ECF-Time combinations are calculated and behavioural parameters (distribution of arrival dates, distribution of clutch frequency by female) are fitted to match the observed tables. This method allows to estimate the unbiased clutch frequency. The use of the method will be demonstrated using several examples of different species.

BEYOND THE TAGGING REFLEX: WHAT TO DO WITH YOUR TAGGING DATABASE? THE PHENOLOGY R PACKAGE

Marc Girondot

Université Paris Sud, Orsay, France

Tagging is a central activity for many marine turtle organizations, even if sometimes the exact goal is not well defined. Even when it is clearly defined, the methodology to analyze tagging data is not straightforward and requires good statistical capacities. In the view to help organizations facing such a problem, I have developed a R package that is specifically designed for marine turtle data analysis. It permits to analyze both the nest counts and the tagging data. From nest counts, it allows to estimate the phenology of nesting and the long-term trend of nesting activities taking into account that some beaches could not be monitored for some years. From tag data, it allows to estimate the tag loss rate, the distribution of the interesting period, the distribution of clutch frequency within a nesting season as well as the distribution number of years between two nesting seasons. Example will be provided of what outputs can be expected.

IMPROVING AGE-CLASSIFIED MODELING THROUGH INTEGRATION OF ACCURATE REMIGRATION RATES WITHIN BREEDER CLASSES

Glenn D. Goodwin[1], William J. Harford[2], and Derek A. Burkholder[1]

[1]*Nova Southeastern University - Halmos College of Natural Sciences and Oceanography, Fort Lauderdale, FL, USA*
[2]*Rosenstiel School of Marine & Atmospheric Science, University of Miami, Miami, FL, USA*

It is difficult to assess population levels of many marine organisms, especially those that are highly mobile and whose life histories involve the pelagic realm. Sea turtle populations can be spread over entire ocean basins, increasing the difficulty of tracking and managing their populations. All sea turtle species are vulnerable or endangered, making accurate assessments of their population dynamics critical for conservation and management decisions. Matrix models can be a useful tool to aid management decisions for these populations. Current models rely on age-classified matrices that incorporate rates for survivorship and fecundity specific to each age class. Within the matrix, each survivorship rate is repeated along the sub-diagonal for each year the individual spends in that age class. At the age of sexual maturity, individuals enter the adult stage and breeding must be accounted for, represented by the fecundity value along the top row for these years. However, female sea turtles do not typically breed every year. This remigration interval (i.e., the length of time spent between breeding seasons, varying from 1-5 years for loggerheads) is often incorporated through an average remigration rate factored into survivorship and fecundity values within the matrix. Representing complexities such as this with averages can be misleading. Instead, we propose a model that incorporates a breeder class within the adult stage. We factored year-specific transition probabilities (the remigration rate factor) into the calculation of survivorship and fecundity for each year. This creates a small, repeating, breeder-class matrix within the larger matrix. Based on remigration rate percentages, an adjusted proportion of adult class individuals breed and restart their specific breeding cycle (e.g., returning to breed every three years). Our model includes four life stages: eggs and hatchlings <1 year old, small neritic juveniles (SNJ), large neritic juveniles (LNJ), and adults. Life stages are defined by their duration values (e.g., LNJ = years 12-22). The adult life stage contains the breeder class and starts at the age of sexual maturity. We populated the life-stage durations and survivorship values in our model using data from the current literature. To deal with uncertainty, we generated multiple matrices with different combinations of these values. We applied four different conservation scenarios to each matrix, involving a 30% reduction in mortality for specified life stages: (1) Original survival rates; (2) SNJ; (3) SNJ and LNJ; (4) SNJ, LNJ, and adults. We then calculated the population rate of change for each scenario and evaluated the sensitivity and elasticities for each matrix. We found that with current conservation strategies, the Northwest Atlantic loggerhead turtle population is still declining. However, by reducing mortality in the neritic juvenile and adult life stages, the populations will begin to increase. Additionally, it was noted that matrix models are fundamentally flawed if stage duration is inaccurate. Sensitivity of the model to each life stage is directly proportional to the duration of that stage. Inaccurate estimates for these values will produce unreliable results.

MODELING THE FATE OF SEA TURTLE HATCHLINGS OCEANIC DISPERSAL IN SOUTH AFRICA

Diane Le Gouvello

Nelson Mandela University, Gqeberha, South Africa

Sea turtles have complex life histories, with changes in habitat and diet at different life stages. After emerging from nests on sandy beaches, hatchlings enter the ocean and spend several years in pelagic habitats before recruiting to neritic foraging areas. This post-hatching phase known as the “lost years” is the least understood life stage of sea turtles. We aim to identify potential dispersal pathways of both loggerhead and leatherback hatchlings from South African nesting beaches using passive particle tracking as “virtual hatchlings” within a regional ocean modelling system. Simulations were run to infer survival under different thermal environments and investigate the influence of hatchling swimming behaviour, the location of nesting beaches, and the date of release on hatchlings dispersal trajectory. The model confirmed that hatchlings are mainly transported south along the coast in the Agulhas current, and that water circulation, hatchling’s swimming behaviour and date control dispersion in South Africa. Simulations revealed that the end trajectories of most virtual particles were located in the South Indian Ocean with very few entering the cold Atlantic waters. Analysis of the simulations allowed to predict hatchling survival revealing that hatchlings drifting into the Atlantic and into Mozambican coastal areas are likely to suffer very high mortality, due to thermal stress and anthropogenic pressures. This highlights the role of ocean current variability on hatchling dispersal ability and survival probability. This passive tracking model allowed to identify important developmental areas for oceanic hatchlings and highlights the value of oceanographic models to gain a better understanding of this cryptic life stage, providing insight for effective conservation strategies. To our knowledge, this is the first attempt to describe sea turtle hatchlings dispersal in the South Western Indian Ocean during this mysterious life stage.

IDENTIFYING DATA NEEDS FOR SEA TURTLE DEMOGRAPHIC STUDIES: A DATA GAP ANALYSIS

Julia Nina-Marie Hart[1], Matthew D. Ramirez[1], Brandon Chasco[1], Alexia Kenney[2], Natasha Nemyre[1], Susan E. Piacenza[2], Martha P. Rincon-Diaz[1], Matthew VanBemmel [1], and Selina S. Heppell[1]

[1]Oregon State University, Corvallis, OR, USA
[2]University of Western Florida, Pensacola, FL, USA

Population assessments of threatened and endangered sea turtle species are often limited by inadequate and incomplete demographic information, which prevents accurate estimation of population size and trend, and ultimately designation of conservation status. Many recent reports have sought to characterize global research priorities for sea turtles and have stressed the need to improve and increase data collection and

vital rate estimation (both means and variance). However, as of yet, a robust and quantitative evaluation of where species-, region-, and stage-specific demographic data gaps exist has not been conducted for sea turtles. The primary objectives of this study are to perform a global literature review of sea turtle reproductive rates critical to population assessment, to identify data gaps based on study location, date of publication and sample sizes by species and region, and to develop recommendations for targeted research. We conducted a two-tiered literature search to compile studies that reported clutch size, clutch frequency, hatching success, remigration interval or breeding probability, hatchling sex ratio, and size of (first time) nesting females. We first performed a structured search of online literature databases (Web of Science, Sea Turtle Online Bibliography), sea turtle books, theses and dissertations, and pertinent global and regional journals and newsletters. We then performed an unstructured literature search by reviewing reference lists of papers found in the structured search. From this search, we have compiled more than 900 data sources from the primary and grey literature. Employing the Regional Management Unit (RMU) framework developed by Wallace et al. (2010), we will assess the quantity (e.g., number, length of studies) and quality (e.g., age of studies) of data for each demographic rate within each RMU. Resulting metadata and bibliographical information will be made available online. This study provides a valuable evaluation of sea turtle demographic rate parameters and knowledge gaps that can be used to guide future research efforts and parameterize demographic models for population assessment.

SEA TURTLE ABUNDANCE IN FLORIDA'S BIG BEND

Richard Herren[1,2], Raymond Carthy[2,3], and David Godfrey[1]

[1]*Sea Turtle Conservancy, Gainesville, FL, USA*
[2]*University of Florida, Department of Wildlife Ecology and Conservation, Gainesville, FL, USA*
[3]*USGS Florida Cooperative Fish and Wildlife Research Unit, Gainesville, FL, USA*

Understanding the distribution and abundance of protected species is one of the keys to managing their recovery. In this study, we describe the distribution and abundance of sea turtles in the nearshore waters of Florida's Big Bend. This region contains 3,000 square km of seagrass beds and may be one of the most important foraging grounds for juvenile and adult sea turtles in the eastern Gulf of Mexico. Vessel-based surveys were carried out over shallow water seagrass beds (0.5–2.5 m) in four main areas of the Big Bend: Apalachee Bay, Steinhatchee, Cedar Key and Crystal River. Observers sighted turtles from a 2.1 m tower and recorded the species, size class, GPS location, vertical location (surface or underwater) and perpendicular distance from the vessel. Weather variables were recorded at the start and end of each transect and included: wind speed, wind direction, sun angle, cloud cover, water temperature and water clarity. We observed 117 green turtles (*Chelonia mydas*), 32 Kemp's ridleys (*Lepidochelys kempii*) and 18 loggerheads (*Caretta caretta*) on 580 km of transects. Abundance was modeled using the distance package in the software R. The probability of detection model was affected most by wind speed and water clarity. The species distribution was significantly aggregated throughout the surveyed area with Crystal River having the highest turtle densities, particularly in 0.8–1.0 m water depths. Most of the observations were green turtles, which appear to be recovering in Florida after decades of exploitation. This species may also be expanding its range due to increased water temperatures driven by climate change. Research over the next two years will focus on three areas of interest that might be influencing green turtle distribution and abundance in this region: (1) environmental and/or habitat variables, (2) genetics, diet and disease, and (3) intra and inter-seasonal movements. We hope the identification of specific areas with higher sea turtle abundance will help wildlife managers identify and protect critical habitat, particularly in the wake of the 2010 Deepwater Horizon Oil Spill and future calls for oil and gas exploration in the Gulf of Mexico.

SEA TURTLE NESTING STATUS ALONG COAST OF BANGLADESH

Mohammad Zahirul Islam

Marinelife Alliance, Bangladesh

The entire coast of Bangladesh is 710 kms and fringed with diverse habitat viz., mangrove, muddy, sandy and small rocky shore at southern St. Martin Island at the south eastern end (20.584327 N, 92.331119 E) and at the south west Sundarban mangrove near Mandarbaria (21.717425 N, 89.105782 E). The project area has a trans-boundary portion at west with India and at the east with Myanmar. Monitoring and conservation along entire coast is ongoing by Bangladesh Sea Turtle Program of Marinelife Alliance since 2013. The mentioned land end points were major nesting beach monitoring area and under the exploration of new nesting rookery. Program intervened along entire Bangladesh coast. According to our investigation approximately 400 kms are sandy and have records of nesting currently. The recorded nesting beaches are: a. Southeast coast (St. Martin Island (18kms), b. Teknaf Peninsula (100km beach), c. Sonadia Island (12kms), Kaladia-Laldia-Dhalghata-Matarbari beach (16kms), Kutubdia (20Kms), Bashkhali-Gohira-Parki (20 kms); Southcentral coast (Kuakata, Char Kukri Mukri, Sonar Char, Tuphania, Shib Char (114+kms) and Sundarban Mangrove coast (Dublar char, Katka, Mandarbaria, Egg Island, Hiron Point, 90kms). The southeast coast is currently under threat from the indiscriminate development, alteration of sand dunes and beach habitat. Government establishing Coal Based Power Generation Plant near Matarbari location, 21 kms north of Sonadia major nesting location. The project area has trans-boundary portion at west with India and at the east with Myanmar. The program also conducting marine foraging habitat survey within the Bangladesh marine territory and the records of satellite tracking revealed turtle both green (Chelonia mydas) and olive ridley (Lepidochelys olivacea) forage along the non-nesting coast. The majority of nesting occurred along the south east coast particularly at Haserchar (Dhalghata), Sonadia and Cox Bazar-Teknaf peninsula. The best is Sonadia Island where within 12 kms the 40 % of all nests are being laid according to current nest monitoring by Marinelife Alliance. The future of Haserchar to Sonadia Island is uncertain due to probable disturbances, pollution and light pollution of Matarbari coal power plant if proper mitigation is not taken. Hope we have overcome the deep-sea port anxiety that prevailed last several years (Islam, 2009, 2010, 2011). In the last 15 years the St. Martin Island Screw pine vegetation land area already severely degraded due to tourism development. Mass tourism, relative disturbances and lighting, marine habitat degradation resulted in declination of 70 % after 2000. The 100 kms long Cox Bazar - Teknaf Peninsular beach stretched from Najirartek at north to Badar Mokam south at Shahporirdwip, whole coast is sandy with boulder habitat in intertidal zone at some points. During the last 10 years beach front lands already been sold to resort developers, thus new threats are coming in future along the entire coast. A large number of people living along this coast and more than 600 boats are landed here in 22 deferent spots. Currently the tourism increasing, but still there are large areas suitable for turtle nesting and wintering birds roosting. The average width of the peninsular beach is 100-150m, and up to 400-500 m wide in some places. The entire area of the coastal strip at the east is subtropical moist semi evergreen forested also much of this is degraded due to severe deforestation during the last 3 decades. About 850 olive ridley nests recorded seasonally during 2013 - 16 and some spots are very important with higher nesting frequencies. 23 spots have been reported for olive ridley nesting.

AUTOMATIC IDENTIFICATION OF FREE-RANGING GREEN TURTLE BEHAVIORS BY SUPERVISED LEARNING ALGORITHMS FROM COMBINED ACCELERATION-DEPTH DATA

Lorène Jeantet

IPHC-CNRS, France

The visual observation of free-ranging sea turtles is a significant challenge. Yet, identification of behaviors is particularly relevant in the understanding of endangered species’ ecology and may considerably contribute to their conservation. Animal-borne high-frequency tri-axial accelerometers and depth recorders have provided valuable improvements in our understanding of fine-scale behaviors. However, inferring sea turtles' behaviors using such devices is not obvious because of the lack of visual validation. The main goal of this study was to determine to which extent we can design an automatic procedure able to correctly infer the behaviors of free-ranging green turtles from acceleration–depth data in blind condition by comparing the putative behaviors inferred from these data with the actual behaviors as observed thanks to video. Nine free-ranging immature green turtles (*Chelonia mydas*) were equipped with an on-board video-recorder associated with a high-frequency tri-axial accelerometer and a depth recorder. While the surface behaviors were identified from depth data, the diving behaviors were inferred by combining predictions of five supervised machine learning algorithms in two ensemble classifiers: Voting Ensemble (VE, which keeps the most predicted behavior) and Weighted Sum (WS, where the prediction of each individual classifier was weighted as a function of its own efficiency). With respect to the behaviors visually identified on the video footage, we showed that VE and WS discriminated the various behaviors with a global accuracy of about 0.7. Their predictions associated with the surface behavior identification based on depth data allowed us to infer a time budget by individual, and compared it to the actual time budgets. The pie charts representing the time spent on the nine behavioral categories showed similar proportions between the predictions and the observations for all the green turtles. This first step in the automatic behavioral identification of free-ranging sea turtles opens promising perspectives to infer activity budget for extended periods using miniature loggers set on free-ranging marine animals, for a better understanding of their ecology in relation to environmental conditions. Combined with location information, the identification of their behaviors should help determine areas where sea turtle concentrate their activities, such as resting and foraging. Those identified core habitats could then be protected in order to conserve their integrity and limit the interaction between sea turtle and human activities in the ultimate goal to protect these endangered species.

THE IMPORTANCE OF TURKISH BEACHES FOR LOGGERHEAD AND GREEN TURTLES IN THE MEDITERRANEAN

İrfan Ekmekçi[1], Mahmut Akan[2], and Yakup Kaska[3]

[1]Turkish Ministry of Environment and Urbanization, Department of Environment Impact Assessment, Ankara, Turkey
[2]Turkish Ministry of Agriculture and Forestry, General Directorate of Nature Conservation and National Parks, Ankara, Turkey
[3]Pamukkale University, Faculty of Arts and Sciences, Department of Biology, Denizli, Turkey Pamukkale University, Sea Turtle Research Centre (DEKAMER), Denizli, Turkey

Loggerhead and green turtles nest on the beaches of Turkish Mediterranean Coast. There are 21 identified nesting sites and 14 of these beaches have been monitored by different group of Volunteers, Ministry staff and research teams under different Universities. The total length of these 21 beaches identified as sea turtle nesting beaches is 290 km. The loggerhead turtles nest mainly western beaches and the green turtle nest on the eastern beaches. The first nest monitoring studies started in 1988 on some of these beaches. Since then, there were 43 MSc theses and 16 PhD studies carried out by the Universities on sea turtles along these beaches. The early years of monitoring were mainly focused on nest counts, but later the topics involved in research are varied from sex ratio estimation to genetic diversity. The total number of nests recorded varied from year to year due to the number of beaches monitored. 14 of these beaches have been monitored regularly in recent years with the same methodology during the entire season. The loggerhead turtle nests were 4066 and 5460 in 2017 and 2018 respectively. These numbers can be corrected by irregular monitoring on sporadic nesting and those beaches that monitored regularly. If these number were corrected by including those data from sporadic nesting, it can go up to 6000 making 20 nests per km for all Turkey. The highest nesting density was Dalyan beach 116 nests/km followed by Belek beach 70 nests/km. The green turtle nests were detected were up to 3504 over the last 30 years and it was almost highest in the last two years. There are 6 main green turtle nesting beaches (52 km in total length) monitored every year on a daily basis. This makes around 67 nests/km on these beaches. The highest nest densities were on Kazanl? as 244 nests/km and 125 nests/km on Samandag beaches. These values show that there is a clear evidence that both loggerhead and green turtle nest counts are increasing in recent years. There is also total nest monitoring activities on all Mediterranean countries. Turkish nest counts clearly show that majority of green turtles nesting in Turkey and around half of the loggerhead turtles are also nesting in Turkey. The survivorship of these turtles are therefore very much dependent on Turkish beaches.

COMPARING THE BREEDING SEX RATIOS OF LEATHERBACKS AND GREEN TURTLES NESTING ON THE SAME BEACHES IN SOUTHEASTERN FLORIDA

Jacob Lasala, Colin Hughes, and Jeanette Wyneken

Florida Atlantic University, Boca Raton, FL, USA

The reproductive behavior of migratory organisms is difficult to characterize as the mating behavior can difficult to observe. For such species it can also be difficult to determine the sex ratio of the population.

The lack of accurate accounts of the numbers of males and females can result in ineffective conservation methods. The goal of this study was to identify the mating system of two species of marine turtles the leatherback (*Dermochelys coriacea*), and the green sea turtle (*Chelonia mydas*) nesting in southern Florida. We used genetic exclusion analysis to determine paternity of clutches. We quantified breeding sex ratios (BSR) by examining paternity of hatchlings. We sampled turtles from two Florida beaches Juno Beach and Boca Raton from 2013-2017 and determined they were the same nesting populations. We sampled and genotyped 157 leatherbacks and 165 green nesters and over 1,800 leatherback and 3,500 green hatchlings. Multiple paternity of clutches was common in both species and across multiple seasons supporting previous studies that showed polyandry. Florida leatherback clutches displayed a higher rate of multiple paternity than previously published studies have found. Our leatherback higher BSR (1.8 males:1 female) may be due to a mainland effect (turtles may be more likely to encounter each other along mainland coastline). Interestingly there was one instance of a male found in more than one nest (polygyny). For green turtles, the rate of multiple paternity was within the range of previously published results (2.5 males:1 female). There was limited evidence of polygyny at both nesting sites. Evidence for indirect benefits of multiple mating was low. The two species use the same beaches and travel to the rookeries from elsewhere. Their BSRs suggest there are enough breeding males and maybe more males than expected. We hypothesize that reproductive females may mate promiscuously both in route and along their rookeries because the numbers of males is higher than one might predict and the level identification of the same father more than once in a season is low.

POPULATION STRUCTURE AND BODY CONDITION INDEX (BCI) OF SEA TURTLES OF ESPÍRITU SANTO ISLAND, MEXICO

Valeria Leal-Sepulveda[1,2], César Paúl Ley-Quiñónez[2,3], Catherine E. Hart[4,5], Renato Leal-Moreno[2,3], Brenda Aracely Espinoza-Romo[5], Carlos Romero-Urías[5], Alejandra Sandoval-Lugo[2,3], Maria del Rosario Vejar-Rubio[5], Alonso Aguirre[6], and Kevin Alan Zavala-Félix[1,2]

[1]*Universidad Autonoma de Occidente*
[2]*GTC*
[3]*IPN-CIIDIR SINALOA*
[4]*Red Tortuguera*
[5]*Grupo tortuguero de las Californias A.C.*
[6]*George Mason University*

Espiritu Santo Island, is located in the state of Baja California Sur, Mexico and is considered a Natural Protected Area in the category of Flora and Fauna Protection Area "Islands of the Gulf of California" since 1978 and declared as a World Heritage Site by UNESCO in 1995. On the marine area of the island, sea turtle monitoring is carried out by the Grupo Tortuguero de las Californias in collaboration with CONANP park rangers. The IPN-CIIDIR Sinaloa collaborated in 2015 in two surveys and with the results obtained, the composition of sizes and structure of the population was reported for the first time, during the period, through the use of gillnets and enclosure technique, 27 turtles were captured, of which 6 were hawksbills (*Eretmochelys imbricata*), 20 black turtles (*Chelonia mydas agassizii*) and one hybrid between both species. The average size of the black turtles was 67.6±6.9 of SCL (Straight Carapace Length) and 53.6±4.4 SCW (Straight Carapace Width), in the same way the curved measurements were obtained with an average of 73.6±8.1 CCL (Curved Carapace Length) and 69.9±6.2 of CCW (Curved Carapace Width). The average weight recorded was 43.5 kg ± 13.8. Due to the registered sizes of this species, in only 11 turtles it was possible to determine the sex based on the length of the tail (9 females and 2 males), the rest were considered as undefined. An average BCI (Body Condition Index) of 1.4±0.2 was calculated for this specie. For the hawksbill turtles, the average size was 60.2±9.7 SCL and 45.3±6.9 SCW, while the CCL and CCW was 64.5±11 and 55.5±10.4 respectively with an average weight of 28.6±17.9. Of these turtles, only the sex of 2 females could be determined. The average BCI of the hawksbill was calculated in 1.2±0.1. The recorded case of hybridization between black and hawksbill is the first in the region and corresponded to a male adult sea turtle of 58 kg in weight, with measures of 75 cm of SCL; 57.7 SCW and 79.2 cm of CCL; 70 CCW, with an BCI of 1.37. With the data reported in this work, it is shown that the most important species on the site are the Hawksbill and black turtles and that the structure of the population is composed of both juvenile individuals and adults of black turtles and mainly of juveniles for the Hawksbills and Both species were categorized as "Very Good" in terms of the body condition index according to the Wyneken classification (2007), so it may be related to a good health condition and availability of food in the area.

KIN STRUCTURE IN A CARIBBEAN HAWKSBILL ROOKERY REVEALS PRECISE NATAL HOMING AND 15 YEARS TO MATURITY

Kathryn Levasseur[1], Seth Stapleton[2], and Joseph Quattro[1]

[1]*University of South Carolina, Columbia, SC, USA*
[2]*University of Minnesota, St. Paul, MN, USA*

Hawksbill sea turtle (*Eretmochelys imbricata*) numbers have declined by more than 80% in the last century, leaving behind remnant populations. Chronically small effective population sizes and subsequent inbreeding depression leave these populations less equipped to adapt and further endangered with extinction. Despite considerable efforts focused on marine turtle biology, many details about fundamental behavior and life history patterns, like natal homing precision and age at maturity, remain unknown. Regional 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 proxies such as growth rates, skeletochronology and bomb radiocarbon dating, but little direct evidence exists for this fundamental life history trait due to the difficulty of tagging and tracking hatchlings. We investigate natal homing precision and age at maturity in the Jumby Bay (JB) rookery of Antigua, West Indies, by genotyping individuals and reconstructing kin structure. The long-term mark-recapture program at JB combined with strong and consistent nest-site fidelity presents a unique opportunity to estimate age in JB nesters and establish generational information. We estimate relationships using a full probability approach which incorporates genetic data from all individuals simultaneously. We then verify relationships with several additional methods, including traditional pairwise relatedness and Mendelian combinatorial methods. Within the JB rookery, we identified 18 long-term veteran nesters as the mothers of 42 young nesters, providing evidence of natal homing to a 1 km nesting site. Time elapsed between first nesting seasons of mothers and daughters is 14-20 years, indicating age at maturity may be as low as 14 years in Caribbean hawksbills. We also present data on full sibling groups nesting across Antigua and Barbuda. Strong homing behavior, like that exhibited by Eastern Caribbean hawksbills, might prevent individuals from colonizing new nesting sites should the need arise, making them more vulnerable to habitat alteration from development and climate change.

HATCHLING TAGGING: A 45 YEAR AUSTRALIAN EXPERIMENT

Colin Limpus

Threatened Species Operations, Queensland Department of Environment and Science, Brisbane, Qld, Australia

When we began turtle research in eastern Australia 50 years ago in 1968 there were many poorly understood aspects of their biology. In particular, folklore rather than science guided our thinking of basic questions like: do turtles return to breed at the beach where they were born; how old are they when they commence breeding and what proportion of hatchlings actually survive to breeding age? In 1972, I conceived an experiment to quantify these three parameters for marine turtles breeding in the southern Great Barrier Reef (GBR) of Australia. At that time, based on folk lore, this experiment was expected to run for 10 years. This was revised to a 30-50 year duration study when, subsequent inwater mark-recapture studies showed that our turtles would take decades to reach breeding age. In this presentation I describe the design of a structured study to quantify natal homing, age at first breeding and survivorship to adult breeding, based on tagging using carapace notching of hatchling loggerhead turtles at GBR nesting beaches. Notching codes used allowed for identification of the year and beach when the hatchlings originated. Hatchling tagging ran over 7 breeding seasons (1973-1979) at 2 rookeries (Mon Repos, Heron Island) with 129,921 loggerhead hatchlings tagged. Three decades later as the tagged hatchlings returned for first breeding, new technologies added to the rigor of the study: gonad examination via laparoscopy of the nesting females allowed for definitive identification of turtles in their 1st breeding season. Satellite telemetry of these nesting turtles originally tagged as hatchlings has facilitated identification of the foraging distribution of adult turtles relative to the beach where hatched. Unfortunately, hatchling survival to adult breeding cannot be quantified because of decimation of the SW Pacific loggerhead turtle population through bycatch mortality within eastern and northern Australian trawl fisheries between 1975 and 2001. However, data will be presented to summarise the age distribution for loggerhead turtles as they commence breeding in eastern Australia. The range of precision of natal homing will be shown to be consistent with current understandings of genetic stock distribution. Observations over successive breeding seasons and telemetry data offer insights regarding inter-seasonal nesting beach fidelity and the foraging distribution of turtles hatched at a single beach.

LONG-TERM TREND IN LOGGERHEAD (*CARETTA CARETTA*) NESTING ACTIVITY AT THE MOST IMPORTANT BEACHES OF BOA VISTA ISLAND (CAPE VERDE)

Ana Liria-Loza[1,2], María E. Medina-Suárez[1], Judit Pinós-Crosas[1], and Luís F. López-Jurado[1]

[1]*Cabo Verde Natura 2000, Boa Vista Island, Cape Verde*
[2]*University of Las Palmas de Gran Canaria, Las Palmas, Spain*

Marine turtle conservation activities in Cape Verde started in 1998 with the discovery of the first signings of turtle nesting activity founded in Boa Vista Island by L.F. Lopez-Jurado. During 1998 summer the identification of the species nesting in the area and the location of the most important sites were conducted. According to the results obtained, in 1999 the first Field Camp to monitor loggerhead reproductive habitats was based on Ervatão beach to monitor the 3km of beaches with the highest nest densities (Ervatão, Ponta Cosme and Calheta de Pau beaches). Daily census and nesting female monitoring have been conducted each reproductive season in these 3km of beaches from 1999 to date. An 18-years trend of these 3km of beaches was analyzed and three important periods had been observed. The first 7 years (2001-2007) was characterized by slightly 2-years fluctuation with a general increasing in the number of nests laid along the period. The second 7-years period (2008-2014) was characterized by very strong fluctuations in the number of females reached the area to nest, showing a general decrease of nest numbers along the period. The last period (2015-2018) showed a very strong increase in the number of nests laid by loggerhead females in the area, which presented more nests in 4 years than the other periods in 7 years. In general, an important increase in the number of nests laid by loggerhead females in these 3 important beaches has been observed along the years, mainly occurred in the last 3 years. Differences between beaches have been also observed, showing the strong increase in nest numbers at Ervatão beach, located between the other 2 beaches. Along the periods, Ponta Cosme and Calheta de Pau beaches had also increased the number of nests but not as strong as Ervatão beach. Overall, important fluctuations in the number of nests laid by loggerhead females in this small but very important area have been observed along the last 18 years, so more and different kind of studies are required to understand the status of the Cape Verde loggerhead rookery.

MAIN DRIVERS OF AN EXTRAORDINARY INCREASE OF LOGGERHEAD TURTLE NESTS IN CAPE VERDE

Adolfo Marco Llorente[1], Samir Martins[2], Elena Abella[2], and Juan Patino-Martinez[3]

[1]*Doñana Biological Station, CSIC, Seville, Spain*
[2]*BIOS.CV, Sal Rei, Boa Vista, Cabo Verde*
[3]*Fundaçao Maio Biodiversidade (FMB), Maio, Cabo Verde*

During the summer of 2018, the number of loggerhead turtle nests in Cape Verde has tripled in respect to previous nesting record just one year before (2017). We could be facing the beginning of the recovery of this threatened population. The number of nests on the beaches is considered a reliable estimator of the total number of adult females of a population and, therefore, of their conservation status. A strong increase in the annual number of nests can be due to an increase in the number of adult females. However, it can also be explained by other causes. Each adult female rarely breed in two consecutive seasons and rests without spawning between 2 and 5 years. Therefore, a very high synchronization of many females could cause an increase on the number of annual nests without varying the number of females. However, during 2018 less than 0.5% of adult female had been identified in 2017. In fact, it can be said that those 15,000-20,000 females that may have nested this year must be added to the 6,000-8,000 that nested in 2017. Ten years ago, the estimation of the total number of adult females in the population was of 8,000 to 10,000. Another alternative could be related to an increase in the annual number of nests laid per female. Each turtle female nests several times during a season every 14 to 18 days. In Cape Verde it has been estimated that each female can lay between 4 and 6 nests per breeding year. However, the start and end of this season have been similar to the rest of previous years and, therefore, it seems impossible that each female has had time to put more than 7 consecutive nests, as usual. It seems that the number of adult females has really increased in the last two years. The mortality of adult females could have been reduced significantly. However, the number of adult female remigrants has not been particularly high in 2018 or 2017. The mortality of females on beaches has been significantly reduced, but there is no evidence of any decrease on mortality on the sea.

In addition, the recapture rates of adult females remain very low, which indicates a high mortality. Another explanation is a very important reduction in the juvenile mortality of this population in their feeding areas, or a significant increase in their abundance due to an increase in the production of females in the last 30 years. The high number of neophyte females, who arrived in 2017 and especially in 2018 seems to support this hypothesis. Now is the 20th anniversary of the beginning of turtle nesting protection in Cape Verde. From 1998 many females were saved and safely nested on these beaches after many decades of a strong hunting pressure, leading to a significant increase on female production on the beaches. Increasing temperatures during the past decades may also be contributing to a larger production of females.

USING AI MACHINE LEARNING TECHNOLOGY TO RECOGNIZE GALÁPAGOS SEA TURTLES: AN IMAGE RECOGNITION ALGORITHM IN SOCIAL MEDIA PICTURES TO IDENTIFY INDIVIDUALS, ASSOCIATE THESE INDIVIDUALS WITH LOCATIONS AND MONITOR THEIR MIGRATION PATTERNS IN REAL TIME

Alban Mazars-Simon[1], Daniela Alarcón-Ruales[2], and Juan Pablo Muñoz-Pérez[2]

[1]*Departamento de Ciências da Vida, Universidade de Coimbra and Galápagos Science Center GSC (Universidad San Francisco de Quito-University of North Carolina at Chapel Hill), Av. Alsacio Northia, Isla San Cristobal, Galápagos, Ecuador*
[2]*Galápagos Science Center GSC (Universidad San Francisco de Quito-University of North Carolina at Chapel Hill), Av. Alsacio Northia, Isla San Cristobal, Galápagos, Ecuador*

The increase species extinction rate is of great concern for the stability of numerous ecosystems worldwide, and the ocean is not the exception. Numerous species of fish, mammals, reptiles, and birds are disappearing from our seas, including sea turtles. Sea turtles have a huge importance in the marine ecosystem; that goes from maintaining productive coral reef ecosystems to transporting essential nutrients from the oceans to the beaches, and they are also in charge of regulating the populations of different species of jellyfishes, sponges, algae. The disappearance of the sea turtles could trigger an ecological disaster of dimensions never experienced by humanity. To mitigate the species disappearances multiple conservation projects have been developed. But, one of the greatest challenges in Conservation Biology is deciding how to commit scarce resources of money and manpower in the best possible ways to achieve conservation goals. Scientists and conservationists have often involved the non-scientific community (citizen science) as a way of increasing the amount of data collected for monitoring purposes. Which is necessary for conservation, especially in species such as sea turtles, where huge gaps of information associated with their migration still remain. However, citizen science can often lead to varying levels of error and bias that can lead to different results and interpretations depending on the methodology used; this has necessitated development of new, more sophisticated approaches to the analysis of large data sets, including innovations in geospatial statistics, exploratory data-mining, hierarchical modeling, and computational biology. The present study proposes a new methodology/application that goes further, decreasing radically the amount of manpower required for data collection as it employs the data available on social media for the monitoring of sea turtles, focusing in the Galápagos region as a passive citizen science. Using deep learning technology, an image recognition algorithm was developed to recognize sea turtles features in the social media pictures and identify individuals, being able to associate these individuals with locations and monitor their migration patterns in real time. The current version of the algorithm is capable of identifying sea turtles on any pictures with a confidence score of 93.81% ± 2.74 on average among a database of three thousand pictures in a few minutes. This could be used as a powerful identifying tool against poaching and wildlife smuggling as the database could recognize any sea turtle that could have been victim of those actions and provide tangible proof for the authorities. This could improve considerably the conservation effort as it could make available tons of data not only from sea turtles but other species as well. The technology once implemented on a conservation scheme would require the minimal involvement of scientist for data gathering. However, the creation of this kind of network will require a high initial investment with a great adoption rate to be efficient; and could be stopped if the social media restrict their access to third-party API as a response against the public distrust such as the Cambridge Analytica scandal.

HAWKSBILL SEA TURTLE-FISH INTERACTIONS: MORE THAN FORAGING FRIENDS?

Ashley M. Morrow[1,2], Ashlyn L. Lewis[2,3], Lidia Salinas[2,4], and Stephen G. Dunbar[2,4,5]

[1]*Union College, Lincoln, NE 68506*
[2]*Protective Turtle Ecology Center for Training, Outreach, and Research, Inc. (ProTECTOR, Inc.), Loma Linda, CA 92350*
[3]*Moorpark City College, Moorpark, Ca 93021*
[4]*Protective Turtle Ecology Center for Training, Outreach, and Research, Inc. (ProTECTOR, Inc.– Honduras), Tegucigalpa, Honduras*
[5]*Marine Research Group, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, CA 92350*

Mutualism, parasitism, and commensalism have been characterized in a wide variety of marine organisms. However, the possibility of mutualistic symbiosis between sea turtles and other species is relatively under reported and unexplored. The hawksbill sea turtle (*Eretmochelys imbricata*) and three angelfish species: gray (*Pomacanthus arcuatus)*, French (*Pomacanthus paru)*, and queen angelfish (*Holacanthus ciliaris)* have an apparent commensal feeding relationship. When feeding, hawksbills expose the soft inner tissue of sponges, making the tissue more accessible to smaller predators, such as angelfish. The main objectives of this study were to quantify how many hawksbill - fish interactions occurred, identify fish species involved in interactions, identify which species arrived first at prey items, and identify on what prey type hawksbills were feeding. We carried out observations of frequency and duration of hawksbill -fish interactions during in-water surveys to gather preliminary data regarding these feeding interactions. We undertook a total of 47 survey dives in the Sandy Bay West End Marine Reserve (SBWEMR), along the west end of Roatan, Honduras, between 29 June and 1 August, 2018. Dives were done once in the morning (approximately 09:00) and once in the afternoon (approximately 14:00) to a maximum depth of approximately 18 m. We gathered digital photos and video recordings of each hawksbill sighting, and when possible, recorded entire individual feeding bouts. If present, we identified the flipper tag number for every individual hawksbill seen. Each species involved in hawksbill interactions was noted, as well as which prey items were consumed. We observed commensal feeding relationships between angelfish (Family Pomacanthidae) and hawksbills, as well as evidence for commensal feeding relationships between hawksbills and several species of wrasses (Family Labridae) and damselfishes (Family Pomacentridae). Interactions between hawksbills and fish species were seen to occur more often when hawksbills were feeding on sponges. Hawksbills were seen on 53.2% of all dives during this study, while interactions between hawksbills and different fish species occurred in 80% of all hawksbill sightings. When the frequency of different fish species was compared, the three most prominent interactions seen were: angelfish-hawksbill at 46%, damselfish-hawksbill at 23%, and blue chromis-hawksbill at 15%. Angelfish-hawksbill interactions occurred significantly more (P,0.001) than any other fish. Further support for a more mutualistic symbiosis relationship between angelfish species and hawksbills may be obtained by surveying the abundance of angelfish compared to other species of fish present in the waters of the Sandy Bay West End Marine Reserve (SBWEMR). Our preliminary results indicate that hawksbills predominantly arrive at prey items before interactions between these species occur, although some observed interactions were initiated before our observations began. We noted that while these fish do not solely rely on hawksbills for food, this relationship provides new foraging opportunities and advantages for survival and in competition with other fish species. Further research and observations on interspecies interactions may be extremely beneficial to our understanding of marine foraging behavior, and mutualistic symbiosis as a whole.

HAWKSBILL AND GREEN TURTLE NESTING POPULATIONS OF SOUTHWEST INDIAN OCEAN: CHAGOS MPA AND REPUBLIC OF SEYCHELLES

Jeanne A. Mortimer[1,2], Nicole Esteban[3], and Graeme C. Hays[4]

[1]Department of Biology, University of Florida, Gainesville, Florida USA; [2]Turtle Action Group of Seychelles, Victoria, Mahe, Seychelles
[3]Swansea University, Department of Biosciences, Swansea, Wales, UK
[4]Deakin University, School of Life and Environmental Sciences, Centre for Integrative Ecology, Warrnambool, VIC, Australia

The IUCN Marine Turtle Specialist Group (MTSG) has identified the Southwest Indian Ocean (SWIO) as the location of one of 17 regional management units (RMUs) for green turtles and one of 13 RMUs for hawksbill turtles. The SWIO hosts globally significant nesting populations of both species. The Chagos Marine Protected Area (MPA) which includes 67 islands with 235 km of coastline (132 km of suitable nesting habitat) is uninhabited by humans, except for Diego Garcia atoll, the site of an Anglo-American military base. To assess spatial patterns of nesting activity the Chagos coastlines were rapid-surveyed by counting nesting body pits and turtle tracks at approximately the same time of year in 1996, 1999, 2006 and 2016. In addition, from 2006 to the present, a 2.8 km Index Beach on Diego Garcia has been monitored semi-monthly by Base personnel to assess nesting seasonality and to quantify levels of reproductive output. In the Republic of Seychelles, with 193 km of suitable nesting beach, long-term monitoring of nesting activity has been underway at certain sites since 1968. Over the past five decades more than 18 new intensive year-round long-term monitoring projects have been added, and more are planned. These range in longevity from one year to 50 years. All other nesting sites in Seychelles have been rapid-surveyed on multiple occasions. Based on our data from Chagos and Seychelles, and on a review of literature from other sites in the SWIO region, we estimate that Chagos accounts for 34-45% of all hawksbill nesting, and 13-18% of green turtle nesting in the SWIO. Together, Chagos and Seychelles account for an estimated 72-95% of all hawksbill nesting, and 44-61% of green turtle nesting in the SWIO. Strong genetic linkages between the hawksbills of Chagos and Seychelles indicate that together they comprise a distinct genetic stock.

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

Colum Muccio

Wildlife Rescue and Conservation Association

Since the early 1980s, sea turtle conservation in Guatemala has relied on an informal system whereby local egg collectors are allowed to harvest olive ridley eggs as long as they turn over a conservation quota of 20% of each nest to a hatchery. 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 management of 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 7 index beaches along the Pacific coast of Guatemala, and collects socioeconomic data. Using this data, it produces an annual Situational Analysis that is distributed to decision-makers and counterparts. Among the principal findings of the 2017 Analysis: The olive ridley population on the Pacific coast of Guatemala continues to increase. ARCAS crawl count data has documented more than a doubling of nesting density in the last 14 years, with 906 crawls recorded in 2003 and 2134 in 2017. The number of sea turtle eggs rescued and incubated on a national scale has increased from 60,000 in 2003 to 589,273 in 2017. This increase is mainly due to the various sponsor-a-nest programs operated by hatcheries, hotels and vacation home owners. In 2017, 51.37% of all rescued eggs were purchased or found on the beach, mainly by the private sector. In 2017, 28,506 successful nests (minus 9.67% of false crawls) were laid on the Pacific coast of Guatemala for a total of 2,641,359 eggs. Of these, 584,273 eggs were rescued and incubated at 25 hatcheries, representing 22.12% of the total number of eggs laid. For the first time, on July 22, 2018, the nesting of a hawksbill sea turtle was documented in the village of Madre Vieja, Taxisco, Chiquimulilla. In 2017, the economic value on the beach (wholesale price) of the market in olive ridley eggs on the Pacific coast of Guatemala was Q 2,925,521 or US$395,340. If we take into consideration the supply chain from collector, to buyer, to wholesaler and then consumer, the retail value of the sea turtle egg trade was Q12,678,526, or US$1,668,227. The population tendency for leatherbacks continues to decline, and in 2017, only three nests were reported on the 254kms of the Pacific coast of Guatemala, and the hatching success of these three nests was zero. Nesting density is much higher in the southeast than in the southwest, with the peak areas being Hawaii and La Barrona. Leatherback and green nesting is also concentrated in the east. 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, it can be said that the collection of eggs is a subsistence activity.

BARNACLE SHELL ISOTOPES REVEAL IMPORTANT LOGGERHEAD TURTLE FORAGING HABITATS

Ryan M. Pearson[1,2], Jason P. van de Merwe[2], Michael K. Gagan[3], Colin J. Limpus[4], and Rod M. Connolly[1,2]

[1]*Australian Rivers Institute - Coasts & Estuaries, Brisbane, Qld, Australia*
[2]*Griffith University, Nathan, QLD, Australia*
[3]*The University of Queensland, St. Lucia, Qld, Australia*
[4]*Queensland Department of Environment & Science, Brisbane, Qld, Australia*

Understanding the geographic distribution of migrating animals within their sub-populations can enhance conservation and management, especially for threatened sub-populations. Here we employ a novel isotope technique to understand the foraging distribution of critically endangered south Pacific loggerhead sea turtles (*Caretta caretta*), and identify critical habitats for priority management. We use isotope ratios from commensal barnacle shells, which form sequentially and store isotope information that reflects temperature and salinity rather than turtle diet. This makes it possible to assign a date to samples and compare isotope ratios with the spatial and temporal distribution of remotely collected sea water parameters. We apply this technique to predict the home areas of loggerhead turtles that nested in southern Queensland, Australia, identifying hotspots and relationships between nesting and foraging habitats. We demonstrate that isotopes from barnacle shells can identify the origin and migration distances of host turtles at varying spatial scales. In eastern Australia, for example, we assign turtles to home areas with >86% accuracy when areas are separated by at least 400 km. This is better resolution than other similar techniques and useful for conservation and management, especially considering migration distances can exceed 2,600 km. We further show that estuarine habitats are important foraging habitats for adult turtles foraging in southern areas, while genuinely marine habitats are likely more important than estuaries for turtles foraging in northern Australia and the southern Pacific islands. We expect these techniques to be applied widely to other turtle populations, taxa and objects that carry barnacles throughout marine journeys.

TOWARD IMPROVING THE PERFORMANCE OF SEA TURTLE SATELLITE TRACKING DEVICES USING ADDITIVE MANUFACTURING AND FLUID DYNAMICS MODELLING

Susan E. Piacenza[1], Salvador S. Mayoral[2], Alexia Kenney[1], Kasey Lugo[1], and Joseph R. Piacenza[1]

[1]*University of West Florida, Pensacola, FL, USA*
[2]*California State University Fullerton, Fullerton, CA, USA*

Satellite-linked platform terminal transmitters (PTTs) enable biologists to study movements of sea turtles. However, PTTs have limitations such as finite battery life, and can fail prematurely due to antenna breakage, biofouling, saltwater switch failure, and premature tag detachment. PTTs also induce hydrodynamic drag that may bias sea turtle behavior and also contribute to premature tag detachment. PTTs are especially valuable for studying the movements and ontogenetic habitat use of juveniles, as these life stages are critically lacking in information across all species. Although, a key challenge is that as juveniles grow, their shell expansion is hypothesized to cause premature tag detachment. In past studies, tags applied

to neonates typically stayed attached for 1-3 months and for larger juveniles 2-7 months. The ability to track juveniles for longer periods, with negligible behavioral bias, would enhance our knowledge as individuals recruit and utilize different habitats. While advances in technology (e.g., battery life, smaller microcontrollers) continue to improve state-of-the-art PTTs, there are additional design opportunities to increase deployment duration, and minimize behavioral biases. Based on a literature review, we identified several opportunities for design improvements, and as a first step, we are focusing on examining the hydrodynamic drag of commercially available PTT form factors. For this work, our initial objective is to minimize the impact of PTTs applied to neritic juvenile sea turtles, which subsequently may lead to longer attachment durations due to reduced loading on the device itself. Firstly, we will build on current methods for measuring the hydrodynamic drag imposed by state-of-the-art PTTs on juvenile sea turtles to obtain baseline data on hydrodynamic drag using wind tunnel testing. To enable the wind tunnel testing, 3D printed turtle models were created by 3D scanning 15 post-mortem sea turtles from Florida and Alabama of four species (*Chelonia mydas*, *Eretmochelys imbricata*, *Lepidochelys kempii*, and *Caretta caretta*) ranging in size from 19.2 cm SCL (*E. imbricata*) to 65.1 cm SCL (*C. caretta*). We post-processed the 3D scans, and eliminated unique features (i.e. epibionts, idiosyncratic head or flipper position due to post-mortem condition, etc.) before printing the models. We are collaborating with four PTT manufacturers (Desert Star Systems, Wildlife Computers, Telonics, and Sirtrack) who contributed tags to mount to the various turtle models during the hydrodynamic testing. The PTTs will be coupled to the turtle models using current best practices for PTT/turtle sizing and attachment methods. Wind tunnel tests will be performed at the California State University Fullerton wind tunnel (59.8 cm H x 76.2 cm W x 121.9 cm L), and will result in estimates of additional drag induced by the PTTs with respect to the turtle size. Moving forward, hydrodynamic drag data will be used to parameterize a computational fluid dynamics model, which will allow the exploration of design trade-offs of various PTT form factors (e.g., shape, frontal area) and their impact on various turtle species. Leveraging the principles of design engineering and modern computational tools will enable novel PTT designs that minimize hydrodynamic drag, and may extend deployment duration. The overarching goal of this work is to reduce behavioral biases of PTTs to obtain data that best represents the true biology of sea turtle species in-water.

A META-ANALYSIS OF SOMATIC GROWTH IN SEA TURTLES

Tamara Popovska

University of Miami, Coral Gables, FL, USA

Growth is a fundamental component of sea turtle life history and strongly influences species population dynamics. Growth models are particularly important to population assessment of long-lived species, such as sea turtles, because they provide one of the only methods of estimating age at maturation. However, most current growth models contain significant data gaps across life stages and species, and some populations lack growth curves altogether. To close these gaps and identify data needs, we performed a literature review and meta-analysis of sea turtle growth information. Our compiled database of somatic growth information spans 40 years of research and contains over 100 studies. This database will be used to quantify somatic growth variation within and among species and populations. To combine data from the different studies, we are conducting a Bayesian hierarchical meta-analysis using the modeling software OpenBUGS, examining the variability in growth attributed to species, sampling methodology (mark and recapture or skeletochronology), and population. Through a hierarchical meta-analysis, we can integrate information from multiple studies that allows us to produce a better estimate of growth and variation for species and populations than we would in a single growth study. Our model is set up with a multivariate prior coupled with multivariate normal data. Von Bertalanffy growth parameter estimates (L_∞, k) from compiled literature are the data in our model. For studies that only presented means and variance in growth rate, we extracted raw data to fit our own von Bertalanffy growth curves. We chose a hierarchical model to maximize the efficiency of the estimation of the growth curves, especially for species that lack substantial growth data. Our final model will estimate the asymptotic growth of sea turtles as a function of tagging technique, population, species, and normally distributed random error. This study can be used as a basis for future evaluation of sea turtle population dynamics, which in turn can be used to evaluate responses of different populations to disturbances. The growth data for each species is also vital when conducting ecological risk assessment and has implications for a better understanding of sea turtle biology. This database can also be used to look for change over time in sea turtle growth, and then evaluate hypotheses about the cause of this change.

DENSITY-INDEPENDENT DECLINE IN KEMP'S RIDLEY SOMATIC GROWTH RATES FOLLOWING THE DEEPWATER HORIZON OIL SPILL

Matthew D. Ramirez[1], Larisa Avens[2], Lisa R. Goshe[2], Melissa L. Snover[3], and Selina S. Heppell[1]

[1]*Oregon State University, Corvallis, Oregon, USA*
[2]*NOAA National Marine Fisheries Service, Southeast Fisheries Science Center, Beaufort Laboratory, North Carolina, USA*
[3]*Population Ecology Services, Pago Pago, American Samoa*

Accurate assessment of species response to disturbance requires baseline information on species ecology and demography. The need for such information was highlighted following the Deepwater Horizon (DWH) oil spill during efforts to understand causes of the multi-year reduction in Kemp's ridley sea turtle population growth. Unfortunately, insufficient pre-DWH demographic data have stymied efforts to identify causal factors. Kemp's ridley humerus bones contain annual records of somatic growth and have been regularly collected from stranded turtles since the 1990's. Assessment of changes in somatic growth rates before and after the DWH oil spill and during periods of population increase for juveniles stranded in the Gulf of Mexico (GoM) and U.S. Atlantic Coast can be used to test hypotheses of DWH impacts. To investigate potential temporal changes in and density-dependent effects on Kemp's ridley somatic growth rates, we compiled a ~25-year dataset using skeletochronology. This study represents an integration of newly collected (2010–2017 strandings) and previously collected (1993–2009 strandings) growth rate data for turtles that stranded from Texas to Massachusetts. Skeletochronological analyses yielding 3672 annual growth rate estimates from 1187 turtles (1998–2015). To increase statistical power, growth rate data were binned by age class (Age 0, 1, 2–5, 6–9, and 10+). Data for GoM and Atlantic stranded turtles were analyzed separately given that their growth rates differ. Generalized additive mixed models (GAMMs) and segmented regression were used to examine temporal patterns of growth and identify structural shifts in the data. Density dependent effects on somatic growth were examined using two metrics: (1) population abundance estimates obtained from an existing Kemp's ridley population model (pre-2010 estimates only) and (2) cumulative hatchling production. Analyses showed significant, non-linear trends in somatic growth through time for the smallest age classes (Ages 0–5) of both GoM and Atlantic stranded turtles. Structural shifts in growth occurred in 2012 for these turtles—mean annual growth rates decreased by 1–2 cm and remained low through 2015. We found no evidence for density dependent effects on somatic growth—mean annual growth rates did not decline with increasing abundance. Our findings are similar to those of a recent mark-recapture study that found Kemp's ridley growth rates after the DWH oil spill were lower than measured in this species in years prior. Interestingly, we found no long-term, negative trend in growth rates that was observed in a previous analysis of a subset of this dataset (GoM, 1988–2009). These results may indicate that there was a delayed growth response to the DWH oil spill, mediated through indirect effects on the food web. Simultaneous declines in growth for oceanic stage turtles (Age 0) and neritic stage turtles (Ages 1–5) from both the GoM and Atlantic Ocean may also suggest a region-wide change in environmental conditions that affected turtles across their range. Continued monitoring of Kemp's ridley growth rates is needed to determine if and when growth rates return to pre-DWH levels, which will require regular, systematic sampling of humeri from stranded animals. Additionally, assessments are needed to quantify effects on species population dynamics.

SPATIAL DISTRIBUTION OF GREEN SEA TURTLE (*CHELONIA MYDAS*) NESTS AT FRENCH FRIGATE SHOALS, HAWAII: IMPLICATIONS FOR CARRYING CAPACITY?

Alexandra S. Reininger, Summer L. Martin, Camryn D. Allen, Marylou K. Staman, Jan Willem Staman, and T. Todd Jones

NOAA Fisheries, Pacific Islands Fisheries Science Center, 1845 Wasp Boulevard, Building 176, Honolulu, Hawaii 96818

The Hawaiian green sea turtle population (i.e., the Central North Pacific population) is functionally a closed population, meaning that turtles primarily breed, nest, and forage all within the Hawaiian archipelago. Ninety six percent of nesting occurs within a single low-lying, remote atoll – French Frigate Shoals (FFS). Annual nesting surveys are conducted on two islands within FFS, East and Tern Islands. Prior to October 2018, East Island had an area of 35,853 m^2, with sandy beach along the entire perimeter, allowing turtles to emerge from the water on any side of the island. Tern Island had an area of 105,276 m^2, and contained remnant manmade structures, which have created barriers confining turtles to three separate nesting beaches. Both islands have shifting sands, tidal inundation, vegetation, and nesting seabirds. A study based on nesting data from East Island (2005-2009) concluded that the beach could successfully support increased nesting activity, thereby suggesting that carrying capacity for the recovering population was more limited by coastal foraging habitat than nesting habitat. The analysis, however, assumed that turtle nests are randomly distributed over the entire area of East Island. In 2017, we collected GPS data on nest locations to test the hypothesis that nest distribution on both islands was random. Using the nearest neighbor spatial statistic tool in ArcGIS, we found that the nests laid on East and Tern Islands were significantly clustered [East Island nearest neighbor ratio: 0.617822 (z-score: -17.363461, $p<0.001$); Tern Island nearest neighbor ratio: 0.304501 (z-score: -18.957266, $p<0.001$)]. Using kernel density analysis methods, for East Island we found that 95% of nests were located within 35% of the total area, and 50% of the nests were located within 10% of the island area. For Tern Island 95% of nests were located within 8% of the total island area, and 50% of nests were located within 2% of the island area. Our results demonstrate that nesting females are only using a small portion of the available area of each island, with most nests occurring in barren spaces along the periphery of the islands. Research in other regions has shown that nest location directly impacts hatching success due to differences in environmental conditions (i.e., microbial activity, temperature, water inundation, or substrate salinity). A clustered nesting pattern may result in higher microbial activity within nests and an increased probability of turtles digging up other nests, directly decreasing hatching success. The previous study estimated that the nesting population at FFS was far below carrying capacity, but our finding of clustered nest distributions combined with the increasing trend in the number of nesting females per year, suggests that the nesting beaches at FFS may soon reach carrying-capacity. We plan to revisit the models used to calculate nesting beach carrying capacity to incorporate a clustered distribution pattern, and further examine relationships between environmental factors and nest locations.

GREEN SEA TURTLE (*CHELONIA MYDAS*) NESTING ACTIVITY AND BREEDING CYCLE DYNAMICS. TORTUGUERO, COSTA RICA

Jaime Restrepo[1], Emily G. Webster[2], and Roldán A. Valverde[1]

[1]Sea Turtle Conservancy, Tortuguero, Costa Rica
[2]CREMA, Rescue Center for Endangered Marine Species, Costa Rica

The study and monitoring of sea turtle nesting populations on Tortuguero Beach, Costa Rica, has been the primary objective of the Sea Turtle Conservancy for the past 60 years. Populations of endangered Green sea turtles (*Chelonia mydas*), critically endangered Hawksbill (*Eretmochelys imbricata*) and vulnerable Leatherback (*Dermochelys coriacea*) and Loggerhead turtles (*Caretta caretta*) select this Northern Caribbean beach as their primary nesting site each year. From June to November tens of thousands of female Green sea turtles leave their foraging areas and arrive at Tortuguero's shore to mate and lay their eggs. This constitutes a highly energetically demanding process that restricts these individuals from embarking on the journey every year. As a result, nesting activity at this rookery is highly dynamic and nest number estimations vary drastically between seasons. Green turtle nesting activity in Tortuguero has shown an important deceleration in recent years, both in season duration and magnitudes. These conditions derived on a plateauing population trend (1986-2017), with potential for further decline considering the low nest numbers recorded in 2018. This study looks to evaluate the Green sea turtle nesting dynamics at Tortuguero beach from the past 32 years by examining inter-annual patterns of activity and exploring possible environmental explanations for these fluctuations. Previous studies elsewhere have associated inter-annual fluctuations of Green turtle nest numbers with El Niño Southern Oscillation (ENSO). Our findings will aid in understand the complexity of this system, in order to eventually predict, with certain accuracy, the magnitude of future nesting seasons. We analyzed an extensive database of encounter records (1986-2018) and calculated the total tag recaptures obtained for each nesting season. We detected that individuals exhibit a lapse in nesting of 2 to 3 years, likely to regain the energy reserves required to return to the nesting beach as part of the breeding population. The limitation on breeding frequency has repercussions for the nesting season, altering the number of females available to participate in each nesting event. From daily nest counts, we determined that regardless of the total number of females nesting during a season, similar seasonal tendencies are demonstrated each year. Two distinctive peaks in daily nest numbers occur, the first in late August, followed by a gradual decrease in nesting. After a brief period of low activity, a higher, prolonged peak occurs in mid-September. Finally, we examined inter-annual fluctuations in nesting and observed that low total nest numbers may be associated with shorter seasons; reducing them by over 20 days and delaying the beginning dates of nesting. We will test for a correlation between Multivariate ENSO Index (MEI) and total nest numbers to identify external events affecting the breeding process for this species at Tortuguero. An enhanced understanding of the parameters guiding these nesting dynamics will provide us with better tools to anticipate and study the *Chelonia mydas* nesting population during its breeding season every year.

Considering the observed population tendencies, characterizing these dynamics is essential to better target conservation efforts and reinforce strategies in order to procure higher protection to this vulnerable population.

MAN-MADE ROCK JETTY ON THE LOUSIANA COAST SERVES AS DEVELOPMENTAL HABITAT FOR JUVENILE GREEN TURTLES, *CHELONIA MYDAS*

David C. Roche[1], Brian M. Shamblin[2], Mandy C. Tumlin[3], Andrew G. Crowder[4], and Kristen M. Hart[5]

[1]*U.S. Geological Survey, Dania, FL, USA*
[2]*Warnell School of Forestry & Natural Resources, University of Georgia, Athens, GA, USA*
[3]*Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA, USA*
[4]*Cherokee Nation Technologies (contracted to the USGS), USA*
[5]*U.S. Geological Survey, Wetland and Aquatic Research Center, Fort Lauderdale, FL, USA*

Five species of marine turtles, all federally listed as threatened or endangered, reside in the Gulf of Mexico (GOM). Many anthropogenic factors such as dredging, trawling, hook and line capture, debris ingestion and entanglement, and boat propeller collisions threaten turtle survival. These threats were then compounded by the Deepwater Horizon oil rig explosion on April 20, 2010. This massive spill, approximately 66 km off the Louisiana coast, released millions of barrels of oil into the Gulf of Mexico, fouled and killed marine turtles, and heavily impacted important habitat for all five species of marine turtles. Long term assessments are necessary to evaluate the impacts of the spill on marine turtle populations, especially in the northern Gulf. Stranding data indicates that coastal bays in the Gulf are important habitat for juvenile marine turtles, but there are still gaps in our knowledge of juvenile habitat utilization patterns. Here we examine an ongoing mark-recapture study as well as genetic connectivity of juvenile and sub-adult marine turtles at Belle Pass, a heavily trafficked channel that leads into Port Fourchon on the Louisiana coast. Port Fourchon handles half of all the offshore service vessel activity for the GOM, from 26,500 to 59,500 vessel trips annually. We captured turtles along a 0.64 km stretch of rock jetty using dip nets twice per year (winter/spring) since December 2014. We captured 134 turtles, with 108 first-time captures and 26 recaptures. Juvenile green turtles, *Chelonia mydas*, constituted 99.3% of the captures. Green turtle straight carapace length (SCL) ranged from 23.1 to 66.4 cm with a mean of 32.77 ± 6.03 cm. The only other sea turtle species captured was a sub-adult loggerhead (*Caretta caretta*; SCL= 72.5 cm). The high concentration of turtles found at this jetty are comparable to aggregations noted for other sea turtle studies conducted in Texas, which reported that jetty habitat received a disproportionately high amount of use. Preliminary mitochondrial control region haplotype frequencies for Port Fourchon green turtles were not significantly different than those of Texas juvenile foraging aggregation, but were significantly different from foraging aggregations in the northeastern and southeastern GOM. The primary contributor was the Western Bay of Campeche management unit comprising Tamaulipas and Veracruz states in Mexico, with smaller contributions from other GOM stocks and Quintana Roo. Due to the large concentrations of juvenile green turtles found in such a small area this jetty habitat may represent a critical developmental habitat for green turtles. In addition to collecting morphometric data, we also collected blood and biopsy punches for future genetic and isotope studies. This information will help to give us a better idea of where these juveniles are recruiting from and what their diet consists of. Likely drawn by the abundance of algae on the rocks, this man-made jetty serves as year-round habitat for these turtles.

ENHANCING OUR UNDERSTANDING OF GREEN TURTLE POPULATION STRUCTURE THROUGHOUT THE PACIFIC WITH NUCLEAR MICROSATELLITE ANALYSIS

Suzanne E. Roden[1], Michael P. Jensen[1], George H. Balazs[2], Cristian M. Cayanan[3], I-Jiunn Cheng[4], Richard Farman[5], Nancy N. FitzSimmons[6], Amy Frey[1], Jessy R. Hapdei[7], Maike Heidemeyer[8], Jennifer Cruce Horeg[9], T. Todd Jones[10], Summer L. Martin[10], Shawn Murakawa[10], Brian Peck[11], Rotney Piedra[12], Tammy M. Summers[13], Miri Tatarata[14], Elizabeth Vélez[15], Shawn Wusstig[3], Patricia M. Zárate[16], and Peter H. Dutton[1]

[1]Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 8901 La Jolla Shores Dr., La Jolla, CA, 92037, USA
1Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 8901 La Jolla Shores Dr., La Jolla, CA, 92037, USA
[2]Golden Honu Services of Oceania, Honolulu, Hawaii
[3]Division of Aquatic and Wildlife Resources, Guam Department of Agriculture, Mangilao, Guam 96913
[4]Institute of Marine Biology, National Taiwan Ocean University, National Taiwan Ocean University, Keelung, Taiwan, ROC
[5]Aquarium des Lagon, B.P. 8185 Nouméa, 98807 Nouvelle-Calédonie
[6]Australian Rivers Institute, Griffith University, Nathan, QLD 4111, Australia
[7]CNMI Department of Lands and Natural Resources, Saipan, MP 96950
[8]Centro de Investigación en Biología Celular y Molecular CIBCM, Universidad de Costa Rica, Costa Rica
[9]NAVFAC Marianas, Santa Rita, GUAM
[10]Marine Turtle Biology and Assessment Program, Pacific Islands Fisheries Science Center, NOAA Fisheries, Honolulu, HI, USA
[11]Rose Atoll National Wildlife Refuge, U.S. Fish and Wildlife Service
[12]Sistema Nacional de Áreas de Conservación (SINAC), Costa Rica
[13]Rainbow Connection Research, Saipan, MP 96950
[14]Direction de l'Environnement, B.P. 4562, 98713 Papeete-Tahiti
[15]Asociación Kuemar, Heredia, Costa Rica
[16]Departamento de Oceanografía y Medio Ambiente, División de Investigación Pesquera, Instituto de Fomento Pesquero, Valparaíso, Chile

In recent years several studies have characterized green turtle population structure using female inherited mitochondrial DNA (mtDNA) markers. However, studies using nuclear DNA (nDNA) markers are needed to gain a comprehensive understanding of population structure and connectivity of populations through male-mediated gene flow. Studies have also shown that informative microsatellite markers can have greater power to detect fine-scale structure than mtDNA. This study builds on the dataset presented in Roden et al. (2013) by analyzing 1,016 green turtles sampled from 20 rookeries with ten nDNA microsatellite markers, and significantly expands our knowledge of green turtle population structure in the Pacific. Major rookeries were sampled from regions throughout the Pacific, including American Samoa (n=81), Northern Mariana Islands (n=30), French Polynesia (n=11), Australia (n=101), Guam (n=12), Taiwan (n=83), Marshall Islands (n=103), Palau (n=32), the Federated States of Micronesia (n=80), New Caledonia (n=33), Hawaii (n=94), Galapagos (n=85), Mexico (n=141), and Costa Rica (n=130). We tested for population differentiation with pairwise comparisons using several statistical metrics (F_{ST} and analogues, and Jost's

D). We found a high degree of connectivity among proximal rookeries in some regions (e.g. Costa Rica) while rookeries located more than 500 km apart generally were highly differentiated, results generally congruent with Management Units (MU) previously defined by mtDNA analysis. Some support for long distance connectivity through male-mediated gene flow was suggested for some populations. For example, our results support what was found in a previous study (FitzSimmons et al. 1997) where no significant differences were found among rookeries sampled at the opposite ends of the Great Barrier Reef, Australia, despite these populations showing a high degree of differentiation for mtDNA. Also, French Polynesia showed genetic similarity to New Caledonia and Palau, despite their showing significant differentiation for mtDNA (Dutton et al. 2014). This microsatellite dataset not only provides greater insight into defining green turtle population structure in the Pacific but also provides the first comprehensive baseline dataset for population assignment analyses ("stock ID") for green turtles of unknown population origin, such as in fisheries bycatch, strandings, and foraging grounds.

MOVEMENTS OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN THE GULF OF CALIFORNIA: INTEGRATING SATELLITE TELEMETRY AND REMOTELY-SENSED ENVIRONMENTAL VARIABLES

Alejandra G. Sandoval-Lugo[1], Teresa L. Espinosa-Carreón[1], Jeffrey A. Seminoff[2], Catherine E. Hart[3], César P. Ley- Quiñonez[1], Kevin A. Zavala-Félix[4], Valeria Leal-Sepúlveda[4], Alonso A. Aguirre[5], and Alan A. Zavala-Norzagaray[1]

[1]*Instituto Politécnico Nacional CIIDIR- SINALOA, Guasave, Sinaloa, Mexico*
[2]*NOAA-Southwest Fisheries Science Center, La Jolla, California 92037 USA*
[3]*Investigación, Capacitación y Soluciones Ambientas y Sociales A.C. Tepic, Nayarit, Mexico*
[4]*Universidad de Occidente, Guasave, Sinaloa, Mexico*
[5]*Department of Environmental Science and Policy, George Mason University, Fairfax, Virginia*

Loggerhead turtles (*Caretta caretta*) are a circumglobal species, listed as endangered in its North Pacific range. The North Pacific Distinct Population Segment nests in Japan and migrates to the North Pacific and Pacific coast of North America to feed. In the Mexican Pacific, records of loggerhead presence are largely restricted to the Gulf of Ulloa along the Baja California Peninsula, where very high fisheries bycatch mortality rates are reported. Records of loggerhead turtles within the Gulf of California (GC) exist; however, their use of this habitat remains poorly understood. We used biotelemetry and environmental variable analysis (chlorophyll-a [Chl-a] and sea surface temperature [SST]) to determine movements and habitat use of five loggerhead turtles ranging in size from 67 to 73 cm (mean: 70.8±2.4). in curved carapace length (mean: 70.8±2.4). Tracking durations ranged from 73 to 293 days (mean: 149 ± 62.5 days), transmissions per turtle from 14 to 1006 (mean: 462 ± 379.5) and total travel distance from 1237 to 5222 km (mean: 3118 ± 1490.7 km). We used displacement plot, travel rate, and Kernel Density analyses to identify seven foraging areas in the GC, which occurred in waters from 10 to 80 m deep, with mean Chl-a concentrations ranging from 1.6 to 7.8 mg m-3 and SST ranging from 27.8 to 34.4°C. This is the first study to describe loggerhead movements in the Gulf of California and, so far, loggerheads in the eastern Pacific have primarily been studied in the Gulf of Ulloa, yet based on our findings it is clear that loggerhead conservation should also encompass the Gulf of California. Our data from loggerhead sea turtles in the GC indicate that they use it as a foraging zone, mainly neritic areas such as the Upper Gulf, the SINMLS and

Tiburon Island. The tracked movements of the loggerhead sea turtles traced in this study provide information on habitat use that will help guide the management decisions fundamental to their conservation.

LINKAGES AMONG SPATIOTEMPORAL DISTRIBUTIONS, POPULATION DYNAMICS, AND OCEANOGRAPHY OBSERVED IN THIRTY-FIVE YEARS OF KEMP'S RIDLEY STRANDINGS

Erin E. Seney[1], Nathan F. Putman[2], Melissa Cook[3], Allen M. Foley[4], Donna J. Shaver[5], Wendy G. Teas[6], Mandy C. Tumlin[7], and Katherine L. Mansfield[1]

[1]*University of Central Florida, Orlando, FL, USA*
[2]*LGL Ecological Research Associates, Inc., Bryan, TX, USA*
[3]*National Marine Fisheries Service, Pascagoula, MS, USA*
[4]*Florida Fish and Wildlife Conservation Commission, Jacksonville, FL, USA*
[5]*National Park Service, Corpus Christi, TX, USA*
[6]*National Marine Fisheries Service, Miami, FL, USA*
[7]*Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA, USA*

Sea turtle stranding datasets are influenced by a mix of factors, including turtle abundance, mortality rates, environmental conditions' affecting stranding probabilities, survey effort, and public awareness and reporting. Despite inherent uncertainties, strandings data have potential to provide valuable information on spatiotemporal distributions, trends, and threats. To enhance our ability to use such data in population-level assessments, we conducted exploratory analyses on a dataset of Kemp's ridley (*Lepidochelys kempii*) strandings documented along the U.S. Gulf of Mexico coast during 1980-2014. Relationships among stranding data, nest production, and oceanography were examined by life stage, geographic region, and over time. Lengths were available for 87% of the nearly 10,000 strandings, and 85% of known-size ridleys were classified as the benthic immature life stage. The benthic immature dataset showed seasonal variation and some long-term trends in standing rates. Notable increases in benthic immature Kemp's ridley strandings were documented in the northern Gulf during 2010-2013, coinciding with beach clean-up, monitoring, and enhanced public awareness following the Deepwater Horizon oil spill; however, increased ridley strandings were also observed in some more consistently-covered areas. The spatiotemporal distribution of adult strandings appeared largely tied to seasonal nesting and foraging areas. Pelagic-stage strandings were primarily concentrated in areas down-stream from dense nesting, and historic benthic immature stranding numbers showed strong correlations with nest counts 10-12 years later. Stranding distributions correlated both with factors likely to influence sea turtle occurrence (e.g., temperature, mixed layer depth) and those affecting stranding probability (e.g., currents, wind stress), with some variation by region and life stage. Although the relationships can be complex, it is informative to correlate strandings data with other variables. When combined with other information, sea turtle strandings data can be utilized to better understand population trends and inform conservation and management decisions.

INTER-SEASONAL RECAPTURE RATES AND NEST SITE FIDELITY OF NORTHERN RECOVERY UNIT LOGGERHEAD TURTLES CHARACTERIZED THROUGH GENETIC TAGGING

Brian M. Shamblin[1], Mark G. Dodd[2], S. Michelle Pate[3], Matthew H. Godfrey[4], Michael S. Coyne[5], Ruth Boettcher[6], and Campbell J. Nairn[1]

[1]*University of Georgia, Athens, GA, USA*
[2]*Georgia Department of Natural Resources, Brunswick, GA, USA*
[3]*South Carolina Department of Natural Resources, Charleston, SC, USA*
[4]*North Carolina Wildlife Resources Commission, Beaufort, NC, USA*
[5]*Seaturtle.org*
[6]*Virginia Department of Game and Inland Fisheries, Machipongo, VA, USA*

Nesting female abundance for marine turtle populations is typically estimated from nest counts using mean clutch frequency and remigration intervals generated from individual nesting histories. Weak nest site fidelity (NSF) relative to the scale of tagging effort can profoundly impact these estimates. Similarly, for many species and tagging projects globally, a large proportion of females are not recaptured in subsequent years. These low recapture rates limit sample sizes for inter-seasonal NSF analyses and potentially bias annual survival estimates. These low inter-seasonal recapture rates are typically attributed to imprecise NSF. We used a genetic capture-recapture approach based on subpopulation-scale clutch sampling and microsatellite genotyping to generate preliminary data on remigration and inter-seasonal NSF for Northern Recovery Unit loggerhead turtles. Over the first three years of the project (2010-2012), we identified 1,772, 1,973, and 2,389 nesting females, respectively. Through the end of the 2017-nesting season, 68% of these females had remigrated, roughly doubling the inter-seasonal recapture rate relative to a single beach perspective. Considering only the 2010-cohort, the recapture rate was not spatially consistent among geographic bins across the subpopulation range. Approximately 70% of females had remigrated within seven years, with a reduced recapture rate on the barrier islands at the southern boundary of the study area (59%), presumably due to an edge effect. Females that nested from North Carolina through Maryland in 2010 had a markedly lower recapture rate of only 51%. Potential explanations for these "missing" females are: 1) longer remigration intervals that will require additional sampling years to detect, 2) females nesting within the study area but going undetected, 3) females nesting outside the study area (Florida), or 4) mortality. Explanation two seems unlikely given the high annual detection probabilities estimated from a robust sampling design (>0.95), although these may be overly optimistic. To provide context for explanation three, we characterized the degree of inter-seasonal NSF for 3,942 remigration observations representing 3,117 individual females. We used each female's median nesting location (MNL) along a coastal transect in each respective nesting year to approximate the spatially explicit distribution of her nesting effort and characterized inter-seasonal NSF fidelity as the displacement distance along this coastal transect between annual MNLs. Displacement ranged from a few meters to 829 km, with a mean of 21.1 (± 59.7) km. Despite the large range, the median displacement was only 2.2 km, and the majority of females nested in close proximity to prior nesting locations, with 67% of the nesting events within 5 km and 84% of the nesting events within 25 km of their previous MNLs. As with intra-seasonal NSF, inter-seasonal NSF was moderately strong, but with sufficient dispersal to necessitate a regional monitoring approach. For observed MNL displacements of greater than 25 km, there was no consistent pattern of directionality, with 325 females shifting to the south and 317 females shifting to the north between nesting seasons. Additional sampling years and incorporation of detection assessed in continuous space and time are needed to better characterize remigration intervals and generate robust survival estimates.

PILOTING THE USE OF STEREO-VIDEO CAMERA SYSTEMS TO DEVELOP AN IN-WATER INDEX OF JUVENILE LENGTH DISTRIBUTIONS IN THE NORTHERN GULF OF MEXICO

Tabitha R. Siegfried and Susan E. Piacenza

University of West Florida, Pensacola, FL, USA

All seven species of sea turtles are listed on the IUCN red list as endangered, vulnerable or data deficient. It is critical to have accurate information on all life stages of sea turtles to effectively conserve them. Juveniles, specifically, are difficult to study with low capture rates for in-water studies, and therefore few reliable data sets exist globally. In addition, current in-water studies often rely on hand or net capture to collect data, such as length measurements, which can be both stressful and risky for the turtles and researchers. However, obtaining length data on juveniles can be especially useful to estimate cohort strength, growth rates, and survival rates. This information can also be linked to data on the nester population, as cohorts recruit into the adult population, and can be used to predict changes on the nesting population. Stereo-video camera systems (SVCS) have been used for other marine fauna, but have yet to be specifically targeted towards sea turtles. SVCS, along with their analysis software, are established as an accurate and precise way to measure fish abundance, biomass, and fish lengths. Furthermore, a SVCS operator does not need extensive training to recognize species or estimate lengths in the field; therefore, the SVCS approach minimizes the potential for inter- and intra-observer variation. In this study, we are piloting the use of the SeaGIS stereo-video camera system to obtain video footage of sea turtles underwater in the Northern Gulf of Mexico. While similar to mark-recapture methods, the stereo-video camera system involves no animal handling; and, therefore, eliminates potential handling stress to the animal. The SeaGIS SVCS comes with EventMeasure software, which allows for species identification, abundance, and measurement of animal lengths. Utilizing this software will allow for the construction of length-frequency distributions of sea turtles. With individual resightings and image recognition software, the video footage can be used to estimate growth rates and survival rates. This technique will open many benefits for future studies, including: individual photo identification of each sea turtle, ability to re-examine video data for quality control, an improved data set to estimate somatic growth rates, survival rates, and potentially can be used to predict population recovery, and correlate population status and environmental change. We will be conducting SVCS surveys in a suite of natural sea grass, fishing piers, and artificial reef habitats along the northern Gulf of Mexico. In our initial SVCS surveys, we will be testing appropriate survey methodologies to maximize turtle encounters and to ensure high quality video. The SVCS will be calibrated with a 3D calibration cube and calibration software provided by SeaGIS. Surveys will be conducted along transects throughout the Northern Gulf of Mexico using the SeaGIS stereo-video camera. The video footage will be analyzed using EventMeasure software, allowing for animal lengths to be measured. Histograms of length data will be constructed for each field season, using the Kolmogorov-Smirnov we will test for differences in the length distribution of the two seasons. We anticipate that SVCS surveys will be an effective and efficient methodology to obtain high quality data on sea turtle distributions and lengths, while minimizing potential handling stress to turtles. Ultimately, this research will improve how sea turtles are monitored and has the potential to improve the quality and accuracy of population assessments. This

approach may also be adapted to other marine wildlife and may improve how those species are monitored and conservation status is assessed.

TOWARDS EFFECTIVE CONSERVATION: A SEQUENCE-BASED NOMENCLATURE FOR OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) MITOCHONDRIAL DNA HAPLOTYPES

Ian Silver-Gorges, Mark Jordan, Julianne Koval, Tanya Soule, and Frank Paladino

Purdue University Fort Wayne, Fort Wayne, IN, USA

Delineating genetically discrete populations, or Evolutionary Significant Units (ESUs), is a critical step towards the conservation of sea turtles. Research focusing on haplotypes of the D-loop of mitochondrial DNA (mtDNA) has been integral towards this end. Researchers use overlapping sequences which are reported at both ~400 and ~800 basepairs (bps), although ~800bps has been the standard used since 2006. ESUs are not well defined for Olive ridley sea turtles (Lepidochelys olivacea) due to inconsistent haplotype naming and reporting, and incomplete sampling globally. Here we present a systematic, sequence-based nomenclature for the 42 current publicly available ~800bp Olive ridley D-loop haplotypes. Our proposed new sequence names reflect phylogeographic divisions between ocean basins where Olive ridleys are found (Indo-Pacific, Eastern Pacific, and Atlantic) as well as sequence divergences within those regions. Sequences within this nomenclature may be easily related and compared to previously reported haplotypes (both at ~400 and ~800bps). This nomenclature is robust with regard to the addition of haplotypes, and we specify clearly how these haplotypes should be named. This nomenclature will ultimately simplify reconstructing and comparing mtDNA data sets between putative populations to better identify ESUs. Future studies should focus on 1) reporting ~800bps sequences from Indian and Sri Lankan Olive ridleys, which are thought to comprise basal populations for this species; and 2) reaching haplotype reporting saturation at arribada sites. It is our hope that this nomenclature will encourage increased sampling of Olive ridley tissues for genetic analyses, and ultimately lead to the designation of clear and effective ESUs for Olive ridleys globally.

GENETIC COORDINATE ANALYSIS IDENTIFIES CRYPTIC STRUCTURE IN A PANMICTIC POPULATION OF EASTERN PACIFIC OLIVE RIDLEYS (*LEPIDOCHELYS OLIVACEA*): IMPLICATIONS FOR BIOLOGY AND CONSERVATION

Ian Silver-Gorges, Julianne Koval, Mark Jordan, Tanya Soule, and Frank Paladino

Purdue University Fort Wayne, Fort Wayne, IN, USA

The delineation of genetically discrete populations, also termed Evolutionary Significant Units (ESUs), has provided the foundation for conservation management plans for all seven species of sea turtles since the 1990’s. Sea turtles display natal philopatry when breeding and ESUs often correspond with nesting regions and beaches. Highly polymorphic short tandem repeats found in nuclear DNA (microsatellites) are commonly used to identify ESUs. It has become easier and more cost-effective to genotype hundreds of individuals at numerous loci. Software exist to analyze these data for population structure, often using either

Bayesian clustering (BC) or coordinate analyses (CA) to identify high likelihood groupings of individuals based on genetic similarity. BC in particular has been commonly used to identify sea turtle populations based on microsatellite genotypes. CAs are less commonly used, but may pick up on cryptic population structure within broad, panmictic populations identified by BC. Here we analyzed data from nesting eastern Pacific (EP) Olive ridley sea turtles (*Lepidochelys olivacea*) from 3 sites in northwestern Costa Rica. While BC identified 1 population, CA identified 4 subpopulations. These subpopulations comprised individuals from across nesting sites. All subpopulations were genetically unique from each other (AMOVA: Fst=0.05172-0.16692, p=0.00), and mean within-subpopulation relatedness was significantly higher than mean global relatedness (r=0.029-0.06, p=0.001) and mean nesting site relatedness (ANOVA, df=3, F=11.287, p=0.00). Subpopulations forced by nesting beach were not unique from each other (AMOVA: Fst=0.001, p=0.42). There was no evidence of genetic bottlenecks at any sites or within clusters (BOTTLENECK, <0.05 for Wilcoxon and Sign tests of IAM, SMM, and TPM after 10,000 iterations). Full- and half-sibships confirmed by COLONY, ML Relatedness, and Cervus were largely contained within clusters and did not correspond to nesting beaches. CA proved more informative than BC in identifying different ESUs that may necessitate unique conservation plans that are independent of nesting beach or locations. It is possible that CA detected 4 lineages of EP Olive ridleys, or genetic structure or gene flow linked to mating behaviors or environmental features. CA should become a standard analysis practice implemented when studying population structure to better inform sea turtle management plans.

OPTIMIZING MONITORING: ANALYZING THREE DECADES OF SATURATION TAGGING TO MAKE DECISIONS ABOUT MARK-RECAPTURE EFFORT

Brian J. Smith[1], Thomas H. Selby[1], Clayton Pollock[2], Zandy Hillis-Starr[2], and Kristen M. Hart[3]

[1]*Cherokee Nation Technologies, contracted to USGS, Davie, FL, USA*
[2]*National Park Service, Buck Island Reef National Monument, Christiansted, St. Croix, Virgin Islands, USA*
[3]*U.S. Geological Survey, Wetland and Aquatic Research Center, Fort Lauderdale, FL, USA*

Programs using capture-mark-recapture methods to monitor nesting female sea turtles provide key information about the status of these imperiled species by estimating so-called state variables that describe population dynamics, especially survival and abundance. The accuracy and precision of the resulting estimates depend on sample size, so for the best parameter estimates, many monitoring programs have employed saturation tagging, attempting to tag every nesting turtle that crawls onto their beach for the entire nesting season. While larger datasets are always more desirable, programs are often faced with tough decisions about resource allocation and seek to optimally allocate their limited funds and time. In the event saturation tagging is not logistically feasible, monitoring programs will want to reduce their effort in a way that still leaves them with the most accurate and precise possible parameter estimates. Here, we examined a 30-year (1988 – 2017) saturation tagging dataset on nesting hawksbills from Buck Island Reef National Monument, St. Croix, US Virgin Islands (BIRNM). We used a multi-state open robust design (MSORD) model to analyze the capture histories of individual turtles, which makes use of both primary periods (years) and secondary periods (inter-nesting periods, approximated to be 14 days here) to estimate the parameters of interest in the face of imperfect detection. We used the MSORD to estimate survival (directly, via the model likelihood) and annual abundance (as a derived parameter, i.e., one calculated from the directly estimated parameters). We first fit the MSORD to the full dataset, and we recorded the resulting parameter estimates as the reference baseline. We then developed 198 scenarios of reduced effort, by varying the number and pattern of secondary periods as well as the number of nights on the beach during each secondary period. For each scenario, we refit the MSORD, calculated the difference between the resulting parameter estimates and their baselines, and summed the errors to assign a single error value to that scenario. Finally, we compared the total error to the total nights of effort in that scenario and evaluated the resulting patterns to make generalizations about how to optimally allocate monitoring effort. The baseline analysis consisted of 98 nights of effort, while our other scenarios ranged from 12 to 91 nights of effort, with varying configurations. From the full dataset, we found that survival was generally high (~90%) and that there was a marked increase in abundance between the years 2000 and 2003, with early years having 20 – 30 nesters per year and more recent years having between 60 and 80 nesters per year. We found that those monitoring scenarios that spread the effort out over the season were better than those that concentrated on consecutive inter-nesting periods. For example, we found that with a pattern of just three secondary periods spaced out over the nesting season (i.e., working every-other secondary period), our parameter estimates remained highly accurate with just 36 to 39 nights of effort – a 60% reduction in effort. Conversely, a pattern with as many as 84 nights of effort (only a 14% reduction) performed similarly to the 60% reduction if that effort was concentrated at the beginning of the season. For those situations where, consecutive secondary periods are most desired, we found that concentrating those periods in the middle of the season outperformed scenarios concentrating those periods in either the beginning or the end of the year. Our analysis provides a framework that managers can use to evaluate their monitoring effort under various time- and cost-saving scenarios.

JUVENILE HAWKSBILL LONG-TERM MARK-RECAPTURE ANALYSIS IN FERNANDO DE NORONHA, NORTHEASTERN BRAZIL

Gustavo Stahelin[1], Maria Angela Marcovaldi[2], Armando J. B. Santos[2], and Claudio Bellini[3]

[1]*University of Central Florida, Orlando, FL, USA*
[2]*Fundação Pró-TAMAR, Salvador, BA, Brazil*
[3]*Centro TAMAR-ICMBio, RN, Brazil*

Monitoring changes in abundance and demographic parameters over time are important for understanding population dynamics and assessing species' status. Capture-mark-recapture programs are used to assess a wide range of parameters (e.g., survival, residency, abundance, and recruitment) for many sea turtle populations. Nesting female data is the most common source of information on sea turtle population assessments; however, lack of long-term demographic parameters from other life stages may introduce biases in population and species assessments. For the hawksbill sea turtle (Eretmochelys imbricata), there is a large data gap for juveniles worldwide. To date, no data are available on juvenile hawksbill survival and abundance in the South Atlantic. We present the first estimates of apparent survival and abundance of juvenile hawksbills at the Fernando de Noronha archipelago in northeastern Brazil, an important foraging habitat for this species. Capture data for this analysis were collected between 1987 and 2016 in Fernando de Noronha by Projeto TAMAR during a long-term, standardized in-water capture program. Turtles were captured during free or SCUBA dives around the archipelago, and subsequently flipper tagged. A total of 512 individuals were captured during 2,446 different encounters. Individual curved carapace length ranged from 28.0 to 84.0 cm (mean 43.5, SD 12.0). Recapture interval ranged from 2 to 5,067 days (mean 1,449, SD 1,101). We used a Cormack-Jolly-Seber model with a two-age class structure (time-since-marking) to estimate survival, and area of the first capture and random effects estimate recapture rates. We estimated abundance using a Horwitz-Thompson type estimator, and used a nonparametric approach to estimate the confidence intervals. We evaluated the trend in abundance using a generalized least squares regression model with maximum likelihood estimation and log-transformed variance as weight to allow the slope of the regression to indicate the rate of change in abundance. Our results indicated an increase in abundance in juvenile hawksbill of more than 1% at each three-month period. This result is encouraging given the current decline in important nesting populations for this species around the world, and the decline in juvenile abundance in the northern Great Barrier Reef, in Australia. Results of this analysis fill an important data gap for this species in the region and provide key information to researchers and managers for future conservation plans.

RESEARCH AT THE GEORGIA SEA TURTLE CENTER: STUDYING SEA TURTLES TO ADVANCE THEIR CONSERVATION AND RECOVERY

David Steen, Breanna Ondich, and Terry Norton

Georgia Sea Turtle Center, Jekyll Island, GA, USA

The Jekyll Island Authority's Georgia Sea Turtle Center (GSTC) is a state-of-the-art facility on Jekyll Island, Georgia focused on sea turtle rehabilitation, research and education. The Research Department at the GSTC works to better understand the ecology and conservation of turtles on Jekyll Island and in the region while collaborating with other individuals and organizations to study a wide variety of wildlife. Our flagship research project is our long-term sea turtle monitoring program: nearly 60 Loggerhead Sea Turtles nest each year on Jekyll Island depositing an average of approximately 140 nests. During the nesting season (May-July) we conduct nightly patrols to identify individual turtles while also locating and protecting their nests. This monitoring program lends itself to several research projects. A few examples of collaborative projects with other institutions include assessing sea turtle behavior following false crawls and quantifying A) prevalence of major injuries and B) concentrations of endocrine-disrupting chemicals. We are also examining interactions between recreational anglers and incidentally-hooked Kemp's Ridley Sea Turtles in the region. Finally, we work closely with GSTC Rehabilitation Department staff to learn more about threats to sea turtles based on the hundreds of sea turtles admitted to the center for veterinary care. We look forward to meeting collaborators and developing new research partnerships that build off our ongoing monitoring and rehabilitation efforts to learn more about sea turtle biology.

LENGTHENING REMIGRATION INTERVALS OBSERVED FOR LEATHERBACK TURTLES NESTING AT SANDY POINT NATIONAL WILDLIFE REFUGE, ST. CROIX, US VIRGIN ISLANDS

Kelly R. Stewart[1] and Claudia D. Lombard[2]

[1]The Ocean Foundation, Washington, DC, USA
[2]US Fish and Wildlife Service, Frederiksted, VI

Sandy Point National Wildlife Refuge (SPNWR), St. Croix, VI, is an important US leatherback nesting beach that has conducted one of the longest studies on leatherback nesting biology. Since 1977, leatherbacks nesting here have been tagged, all nests monitored and nesting histories evaluated. Since 2009, which was the biggest nesting year on record at Sandy Point (202 individual turtles), nest numbers and the number of individual females has been steadily and dramatically declining. Since 2016 in particular, there has been a precipitous decline in the number of females (and subsequently, nests). Recently, we have observed that some of the remigrant turtles seen in the past three nesting seasons had not been seen for several nesting seasons (over 3 years), when they had been regular nesters before that (generally every 2 years). We hypothesized that remigrants may be delaying reproduction, and that this may be part of the cause for the decline in individuals and nests. To investigate whether there was a pattern to our observation of lengthening remigration intervals, we compiled all nesting records of remigrant leatherbacks seen from 2016 to 2018, and then looked back at their nesting histories since they were first tagged. We first calculated the average remigration interval for turtles for all years prior to 2016. We then noted the number of years since the turtle was last seen and compared that to the remigration interval observed previously. In 2016, 2017 and 2018, we had 22, 15 and 17 individual remigrant turtles respectively ($n = 54$). In 2016, remigrants had an average remigration interval of 3.3 years, compared to 3.0 years previously (difference = 0.3 years). For 2017, the remigration interval was 3.2 years, while it had been 2.8 years before that (difference = 0.4 years). In 2018, we found the largest difference in remigration intervals for remigrants. For these turtles ($n = 17$), the previous average remigration interval was 2.6 years, while in 2018, we found an average remigration interval of 4.5 years (difference = 1.8 years). For all turtles across years, we found that prior to 2016, the average remigration interval was 2.8 years, while after 2016, it was 3.6 years. Therefore, we found a statistically significant longer remigration interval for nesting leatherbacks since 2016 ($t = 2.52$, $df = 53$, $p = 0.0146$). If all nesters at Sandy Point are on a similar trajectory, we may see longer time frames between high and low nesting years in the future. Although our investigation here was to understand recent changes to the remigration pattern at SPNWR, it would be useful to investigate if similar trends exist on other leatherback beaches in the region and if they could potentially be the reason for similar declines in nesting throughout the Wider Caribbean. We will continue to monitor this population level parameter at Sandy Point into the future as well as studying this pattern from our extensive historical data.

SKELETOCHRONOLOGY AND ANNUAL GROWTH MARKS – VALIDATION FOR A TEMPERATE GREEN TURTLE POPULATION

Cali Turner Tomaszewicz[1], Tomo Eguchi[1], Erin LaCasella[1], Robin LeRoux[1], Larisa Avens[2], and Jeffrey A. Seminoff[1]

[1]*NOAA/NMFS Southwest Fisheries Science Center, La Jolla, California, USA*
[2]*NOAA/NMFS Southeast Fisheries Science Center, Beaufort, North Carolina, USA*

Understanding vital rates and improving the estimates of demographic parameters of sea turtles is a primary objective for successful management of turtle populations. Specifically, the need to estimate growth rates, age-at-settlement, age-at-maturity, and survivorship are essential for sea turtle population assessments and recovery plans. Yet progress in estimating these demographic parameters has been slow, largely due to sea turtles' longevity and researchers' inability to access turtles regularly as individuals move among remote and disparate ocean habitats during their lifetime. For decades now, skeletochronology has proven to be a valuable tool to estimate age and growth rates for all sea turtle species. For the hard-shelled, cheloniid species, histological preparations of the humerus reveals recurring patterns of light bands (growth zones) and darker lines (lines of arrested growth, LAGs), which are assumed to repeat annually. The identification, count, and measurement of these growth marks (GMs) directly facilitates estimation of demographic parameters such as annual growth and age-at-maturity. And precisely because of the implications of these parameter estimates, validating fundamental skeletochronology assumptions is critically important. Two primary approaches can provide this validation using bones from dead-stranded turtles: 1) the examination of humeri from known-age turtles, and 2) marking live turtles with oxytetracycline (OTC), releasing them, and later recovering the OTC-marked turtles as dead-stranded. Here we present preliminary results from the first, on-going study of a temperate green turtle population using both of these approaches. We assess concurrent validation using 1) OTC-marked wild turtles (juvenile and adult), and 2) known-age captive-raised turtles. As part of a long-term in-water monitoring program in southern California, USA, a total of four wild OTC-marked East Pacific green sea turtles have been recovered after stranding dead. Curved carapace length (CCL, cm) ranged from 56.6 to 110 at time of OTC injection, and from 80 to 110.5 at stranding. Time between OTC injection and stranding ranged from 0.75 to 2.4 years, and growth during that time ranged between 0.5 and 6.3 cm. By examining paired cross sections from these previously marked and recovered wild turtles, we were able to use skeletochronology and identify, count and measure lines of arrested growth (LAGs), and view unprocessed bone under UV light to identify and measure the mark formed by OTC at the time of injection. We also present data from 13 known-age captive sea turtles to add to the validation of skeletochronology assumptions and contribute to our understanding of annual bone and somatic growth for this population. The CCL of known-age turtles ranged from 53 to 76 cm, and 3.0 to 9.0 yrs old at stranding. These results provide the first preliminary validation, for temperate green sea turtles, of 1) the annual formation of LAGs, 2) back-calculation of body size (CCL), 3) annual growth, and 4) timing of growth mark deposition.

FIRST COMPLETE STUDY OF THE ENTIRE NESTING HABITAT OF LOGGERHEAD TURTLES IN CAPE VERDE

Nádia Veiga[1], Adolfo Marco[2], and Samir Martins[1]

[1]*BIOS.CV - Conservation of the Environment and Sustainable Development, Sal Rei – Boa Vista Island, Cabo Verde*
[2]*Estación Biológica de Doñana, CSIC, Spain*

Cabo Verde archipelago supports one of the largest and most threatened populations of the loggerhead turtle in the Atlantic. The nesting activity occurs throughout the archipelago, although, it does not occur in a homogeneously with 90% of the nesting activity taking place in a group of islands. The information available on the number of nests and the anthropogenic and natural threats are scares and are mostly from the main islands with the highest nesting activity. Even though there is a national network for sea turtle conservation there are no approved protocols for the data collection at a national level. The islands with lower nesting activity lack vital information such as the rate of illegal captures of females and the annual number of nests. In addition, there are no regular methodology in place for the data collection. This study aims at developing a national catalog to gather the information and data of several nesting seasons. Also, the physical characterization and evaluation of the natural and anthropogenic risks of each beach were carried out. The catalog covers 77 variables that include the physical and biological characteristics, data on the number of nests, tracks, captured females, recaptured and females caught, the emergence success and nesting success, the anthropogenic and natural threats, areal panoramic photos, and nest density maps. The study also contributed to gain knowledge and to identify knowledge gaps. This study can be used as starting point for the development of an online platform of open access to the general public and the organizations responsible for marine turtle conservation enabling sharing, making corrections, adding information and filling in the knowledge gaps. The online platform could also become a useful tool for the development and the promotion of the citizen science.

ASSESSING AND COMPARING NEST TO SURF MORTALITY OF FLORIDA'S EAST AND WEST COAST LOGGERHEAD SEA TURTLE HATCHLINGS

Brianna Vindiola

Florida Atlantic University, Boca Raton, FL, USA

During the crawl from the nest to the surf, sea turtle hatchlings experience a variety of environmental threats (i.e., predation, physical barriers, and photopollution), which can affect their ability to successfully locate the surf zone. This study focuses on identifying and quantifying the effects of natural and anthropogenic threats that loggerhead (*Caretta caretta*) hatchlings face on Florida beaches on both the Atlantic and Gulf of Mexico coasts. During the 2017 and 2018 nesting seasons, we quantified survival success of 1,388 loggerhead (*Caretta caretta*) hatchlings on nesting beaches with different environmental characteristics (natural nesting beaches compared to urban nesting beaches, east coast versus west coast). We sampled 48 nests on the east coast, and 76 nests on the west coast. We observed 15 emergences on the east coast and 12 emergences on the west coast. We documented 441 hatchling fates from east coast emergences, and 947 hatchling fates from west coast emergences. On the east coast, there were 22 hatchlings that were documented as having faced mortality and on the west coast there were 73 hatchlings documented as having faced mortality. The goal was to understand hatchling survival success in the context of site-specific environmental threats. Hatchling mortality due to natural threats came from ghost crabs, foxes, coyotes, raccoons, night herons, and fire ants. Anthropogenic threats resulting in hatchling mortality included sky glow, concentrated sources of artificial light, and barriers such as uncovered holes in the sand. The abundance and types of threats associated with study site nests were location-specific and differed between natural and urban beaches. We identified that ghost crab (*Ocypoda quadrata*) and night heron (*Nyctanassa violacea*) predation can be cryptic. Through a better understanding of the threats that hatchlings face and their impact on hatchling mortality, population demographic trends can be refined. Current methods used to estimate cohort recruitment rely heavily on nest inventories to assess how many hatchlings exit the nest. Nest inventory data are then used to calculate hatchling production. This method, however, does not account for post-emergent hatchling mortality that occurs between the time hatchlings leave the nest and the time they enter the surf zone. Understanding how environmental factors affect hatchling survivorship will lead to more effective conservation management practices to ensure the survival of sea turtles.

DIAMONDBACK TERRAPIN DISTRIBUTION AND HABITAT UTILIZATION IN SOUTHEASTERN NORTH CAROLINA

Morgan Whitmer[1], Hope Sutton[2], and Sarah Finn[3]

[1]*Department of Biology and Marine Biology*
[2]*North Carolina Coastal Reserve & National Estuarine Research Reserve*
[3]*North Carolina Wildlife Resources Commission*

Diamondback terrapins (*Malaclemys terrapin*) inhabit salt marshes, sounds, and estuaries on the east coast of the United States, and exhibit habitat overlap with several species of sea turtle. Both terrapins and sea turtles are threatened by anthropogenic factors, such as fisheries interactions, in inshore habitats. For terrapins, habitat loss and incidental bycatch in crab pots have contributed to population declines throughout their range. Conservation status and protections for terrapins are designated on a state-by-state basis, as they are not federally listed as threatened or endangered. In the state of North Carolina, the diamondback terrapin is listed as a Species of Special Concern, yet little has been done to identify and monitor the existing populations or the effects of fisheries interactions and other threats on those populations. The primary goals of this study are to 1) identify areas of relatively high terrapin abundance in southeastern North Carolina, and 2) evaluate environmental variables associated with areas of high terrapin abundance. The North Carolina Coastal Reserve and the North Carolina Wildlife Resources Commission implemented a citizen science initiative beginning in 2014 to address the lack of data on terrapin distribution in southeast North Carolina. The annual Terrapin Tally engages volunteers to assist in the collection of population data through kayak-based visual surveys. Participants use a smart phone app to document terrapin sightings, as well as locations of crab pots, along designated paddling routes. We will use Terrapin Tally data to identify areas of relatively high terrapin abundance, and conduct habitat characterization studies within these areas. Specifically, we will conduct vegetation and benthic invertebrate surveys and document abiotic conditions (i.e. sediment type, tidal influence, salinity) in order to characterize the habitats in which terrapins are found. We will use species distribution models to describe the patterns in terrapin abundance that we observe and make predictions regarding the distribution of terrapins based on habitat characteristics. Our study will contribute to terrapin conservation by 1) identifying areas for long-term population monitoring, and 2) generating data on terrapin distribution and habitat utilization that may be used for risk assessment and to inform development of appropriate management strategies to protect terrapins.

NATAL ORIGINS AND GENETIC VARIATIONS OF JUVENILE HAWKSBILL TURTLES FORAGING IN A MARINE PROTECTED AREA IN ROATAN, HONDURAS

Marsha Wright[1,2], Dustin Baumbach[1,2], Lidia Salinas[3], and Stephen G. Dunbar[1,2,3]

[1]*Marine Research Group, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, CA, USA*
[2]*Protective Turtle Ecology Center for Training, Outreach, and Research, Inc. (ProTECTOR Inc.), Colton, CA, USA*
[3]*Protective Turtle Ecology Center for Training, Outreach, and Research, Inc. (ProTECTOR - Honduras.) Tegucigalpa, Honduras*

Mitochondrial DNA (mtDNA) haplotypes have been used to estimate sea turtle establish connections between nesting rookeries and foraging areas. Using haplotypes, the contributions of source rookeries to a single mixed stock population can be estimated through mixed stock analysis. Currently, an uncharacterized foraging population of juvenile hawksbills (Eretmochelys imbricata) resides off the coast of Roatán, Honduras in the Sandy Bay West End Marine Reserve (SBWEMR). We sought to analyze the current structure of this population and to determine the contributions of rookeries in the wider Atlantic. A total of 36 juvenile hawksbills were analyzed for this study. DNA was extracted using the standard extraction protocol for reptilian blood and a ~ 800 bps segment of the mitochondrial control region was amplified using LCM15382 and H950 forward and reverse primers. Sequencing reactions were performed by Eton Bioscience Inc. and a total of 15 mtDNA haplotypes were identified within the SBWEMR population. Ten haplotype sequences (EiA01, EiA02, EiA09, EiA11, EiA20, EiA41, EiA43, EiA47, EiA63, and EiA83) have previously been characterized. The remaining five haplotype sequences have yet to be identified and were labeled orphan haplotypes. Orphan haplotypes were found at a low frequency within the SBWEMR foraging population, each accounting for 3% of the sampled population. Haplotype (h) and nucleotide (π) diversities for the SBWEMR population were 0.8619 (SD+/- 0.0039) and 0.007656 (SD +/- 0.004179), respectively. Fixation index (Fst) comparison indicated variation in genetic composition between the SBWEMR and the baseline rookeries (Fst = 0.53505). We analyzed baseline rookery contributions to the SBWEMR using 'BAYES' program. MCMC analysis was conducted using 15 chains, one for each baseline stock. Baseline stocks included Antigua, Barbados (Leeward and Windward), Costa Rica, Dominican Republic (Jaragua national park and Saona Island), Guadeloupe, Mexico, Nicaragua, Puerto Rico, Tobago (Northeast and Southwest), and the USVI (Buck Island and Sandy Point). Mixed-stock composition was estimated from the mean of all fifteen chains using uniform priors. Bayesian mixed stock analysis estimated that the majority of juveniles foraging in the SBWEMR originated from the Windward side of Barbados and from Sandy Point and Bucks Island in the US Virgin Islands. Although these regions have the highest estimated contributions of the entire baseline stock, the overall contribution from the baseline stock to the SBWEMR juvenile foraging population is small. Several haplotypes found within the SBWEMR foraging population were removed from the analysis due to their absence from the baseline stock. These preliminary results suggest that several rookeries contributing to this foraging population have yet to be characterized or remain unpublished. In order to estimate accurate rookery contributions, additional rookeries should be added to the baseline. The results from this study can be used to infer international movement patterns of juvenile hawksbills in the western Caribbean and wider Atlantic. Additionally, this information can be used to confirm the SBWEMR as an indispensable location for recruitment of juvenile hawksbills. The protection of this marine reserve may be essential in the continued protection and propagation of hawksbill populations throughout the Caribbean.

BASELINE STUDY AND CONSERVATION OF SEA TURTLES IN THE NORTHERN COASTLINE OF CAMEROON

Lionel B. Yamb, Aristide k. Takoukam, Eddy A. Nnanga, and Rodrigue Ngafack

African Marine Mammal Conservation Organisation, Dizangue, Littoral, Cameroon

Cameroon has about 400 km of Atlantic shoreline divided into two principal sections including the Northern part of the coast and the Southern part. Several studies have been conducted in the Southern part of the coast. However, very little research effort on sea turtles has been done in the Northern coastline stretching for nearly 180 km long and characterized largely by black sandy and rocky beaches. The goal of this research project is to collect baseline scientific data in order to make a first evaluation of marine turtle's population status in the Northern coastline of Cameroon and raise awareness of local peoples. Between December 2016 and April 2018, 117 questionnaires were applied in 05 project sites including Limbe (18), Batoke (26), Bakinguili (26), Idénau (28) and Bamusso (19). A total of 99 daily patrols were carried out on the project sites along the Northern coastal line during two nesting periods (2016/2017 and 2017/2018) and five awareness campaigns were organized. As a result, very few sea turtles or signs of evidence were detected during beaches monitoring over the two nesting periods. We have recorded 12 sea turtles and signs of evidence along the beaches monitored during 02 years. However, 77 sea turtles sightings were recorded at sea along the beaches bordering the Northern coastal line by our marine turtles sighting network. Moreover, 60% of respondents to the questionnaire surveys answered that marine turtles are more frequently observed at sea all over the year especially during the dry season but rarely on the beaches. Respondents also reported a small illegal trade of marine turtles in the area.

POPULATION STRUCTURE AND BODY CONDITION INDEX (BCI) OF BLACK TURTLE (*CHELONIA MYDAS AGASSIZII*) FROM EL SARGENTO ESTUARY, MEXICO

Kevin Alan Zavala-Félix[1,2], César Paúl Ley-Quiñónez[2,3], Catherine E. Hart[4,5], Renato Leal-Moreno[2,3], Brenda Aracely Espinoza-Romo[5], Carlos Romero-Urías[5], Alejandra Sandoval-Lugo[2,3], Maria del Rosario Vejar-Rubio[5], Alonso Aguirre[6], and Valeria Leal-Sepulveda[1,2]

[1]*Universidad Autonoma de Occidente*
[2]*GTC*
[3]*IPN-CIIDIR SINALOA*
[4]*Red Tortuguera*
[5]*Grupo tortuguero de las Californias A.C.*
[6]*George Mason University*

Canal del Infiernillo, is a narrow marine channel located between the Tiburon island and the coast of the state of Sonora in Mexico. In the Seri language it is called Xepe Coosot, (narrow sea), or Xepe Heeque, (small sea). On its shore is located the Seri community (Comcáac), which has inhabited the region since pre-Hispanic times. This settlement is called Punta Chueca (Socaaix in the Seri language). The strait has many sand bars and breakwaters on both coasts, and its configuration is very changeable, where the "Sargento" estuary is located. In 2009, the Canal del Infiernillo and estuaries of the Comcaac territory were included as a RAMSAR site, protecting an area of 27 900 ha., the site is home to 81 endemic species of invertebrates from the Gulf of California and several threatened species, including sea turtles. In 2016, the IPN-CIIDIR Sinaloa collaborated in a monitoring of sea turtles and with the results obtained, the composition of sizes and structure of the population was reported for the first time. Through the use of gillnets and enclosure technique, 34 turtles were captured, all of them was *Chelonia mydas agassizii* (black turtle). The average size was 67.7±10.9 of SCL (Straight Carapace Length) and 52.4±7.1 SCW (Straight Carapace Width), in the same way the curved measurements were obtained with an average of 71.4±13.1 CCL (Curved Carapace Length) and 69.1±9.4 Curved Carapace Width (CCW). The average weight recorded was 42.4 kg±21.8. Due to the registered sizes of this species, in only 6 turtles it was possible to determine the sex based on the length of the tail (4 females and 2 males), the rest were considered as undefined. For this species an average BCI of 1.27±0.15 was calculated. With the data reported in this work, it is shown that the most important species in the site is black and that the structure of the population is composed mainly of juveniles (82.4%) and adults (17.6%), and were categorized as "Very Good" in terms of the body condition index according to the Wyneken classification (2007), so it may be related to a good health condition and availability of food in the area.

SOCIAL, ECONOMIC, AND CULTURAL STUDIES

MARINE TURTLES IN THE TRADITIONAL PHARMACOPOEIA: NEW EVIDENCE OF THE RELATIONSHIPS BETWEEN THESE SPECIES AND ANCIENT CULTURES*

Hector Barrios-Garrido[1,2,3,4], Jordano Palmar[2], Carolina Martinez[5], Natalie Wildermann[1,2,3,4], Jesus Mba Mba[5], Daniela Rojas-Cañizales[2,3], Angela Formia[5], Alejandro Fallabrino[5], Amy Diedrich[1], and Mark Hamann[1]

[1]*TropWATER – Centre for Tropical Water and Aquatic Ecosystem Research; College of Marine and Environmental Sciences, James Cook University, Townsville, Australia*
[2]*Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV), Maracaibo, Venezuela*
[3]*Centro de Modelado Científico (CMC), Laboratorio de Ecología General, La Universidad del Zulia (LUZ), Maracaibo, Venezuela*
[4]*Marine Turtle Research, Ecology and Conservation Group, Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL, USA*

Marine turtles play a key role in the beliefs, traditional, and cultural system of multiple aboriginal people worldwide. Some authors have evaluated the connections between utilitarian values of marine turtles; however, the medicinal use is still lacking details. Herein, we preliminarily assess the medicinal value of marine turtles in two indigenous groups, the Wayuú (Colombia and Venezuela) and the Bengas (Gabon and Equatorial Guinea). We carried out a comprehensive open-ended question-based survey of traditional healers, caretakers, and elders (key-informants) from four Wayuú communities in the Venezuelan portion of the Guajira Peninsula, and from three Benga communities in Equatorial Guinea. We documented customary practices where marine turtle's body parts are used as key element of the traditional remedies. Up to eleven different parts of marine turtle body are used in Wayuú traditional pharmacopoeia, and seven parts were identified as ancestral medicine according to the Benga traditions. Green, hawksbill, and leatherback turtles were mentioned as key species by our respondents in both cultures. In the Wayuú and Benga cultures, reaching a healthy adulthood is determined by family beliefs and the use of marine turtles, mainly green turtles. We identified that Wayuú and Benga people have strong cultural traditions of believing that there are important health benefits received through the use of the marine turtle products. As suggested by the respondents, the marine turtle have been used throughout generations by both Indigenous communities, and it still remains an important link to their past, and therefore maintenance of use is significant part of the future culture. All respondents highlighted the relevant and vital role of marine turtles in the pharmacopoeia and health values systems. Our results are important in the context of likely future evaluations of the current legal frameworks in Venezuela and Equatorial Guinea to consider inclusion of Traditional Indigenous Knowledge and use of marine turtles.

THE PERCEPTION OF TOURISTS ON SEA TURTLE CONSERVATION STRATEGIES IN BOA VISTA, CAPE VERDE

Stephanie Butera[1], Maria Medina Suarez[1], Ana Liria Loza[2], and Judit Pinos Crosas[1]

[1]*Cabo Verde Natura 2000, Boa Vista Island, Cape Verde*
[2]*Universidad de Las Palmas de Gran Canaria, Las Palmas, Spain*

With the facilitation of travel between countries, the problem of environmental destruction and overconsumption of natural resources is being exacerbated. Tourism in developing countries is often a main

source of income, at the expense of the environmental integrity of these often more biologically significant regions. Tourism results in overconsumption of natural resources and biological degradation indirectly by increasing the demand for industrial production in country, however ecotourism may affect the ecology of the area more directly if not properly managed. Ecotourism refers to tourism that is based on the commodification of nature. People visit destinations that are rich in biodiversity, possess unique landforms, or for specific species or phenomena. There are a number of benefits that result from ecotourism, both for the economy of the country and its social welfare, and for the conservation of the ecological attraction. Ecotourism can be managed sustainably if some of the funds earned are used to conserve the resource, however in many cases tour operators, guides, and travel agents are self-interested. Legislation can help conserve the resources; however, it is often difficult and expensive to enforce in remote areas or when corruption is high. In Boa Vista, Cape Verde, one of the most significant forms of ecotourism revolves around the nesting of Loggerhead sea turtles (*Caretta caretta*). Tours are offered at all of the hotels including transportation to remote beaches within protected areas at night to watch turtles lay eggs. It is prohibited to use white light within these protected areas at night, and cars use red filters taped to the headlights to comply with the regulation. Protected areas authorities of the island rely heavily on NGOs working on the destination beaches to control tourism, ensuring that guides present authorization and that both guides and tourists follow the regulations. The purpose of this study is to evaluate the tourists' perception on conservation strategies for marine turtles in Boa Vista and the quality of turtle watching tours in their current state. In order to do this, a short questionnaire was prepared for tourists that visited Ervatão or Ponta Cosme beaches in the daytime or in the night after a turtle watching tour. Inquiries prompted tourists to express whether they learned about sea turtle biology during the tour and whether the guide taught them or if they encountered surveyors from one of the NGOs. Tourists were also asked whether they think that the government, NGOs or local communities manage sea turtle protection. Through the collection of this data, it is anticipated that protected areas authorities will use the information to consider programming standardized training of guides and tour operators for the coming nesting seasons. Educating tourists will help them to make informed decisions about the kinds of ecotourism they choose to engage in. If demand is channeled to sustainable forms of ecotourism, the standard will increase for the industry as a whole in order to meet demand.

LAWAI'A PONO: ENGAGING RECREATIONAL ANGLERS IN SEA TURTLE CONSERVATION AND EVALUATING IMPACTS

Thomas Cutt and Jennifer Aleysa Martin

Maui Ocean Center Marine Institute, Maui, HI, USA

Maui Ocean Center Marine Institute (MOCMI), a nonprofit organization, coordinates response to sick, injured, distressed, or expired sea turtles on the island of Maui, Hawai'i in partnership and coordination with NOAA Fisheries (as per regulations: 50 CFR Part 222.301). Since April of 2017, MOCMI has received 154 reports of stranded sea turtles; 62.34% were due to interactions with fishing gear, with 78.13% of reported fisheries interactions caused by fishing line entanglement (MOCMI unpubl. data). Recreational fishing gear, including entanglement in monofilament fishing line, is identified by the NOAA Pacific Islands Fisheries Science Center as the primary cause of strandings of sea turtles in Hawaii. The threat posed by recreational fishing gear has surpassed the tumor-bearing disease Fibropapillomatosis (FP) in Hawaii's green turtle (Chelonia mydas) population. Fishing is integral to the way of life in Hawai'i. In 2012, NOAA Fisheries Pacific Islands Regional Office spearheaded the Fishing Around Sea Turtles (FAST) program, a multi-agency effort designed to promote co-existence and educate fishers on practical fishing tips that may help to prevent interactions and reduce the severity of injury to accidentally caught sea turtles. The FAST program has raised awareness, resonates with fishermen, and has provided a strong starting point for a new initiative focused on preventing discarded fishing line from entering the ocean. To prevent pollution and decrease harmful interactions between sea turtles and fishing line, MOCMI launched the Fishing Line Recycling Program (FLRP) in June 2018. The FLRP provides an easily accessible method for fishers to take a hands-on, proactive approach to prevent pollution and reduce entanglement hazards by properly discarding their line. Fishing line recycling bins and educational signage are installed at 25 high-traffic fishing locations along Maui's shoreline, harbors, and boat ramps, and on four sites in Hilo, Hawai'i Island. The fishing line is routinely collected, sorted of hooks and weights, and shipped to the Berkley Conservation Institute where it is melted down and repurposed into fish habitat structures and other equipment. Since June 2018, a total of 7,171.96 meters of fishing line has been collected in MOCMI fishing line recycling bins. MOCMI staff and interns conduct qualitative surveys each week at select fishing sites to gather baseline knowledge of fishers' awareness of proper methods for discarding fishing line and their general willingness to participate in a conservation initiative. To date, 65% of the 60 fishers surveyed have reported accidentally catching a sea turtle while fishing; 98.3% reported that they are likely to use MOCMI's fishing line recycling bins if they see them; and 88.3% reported that they would be willing to participate in underwater cleanups to help remove lost gear. Of the 60 fishermen surveyed, 76.7% were residents of Maui, 20% from Oahu, and 3.3% from Molokai. With our more targeted outreach and increased contact with the recreational fishing community, we have been able to improve our understanding and engagement. As we continue to grow and evaluate the impacts of the FLRP, we hope that our findings will help determine best management practices in regard to fishing gear and retrieval/recycling methods.

ENHANCING WISE USE OF MARINE AND COASTAL HABITATS BY COASTAL COMMUNITIES THROUGH INCENTIVES AND EDUCATION IN VIDATALTIVU, MANNAR, SRI LANKA - AN UPDATE ON NEW TCP'S ONGOING PROJECT*

Thushan Kapurusinghe, Shyama Wijekulasuriya, Dayani Akshika, and Revati Ganasan

Turtle Conservation Project, Sri Lanka

Vidataltivu is a coastal village in Mannar district in the Northern Province of Sri Lanka consisting of a war affected and marginalized community. Vidataltivu contains extensive areas of seagrass meadows, mangroves and a coral reef called the 'Maldiva Bank' (coral island). Existing mangrove forest, lagoon and the coral reefs provide habitats for marine turtles, dugongs, dolphins and many other marine species. This unique area of the Indian Ocean provides invaluable resources for the coastal community members in the Vidataltivu village to depend on. However, due to unsustainable resource utilization patterns, most of these resources have now been over exploited. Dynamiting in the coral island is a common practice to catch the fish endangering the reef habitat and fauna. Use of mangroves as fuel for cooking, cutting of forest trees to make wooden poles which are used in anchoring stake nets and the use of mangrove branches as kraals in squid fishery threatens the existing mangroves. Heavy use of gill net fishery and bottom trawling have increased the sea turtle and dugong by-catch in the area and also destroy the sea grass meadows. Overfishing has resulted in reducing the fish catch and fish size considerably. These unsustainable fishing practices have led the community to suffer both economically and environmentally. In response to the issues described above in Vidataltivu village, the Turtle Conservation Project (TCP) has initiated an on-going community based alternative livelihood development project to alleviate the existing poverty and to conserve the environment. In addition, TCP has also initiated an awareness raising programme to educate the fishing community in conservation and management. The main objective of this project is to provide incentives to the local fishing communities with the hope of reducing marine turtle by catch, eradicate the slaughter of marine turtles, and address the dynamiting issue in the coral reef. This project is funded by UNDP GEF SGP in Sri Lanka and the project was started in May 2018 and will be completed in September 2019. Proposed alternative livelihood development activities include training of fifteen fishermen as tourists guides to show tourists the coral reef island in Vidathaltivu. This ecotourism programme is implemented in collaboration with the Sri Lanka Tourism Development Authority (SLTDA) and the Department of Wildlife Conservation (DWC). The potential for a sustainable ecotourism project is very high in Vidathaltivu area due to the presence of coral island, sea turtles, dugongs, sea grass meadows, mangroves and many migratory birds along with the peaceful political environment. We have identified the beneficiaries for the tourists guide training programme and also prepared the training programme schedule which will be started in November 2018. Furthermore, TCP has implemented a community sewing training programme for ten women community members. So far, the trainer has completed 16 training sessions out of 24 sessions. After the training, materials will be provided for the beneficiaries in order to start their own business. To support more community members, TCP also initiated an ornamental fish breeding project with 10 beneficiaries. All training sessions have been completed at the moment and large fish tanks are currently being constructed for the beneficiaries. Fish fry, shading nets, fish feed etc. will be provided along with the fish tanks. In addition to the alternative livelihood development, TCP conducted six awareness programmes at the time of reporting. The target groups included fishermen, school children, youth, religious leaders, NGOs and law enforcement authorities etc. As an ongoing project, TCP seeks to develop more partnerships with other institutions both nationally and internationally in order to increase collaborations and expand the working scope in the war affected Vidathaltivu village.

IMPROVING LIVELIHOOD OF LOCAL COMMUNITY TO SUPPORT LEATHERBACK CONSERVATION IN ABUN DISTRICT, WEST PAPUA PROVINCE, INDONESIA

Rivyelta Korwa, Kartika Zohar, and Fitryanti Pakiding

Lembaga Penelitian dan Pengabdian pada Masyarakat, Universitas Papua, Manokwari

Abun district in West Papua, Indonesia hosts the largest nesting activity of leatherback turtles in the western Pacific. Over the past few decades, the number of nests has decreased significantly due to various factors, such as predators and extreme sand temperatures. Various efforts continue to be made at the nesting beach to improve leatherback hatchling production. These efforts need to be supported by local community so that members of the community do not take turtle eggs for consumption or cash needs. People in Abun have the lowest Human Development Index in Indonesia. Community members that struggle to fulfill their daily needs could not provide full support to the leatherback conservation program. Therefore, a community empowerment program to improve the economy of people in Abun was developed so that the community had the capacity to fulfill their needs but also began to be involved in efforts to protect leatherback turtles near them. One of the economic improvement activities developed is processing bananas and coconuts into products with added value and a long shelf life. Local community still lacked the skills to produce good quality banana chips and coconut oil products, and access to market the products outside the village is very limited. To overcome this problem, we placed two community workers who had been trained to transfer the processing technology and to also help with marketing these products to nearby cities. Twice a month, the processed products are sent to Manokwari, later to be marketed. The community earned income with a value of around IDR 50,000 up to IDR 100,000 per person per production session, depending on the length of work. Overall, local community responded positively to our program. We were able to market approximately 80% of the products, and many consumers responded positively to the products, which would help this program to continue in the long term. One of the challenges that the program faced is inconsistent transportation between the village and the market in Manokwari. With sufficient capacity, the community can develop banana chips and coconut oil businesses as a source of income to meet their daily needs. Thus, with a better economic situation, the community will have the ability to be involved in efforts to protect leatherback turtles in the future.

COROZALITO: SOCIO-ECONOMIC AND CONSERVATION IMPACTS OF A YOUNG GROWING ARRIBADA BEACH ON A SMALL COSTA RICAN COMMUNITY*

Carmen Mejías-Balsalobre[1], Daniela Rojas-Cañizales[1], Roger Fusté-Mach[1], Emily Grace Webster[1], Daniel Arauz-Naranjo[1], Isabel Naranjo[1], Héctor Barrios-Garrido[2,3,4,5,6], and Randall Arauz[7,8]

[1]*CREMA, Rescue Center for Endangered Marine Species, Costa Rica*
[2]*Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV)*
[3]*Laboratorio de Ecología General, La Universidad del Zulia (LUZ), Venezuela*
[4]*Centro de Modelado Científico (CMC), La Universidad del Zulia (LUZ), Venezuela*
[5]*TropWATER, Centre for Tropical Water and Aquatic Ecosystem Research, College of Marine and Environmental Sciences, James Cook University, Townsville, Australia*
[6]*Marine Turtle Research, Ecology and Conservation Group, Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL, USA*
[7]*Fins Attached Marine Research and Conservation, Colorado Springs, CO, USA*
[8]*Migramar, Olema, CA, USA*

Playa Corozalito is located on the Southern Nicoya Peninsula, Costa Rica, and it is primarily known as a solitary nesting beach for Pacific Olive Ridley turtles (*Lepidochelys olivacea*). In addition to solitary activity, small sporadic, and growing arribada nesting events have been recorded in recent years. For this reason, in 2008, PRETOMA (Programa de Restauración de Tortugas Marinas) started a sea turtle conservation program to monitor the nesting activity on this beach, which has been led by CREMA (Rescue Center for Endangered Marine Species) since 2015. The presence of an arribada beach, although small, presents many challenges from a conservation and research perspective. For the community it means addressing shifts in areas such as tourism, poaching and predation dynamics; therefore, represents a potential catalyst for changing attitudes towards sea turtle conservation. The aim of this ongoing study is to understand the impact that a young growing arribada beach has on the attitudes of the local community towards threats to sea turtles, conservation, and potential future tourism activities. Field research using in-depth semi-structured interviews with local key-informants is being carried out in Corozalito from September to November 2018 to explore the local mindsets on these topics. Preliminary results suggest that there is a general understanding among the community about the importance of sea turtle conservation. The community of Corozalito has diverse perceptions of the main threats that sea turtles face at the beach, with egg poaching being the main cause for concern. In fact, encouraged by CREMA but lead on their own, some members of the community have initiated a volunteer group to patrol the beach with the main objectives of deterring poaching and detecting arribadas. Nevertheless, the conditions and cleanliness of the beach, the increase of natural depredation and nest destruction associated with arribadas, were occasionally mentioned as arguments in favor of egg extraction. Although some locals are already benefitting from ecotourism, there is a generalized feeling that Corozalito is not as renowned as it should be, and that tourism should be promoted for economic revenue in the short-term future. While the majority of the respondents so far believed tourism should be controlled and regulated, there does not seem to be a clear consensus on how. However, there is a general unease about the possibility of the beach being privatized and access restricted. Due to its mysterious and impressive nature, arribadas may present many challenges and erroneous perceptions regarding sea turtle conservation. Although there is a need to further awareness, Corozalito has the potential to be an example for community-based conservation, with many community members conscious of the importance of the natural resource available to them. These individuals are taking steps to protect and manage this resource in a responsible way while simultaneously improving their economic well-being. Overall, the final results of this study will present insights into the impacts of arribadas on a rural community, and the shifts in local attitudes and perceptions associated with these challenges, which might be used as an example for communities facing similar challenges.

USING TRADITIONAL ECOLOGICAL KNOWLEDGE TO COMPLEMENT THE GAPS OF INFORMATION: THE SHIFTING BASELINE OF ARRIBADAS AS CASE STUDY

Carmen Mejías-Balsalobre[1], Daniela Rojas-Cañizales[1,2], Roger Fusté-Mach[1], Emily Grace Webster[1], Daniel Arauz-Naranjo[1], Isabel Naranjo[1], Héctor Barrios-Garrido[2,3,4,5,6], and Randall Arauz[7,8]

[1]*CREMA, Rescue Center for Endangered Marine Species, Costa Rica*
[2]*Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV)*
[3]*Laboratorio de Ecología General, La Universidad del Zulia (LUZ), Venezuela*
[4]*Centro de Modelado Científico (CMC), La Universidad del Zulia (LUZ), Venezuela*
[5]*TropWATER, Centre for Tropical Water and Aquatic Ecosystem Research, College of Marine and Environmental Sciences, James Cook University, Townsville, Australia*
[6]*Marine Turtle Research, Ecology and Conservation Group, Department of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL*
[7]*Fins Attached Marine Research and Conservation, Colorado Springs, CO, USA*
[8]*Migramar, Olema, CA, USA*

Synchronic mass-nesting events, or arribadas, occur at only a few beaches worldwide. These events usually occur in remote and inaccessible areas and due to their ephemeral nature, they can easily go undetected for years. This seems to be the case of Playa Corozalito, a beach located on the Southern Nicoya Peninsula with both solitary nesting and sporadic arribada activity of Olive Ridley turtle (*Lepidochelys olivacea*). In light of this phenomenon in 2008, PRETOMA (Programa de Restauración de Tortugas Marinas) initiated a sea turtle conservation program to monitor it and since 2015 this program has been run by CREMA (Rescue Center for Endangered Marine Species). We found that Corozalito´s sporadic arribadas have shifted in frequency and magnitude, exhibiting a fluctuant-growing trend. However, there is a lack of monitoring data for nesting activity prior to 2008. Understanding the historical baseline of an arribada beach has significant implications for evaluating its future trends. An alternative to approach this information gap is assessing and understanding traditional ecological knowledge and anecdotal memory of local community members. The aim of this ongoing study is to compile knowledge from the local community to develop a crucial understanding of the commencement and evolution of the arribada activity at Corozalito beach. From September to November 2018 using a cross-sectional and convenience sampling, semi-structured interviews are being conducted with local key informants to document their knowledge and perceptions on the history of Corozalito arribadas. Preliminary data suggest that although there is no specific date for the commencement of the arribadas in Corozalito, most locals estimate it at 20 years ago, based on incidental observations. The majority of the interviewees so far perceived that during the 1990's the previously low nesting activity increased, and that by the end of the decade they started sighting sporadic arribadas. There was no consensus on the causes of this phenomenon or a specific moment when the locals realized the presence of the arribada. At present, data is still being collected. It is challenging to set an accurate date for the appearance of this phenomenon due to its continuous progression, low number of observers, and the nature of anecdotal results, which might be imperfect or exaggerated. Nevertheless, with the future results we expect to have more aligned statements to shed some light on the establishment of this phenomenon. Arribada survey protocols have changed over the years in Corozalito and anecdotal information is less reliable than the more recently developed arribada protocol; however, it does give at least a baseline estimation of the establishment of the arribada, which will help to assess its progress in future evaluations. Overall, this study will enhance current knowledge about Olive Ridley mass nesting events along the

Eastern Pacific. Given the ease with which arribadas go undetected in their early stages, social studies and traditional ecological knowledge can be used as a key tool to complement the scientific monitoring in the understanding of this natural phenomenon.

BRINGING THE BEDFELLOWS HOME: REPORTING TO THE ISTS COMMUNITY ON CONSERVATION AND CONSUMPTION ACTIVITIES AND PERCEPTIONS IN OUR MIDST*

Cherise Anne Chrispen[1] and Zoë A. Meletis[2]

[1]*Northlands College, La Ronge, Saskatchewan, Canada*
[2]*University of Northern British Columbia, British Columbia, Canada*

This paper/presentation represents data return or knowledge mobilization from Chrispen's Master of Arts thesis (2018; supervised by Meletis) to Symposium-attending members of the international sea turtle conservation community. The thesis is centred on a discussion of conservation and consumption using a case study of self-identified North American sea turtle conservationists. Chrispen and Meletis promoted the thesis project at a previous Symposium (New Orleans) and recruited survey participants via International Sea Turtle Society-related networks. Ultimately, Chrispen conducted an online survey with voluntary participants who identified as sea turtle conservationists (n=24). She later examined respondent statements about their own consumption patterns and beliefs, as well as those of others. She considered survey responses and patterns of responses within contexts of community messaging (e.g., online; at Symposia), and related literatures (political ecology; consumption studies; social marketing). Four key themes emerged in the analysis of responses: 1) a primarily negative association with the term consumption, which influences and limits engagements with consumption; 2) mixed messaging about some encouraged consumption (e.g. sustainable seafood is promoted within this community, but is debated by respondents and researchers); 3) over-confidence in information provision as key to changing consumer behavior, despite evidence to the contrary; and 4) limited recognition of the international sea turtle conservation community's success and power with respect to promoting and benefitting from "consuming to conserve" activities. This paper ends the way the thesis does, with academic and applied recommendations for more comprehensive engagements with intersections between conservation and consumption. The authors also express gratitude and appreciation towards the ISTS for being a community of scholars, practitioners, and volunteers willing to critically examine its own beliefs and practices, in the spirit of knowledge generation and improved conservation. Lastly, they encourage the community to think about how they might leverage their successes and use their "conservation and consumption" powers for positive changes.

SOCIOCULTURAL BELIEFS, ECONOMIC INCENTIVES, AND LEGAL AWARENESS UNDERLIE CONSERVATION ACTION AND THE OUTCOME OF SEA TURTLE-FISHER INTERACTIONS AT SAGARESHWAR BEACH IN VENGURLA, MAHARASHTRA, INDIA

Andrea D. Phillott, Ananya Singh, Anjali Chandawarkar, Ankitha Kammaje, Arundhati Karumampoyil, Ishana Sundar, Kunjika Pathak, Muskan Agarwal, Neelanjana Varanasi, Nived Dharmaraj, Paloma Chandrachud, Rhea Dhar, Riddhi Jain, Shreyasi Rao, Siddharth Sapre, and Vandit Dharamshi

FLAME University, Pune, Maharashtra, India

While compiling local knowledge to inform understanding of sea turtle biology and threats in Vengurla, Maharashtra, we documented actions, stories, beliefs and perspectives that may underlie conservation action and the outcome of interactions between sea turtles and small-scale subsistence and commercial fishers in local waters. We used convenience sampling to interview fishers from Sagareshwar Beach, Vengurla. Nearly all respondents had observed turtles while fishing and many had accidentally captured turtles (which they reported as being released) while fishing. Fishers were also aware of a nearby turtle nesting beach, hatchery, and/or rescue center. Sea turtles and their eggs in India are legally protected under Schedule I of the Wildlife (Protection) Act, 1972. Knowledge about the legal protection of turtles was high among survey respondents, and most indicated that intentionally killing a turtle was punishable but that accidentally killing a turtle was not. However, we learned about and observed illegal activities such as the consumption of turtle meat and eggs, fishing during seasonal closures, and use of purse seines in restricted fishing areas; therefore, the strength of legal awareness as a driving force underlying conservation of turtles among this group of fishers is unknown.The majority of respondents described sociocultural (including religious) beliefs about sea turtles, predominantly related to turtles being an incarnation of the Hindu God, Lord Vishnu, and the bad luck resulting from turtles being harmed or killed. These beliefs are similar to those previously perceived to contribute to fisher efforts to release live turtles from their nets without injury, and the low consumption rates of turtle meat among Hindus and Muslims, but not Christians or ethnic groups. Economic incentives may, too, be a strong motivator for actions that conserve sea turtles. Rewards are offered by the Maharashtra Forest Department for anyone reporting sea turtle eggs or stranded or injured turtles. The financial compensation for turtle eggs has been widely publicised but that for injured turtles has not. Such payments were described by a low proportion of fishers as the reason for releasing turtles from their nets while still alive and are regarded by a local fisher and turtle conservationist, who is highly regarded among the local fishing community and also works with the Forest Department, as a major motivator to ensure positive outcomes for turtle bycatch. Fishers can also benefit financially by selling their irreparable gear to the local scrapyard rather than disposing of it at sea or on the beach. Based on our findings, economic incentives and sociocultural beliefs are more likely than legislation to contribute to positive outcomes of sea turtle-fisher interactions and the reduced threat of ghost gear in this location. We recommend that the local Forest Department office and NGO's consider utilising either or both of these motivators in their conservation efforts.

AN ECONOMICS PERSPECTIVE OF US MARINE TURTLE BYCATCH REDUCTION REGULATIONS: ARE THEY MEETING THE GOAL?

Natalia S. Teryda[1], Richard Norris[2], Stephen Stohs[3], and Jeffrey Seminoff[3]

[1]*School of Natural Resources and Environment, University of Florida, Gainesville, FL, USA*
[2]*Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, USA*
[3]*NOAA-Southwest Fisheries Science Center, La Jolla, CA, USA*

The United States' fisheries are among the better-managed fisheries in the world. Federally managed United States (US) fisheries employ stringent regulations under the Endangered Species Act to reduce bycatch of untargeted endangered species like sea turtles. While such regulations have proven successful at reducing bycatch, they create potential negative economic impacts due to the high cost of compliance, resulting in greater challenges to meet consumer demand. For example, swordfish (*Xiphias gladius*) is one of the most popular fish in the US marketplace, but domestic production does not meet demand; instead, it is fulfilled by importing upwards of 80% of the swordfish consumed within US borders. This supply-demand scenario results in a "market transfer effect", which generates an increase in market production elsewhere and a potential unintended increase in sea turtle bycatch if higher bycatch in foreign fisheries results from increased fishing effort for swordfish destined for US markets. Here, we examine import values, compare management regimes from the predominant importing countries, and evaluate sea turtle bycatch rates to assess the intended gains and unintended consequences of fisheries regulations implemented on US-based swordfish fisheries. US swordfish production and import data were obtained from National Oceanic and Atmospheric Administration's Commercial Fisheries Statistics and Annual Trade websites. Bycatch data were retrieved from Regional Fisheries Management Organization and government reports and published literature. We calculated the estimated turtle bycatch (ET) for the imported amount of swordfish for each country and the counterfactual estimated turtle bycatch (CETB) the US hypothetically would catch should it produce the equivalent amount of swordfish imported. Finally, a market transfer effect analysis was conducted by comparing the ET of each importing country to the CETB. In 2017, Brazil, Canada and Ecuador were identified as the main importing countries with imports ranging from 1,560 to 2,706 metric tons, which cumulatively amounted to 44.5% of the total swordfish imported to the US. The three countries differed in their bycatch reduction efforts and regulatory compliance compared to US-based fisheries: Canada had the most similar measures to the US, followed by Brazil, although Brazil's were not as stringent in regard to compliance. From the literature consulted, it was estimated that the swordfish imports accounted for 1,025 and 9,472 turtle interactions (ET) from Canada's and Brazil's fleets, respectively. In contrast, the CETB showed considerably lower numbers for the same hypothetical US swordfish production, with 802 and 314 interactions, respectively. The market transfer effect is a real phenomenon and results in increased sea turtle bycatch by foreign fleets due to stringent regulations within the US. As a result, the same species that are intended to be protected by US fisheries management legislation are actually impacted to a greater degree. There is no easy fix for this problem due to the complexity of international fish protein trade and supply-demand dynamics worldwide. However, to eliminate the problem we must focus on alternative means besides unilateral regulation of US fisheries. Promoting better bycatch reduction measures, and greater compliance and enforcement worldwide should be important goals for fisheries management.

USING SCIENCE TO INFORM CONSERVATION

THE CIRCLE HOOK IN BRAZIL: WHAT HAVE WE LEARNED ALONG 15 YEARS OF RESEARCH AND AWARENESS CAMPAIGN

Bruno de Barros Giffoni[1], Gilberto Sales[2,3], Fernando N. Fiedler[4], Milagros L. Mendilaharsu[1], and Maria Ângela Marcovaldi[1]

[1]Fundação Pró-TAMAR, Rua Rubens Guelli, 134 sala 307, 41815-135 Salvador, Ba, Brazil
[2]Centro TAMAR
[3]ICMBio [i]
[4]Centro Nacional de Pesquisa e Conservação da Biodiversidade Marinha do Sudeste e Sul (CEPSUL)

Until 1998 there was no information regarding sea turtle interaction with longline fisheries in South Western Atlantic Ocean (SWAO). Uruguayan researchers presented the first note in this topic during the XXVIII International Sea Turtle Symposium. At the same year, Brazilian researchers presented a short note about incidental capture of loggerhead turtles in longline fishery, during a national oceanography conference. In 2001, Projeto Tamar started the national program to assess and mitigate the incidental capture of turtles in fisheries. This resulted in a systematic collection of information. Through increasing regular monitoring of the longline fleet by the Brazilian Government and by a pool of institutions leaded by Projeto Tamar, including others partners (CEPSUL, Projeto Albatroz, Nema, UNIVALI and UFRPE), it became clear that pelagic longline posed a major threat for sea turtles in SWAO. Here we will report the strategies adopted by Projeto Tamar, throughout 15 years: beginning with the study of the effectiveness of circle hooks to reduce bycatch, to the publication of a federal regulation requiring the use of these hooks and mitigation toolkit. Between 2004 and 2008, Projeto Tamar, supported by NOAA, performed the circle hook's tests (18/0 10º offset) in Brazil, reaching encouraging results. This would not be possible without the voluntary participation of fishers and fishing companies. There is no consensus among scientists about the advantages of circle hooks, mainly due to the increase of shark capture. However, there is no ideal mitigation measure for longline fishery (i.e. that one which reduces the captures of threatened species, maintain or increase the captures of target species and reduce the captures of all species below the catchable size). Moreover, in Brazil, sharks are target species, which makes more complex the discussion about its implementation. Thus, understanding the need to disseminate the information and promote the discussion about circle hooks among different stakeholders (i.e. scientists, fishers, fishing entrepreneurs and ordinary people); a set of actions started. Thereby, recognizing the distinct interests of the stakeholders and the need to build a common sense between them, communication strategies were developed, such as: i) weekly informal talks with captain and longline crew anchored on the most important fishing harbor complex in Brazil (Itajaí / Navegantes), ii) donation of circle hooks, mitigation toolkits and fishermen training, iii) publication of scientific papers and presentations of results in conferences, iv) lectures and meetings in the fishing associations, v) production of two short videos about the impact of longline fisheries on sea turtles and the use of circle hooks, vi) interviews for tv programs and journals. At the same time, we brought the circle hook's discussion to the decision maker scale, to be part of the main governmental forums (i.e. Scientific Sub-Committee for Tunas and Permanent Committee for Tuna Fishing Management). We also participated on ICCAT's Sub-committee on Ecosystem meetings. As a consequence of this process, in November 2017, the Brazilian government published a specific normative (Act 74/2017) forbidding the J hooks and requiring the use of circle hooks, as well as mitigation tools (i.e. de-hookers, line cutters and dipnets) for all licensed longline vessels targeting swordfish and tuna. Although published in 2017, this legislation would only become valid a year later. We were in face of a new challenge. How to avoid a market shortage caused by near future strong demand for circle hooks and mitigation tools? Therefore, during this period, we contacted manufacturers and importers to inform about the new act and consequently new demand expected for circle hooks and mitigation tools. The set of strategies reported here succeeded due to an agreed common objective and an institutional mobilization through a solid network.

QUANTIFYING HISTORICAL AND FUTURE AVAILABLE SEA TURTLE HABITAT ON THE FLORIDA ATLANTIC COAST TO MAKE SCIENTIFICALLY DEFENSIBLE MANAGEMENT DECISION

Joseph W. Long[1] and Ann Marie Lauritsen[2]

[1]*University of North Carolina Wilmington*
[2]*U.S. Fish and Wildlife Service*

Following the 2015 U.S. Fish and Wildlife Service (USFWS) workshop on coastal armoring along sea turtle nesting beaches, coastal change researchers from the U.S. Geological Survey (USGS) and the species coordinator from the USFWS partnered to develop methods that could use available coastal change science to address pressing management concerns for sea turtle nesting habitat. The initial goal is to take historical data of shoreline and dune positions and tools developed to predict short and long-term shoreline evolution and adapt them to assessments that quantify changes in sea turtle nesting habitat. The shoreline represents the ephemeral boundary that separates terrestrial and marine environments and is a parameter used to quantify the amount of sub-aerial sand available for species habitat, including the nesting of sea turtles. Unlike sand dunes that define the landward boundary of the beach, shorelines evolve over time with scales ranging from days to decades. The movement is dictated by a combination of wave processes, short and long-term changes in water levels (e.g. storms and sea-level rise), increases or decreases in sediment supply, alongshore gradients in sediment transport and anthropogenic influences (e.g. beach nourishment, coastal armoring). Understanding the time scale over which beaches naturally erode and prograde is essential to making decisions that balance the competing needs for protection of nesting habitat and the protection of coastal infrastructure. Given that coastal armoring can permanently remove sea turtle nesting habitat, and accelerate erosion seaward and adjacent to structures during storms, it is essential to understand the time scales of coastal change to eliminate impulsive management decisions that have long-term consequences (e.g., construction of seawalls following a large storm event before beaches have a chance to naturally recover). Hence, an understanding of what drove past changes in habitat and having defensible, science-based predictions of longer-term (e.g. 10-year) shoreline positions and quantified uncertainty will help managers to 1) quantify the potential natural loss of sea turtle nesting habitat, 2) quantify the potential impact to sea turtle nesting habitat that would occur with increased coastal armoring; 3) prioritize long-term protection of sea turtle nesting habitats using scientific predictions. We focus the initial assessment on analyzing past shoreline and dune information for the Florida Atlantic coast and comparing/contrasting these trends to historical records of storms, nourishments, and coastal development. This section of coast is crucial to the long-term sustainability of the NW Atlantic loggerhead Distinct Population Segment (DPS). The southeast United States hosts the largest assemblage of nesting loggerheads in the world and Critical Habitat has been designated for most of these nesting beaches. In addition to the historical assessment, we also use a Kalman filter approach to predict the 10-yr shoreline and dune positions and beach width to guide pressing management actions.

HAWKSBILL TRAFFICKING: TEN YEARS OF RECORDS OF THE HANDICRAFT AND MEAT TRADES OF THE HAWKSBILL TURTLE (ERETMOCHELYS IMBRICATA) IN CARTAGENA DE INDIAS, COLOMBIA

Karla G. Barrientos Muñoz[1], Cristian Ramírez Gallego[1], Brad Nahill[2], Rogelio Perea[3], and Elver Espinel[4]

[1]Fundacion Tortugas del Mar
[2]See Turtles
[3]Establecimiento Público Ambiental
[4]Policia Nacional

The hawksbill turtle is one of four sea turtle species that nest in the Colombian Caribbean. This species has suffered prolonged anthropogenic pressure, primarily in the forms of tortoiseshell trade and consumption of their eggs and meat. We investigated the occurrence of hawksbill products for sale in Cartagena de Indias (Cartagena), Colombia. We found that the sale of hawksbill turtle items was carried out by street vendors only on the streets of the San Diego and La Matuna neighborhoods of the old walled city section. We estimated that 1,800 – 2,800 items per year were offered for sale during the five years of this study. The majority of items were articles of jewelry (96.2%). The prices of items varied greatly depending on the size, design, quality, season, and the origin of tourists. Two restaurants in the Getsemaní neighborhood were found offering sea turtle meat on their menu. Based on our results, we recommend a heightened awareness campaign aimed at informing tourists of the protected status of hawkbsills, including restrictions on internationally transporting hawksbill products. We also recommend that capacity building is needed for police and environmental authorities, so protective regulations can be enforced for the benefit of the conservation of hawksbills at local and regional levels along the Caribbean coast of Colombia.

PLANNING FOR OR PLANNING WITH SEA TURTLES: EVALUATING SOUTH AFRICA'S NEW MPA NETWORK

Ronel Nel

Nelson Mandela University

Despite increased protection many turtle populations are still declining, suggesting a lack of enforcement of regulations or conservation practices that address the wrong suite of threats. South Africa's sea turtle conservation seems to exemplify this; two nesting species have been protected with the same legislation and conservation effort since 1963. Nesting habitat, females and offspring are fully-protected in a world heritage site, and legislatively protected outside MPAs across the South African EEZ. However, the two populations have responded differently to this protection. Explicit conservation targets were set at inception aiming to 'recover' the population to 200 leatherbacks and 500 loggerhead females nesting per annum, at which time sustainable harvesting would be considered. In the 55 years of protection, loggerheads increased from 200 to ~ 1000 nesting females per annum, while leatherbacks increased from 20 to 70 females in the first decade but have remained stable since. The hypothesis that different species of sea turtles, presumably exposed to similar anthropogenic pressures, will respond equally to the same conservation practices was thus falsified. Possible explanations were either in differing production or disparate threats. Nest monitoring

indicated that leatherbacks (Dc) had a higher per capita reproductive output than loggerheads (Cc); Dc females laid 104±25 eggs and nested 6.7 times per season, whereas Cc females laid 114±25 eggs, nesting 3.7 times per season. A spatial comparison of current fisheries impacts (longline, gillnet, beach and purse seine, and trawl fisheries) with emerging hydrocarbon pressures, overlaid with migration corridors for the two species, suggested that (in absolute numbers) fishing-related mortality was higher for loggerheads than leatherbacks, although gillnetting was more important for loggerheads (with ca. 3000 for Cc vs 500 for Dc) and longlining for leatherbacks (ca. 5100 for Dc vs 4300 for Cc). Relative to population size, leatherbacks are thus more vulnerable. These pressures however seem unsustainable for both species based on a direct comparison between nesting female abundance, age to maturity (at 16 years for Dc vs 36 years for Cc) and suspected mortality. This mismatch between production and mortality suggest that other factors, are boosting/suppressing population growth of particularly leatherback turtles which complicates setting conservation priorities. Alternative approaches, like marine spatial planning tools, which maximize biodiversity and habitat heterogeneity, whilst minimizing cost (or risk) are increasingly used as an 'umbrella' protection tool. South Africa has just announced the establishment of 20 new marine protected areas (MPA), which with increase the achieved protection targets from 0.4% to 5% of the EEZ. The distribution of satellite-tracked loggerhead (n=20) and leatherbacks (n=14) scaled to population level migration corridors, along with nesting and internesting habitat use were included to generate the MPA network. However, as the planning was not done explicitly for turtles, only a small fraction of their total distribution falls within this MPA network. These MPAs are established under current best practice principles and with best available data, but with no clear framework for identifying conservation targets for migratory species like sea turtles, it is difficult to a priori evaluate the value of these steps for turtle conservation. Loggerhead and leatherbacks may benefit greatly from the new expanded MPA network, or fishing and other pressures may simply be displaced elsewhere, impacting on sea turtles on other parts of the migration route or outside the national border. Only time will tell, if planning with, or planning for, sea turtles is effective to protect or enhance these populations.

SCDNR MARINE TURTLE CONSERVATION PROGRAM: A LOOK BACK AND WHAT'S TO COME

Emma A. Schultz, Charlotte P. Hope, Jeffrey A. Schwenter, Kacie M. Ferguson, Tyler S. Dillon, and S. Michelle Pate

South Carolina Department of Natural Resources

South Carolina has made significant contributions to sea turtle research and conservation efforts since the late 1970's. The state was the first to require turtle excluder devices (TEDs) on shrimp trawlers and establish safe dredging windows in conjunction with the U.S. Army Corps of Engineers (USACE). State biologists also pioneered the use of sonic and radio telemetry as methods for in-water sea turtle tracking. The South Carolina Department of Natural Resources (SCDNR) was among the first to create state-wide nesting and stranding volunteer networks as a means of collecting data on these species. South Carolina also led the way in beach protection with the passing of the Beachfront Management Act in 1988. This act prevents the placement of hard structures along the coast, protects the beach and dune systems, and advocates for public accesses to beaches. More recently, research throughout the state is helping to guide current management efforts of sea turtle species present along its coast. For example, SCDNR is continuing a regional in-water trawl survey that began in 2000 to collect data on the distribution, abundance, and health parameters of sea turtles in nearshore waters of the southeast Atlantic. SCDNR has also collaborated with the University of

Georgia (UGA), participating in the Northern Recovery Unit loggerhead DNA project since 2010. This project has revealed a great deal about nest-site fidelity, inter-nesting intervals, and remigration intervals. Between 2015 and 2017, the SCDNR Marine Turtle Conservation Program (MTCP) cumulated all 6,401 state historical stranding records into an electronic database to better allow for analysis of decades of data and track mortality trends. Initial analyses reveal two key findings with conservation implications for sea turtles in South Carolina. First, juvenile Kemp's ridley and green sea turtles have increased in abundance and now constitute a significant percentage of stranded turtles in state waters. Second, watercraft interactions have increased significantly in the state and are now the leading probable cause of stranding. Looking to the future of sea turtle conservation efforts within South Carolina, research focuses will have to address several new challenges caused by increasing coastal populations and limited resources. New management hurdles include coastal zone development, changing climate, efforts to amend or eliminate the Beachfront Management Act, and additional strain on coastal resources. MTCP will need to continue to advocate for the Beachfront Management Act to prevent hard structure development along the coast and preserve sea turtle nesting habitat. MTCP will also begin a diet study investigating stomach content of stranded turtles to establish a baseline and to determine if and how dietary behaviors are adapting to changing parameters effecting traditional feeding habitats. As future challenges to the management of sea turtle species in South Carolina arise, MTCP biologists are hopeful that lessons learned through past successes will continue to guide future research supporting the protection of these species along the coast.
Acknowledgements: The authors thank two former coordinators—S.R. Murphy and D.B. Griffin—of the South Carolina Department of Natural Resources Marine Turtle Conservation Program for building and growing the Sea Turtle Stranding and Salvage Network (STSSN) in South Carolina. The long-term stranding and nesting dataset would not be possible without the dedication and hard work of our STSSN network and nesting volunteers.

RISING SEAS AND SINKING SANDS: BEACH NOURISHMENT ON FLORIDA'S SEA TURTLE NESTING BEACHES

Robbin N. Trindell[1], Ann Marie Lauritsen[2], Sara Burke[1], Erin Leone[1], Joseph Long[3], David Thompson[3], Ping Wang[4], Mathieu Vallee[4], and Meghan Koperski[1]

[1]*Florida Fish and Wildlife Conservation Commission*
[2]*U.S. Fish and Wildlife Service*
[3]*U.S. Geological Survey, U.S. Geological Survey*
[4]*University of South Florida*

Florida's 825 miles of sandy beaches provide critical nesting habitat for three species of threatened and endangered sea turtles. Approximately 227 miles, or 56%, of these nesting beaches are classified as critically eroded by the Florida Department of Environmental Protection. Under Florida law, beachfront property owners or communities can either install coastal armoring or place sand through dune or beach nourishment to protect upland development from storm damage on these narrow, eroded shorelines. Both options can alter the remaining beach. However, if properly designed and managed, sand placed during nourishment can increase the amount of nesting habitat remaining adjacent to upland development. Over the past thirty years, state and federal resource agency staff has utilized data from nourished beaches to assess sea turtle nesting and reproductive success and then to advise regulatory agencies on best practices to minimize impacts from future projects. For example, site-specific nesting data is used in our efforts to avoid construction on Florida's high-density nesting beaches during nesting season. Managers also used this information to develop specific post-construction requirements to improve nourished beaches suitability for nesting, including tilling of placed sand and scarp remediation. During the 1990s, agency staff further refined post-construction monitoring to ensure a statistically valid sampling scheme and standardized data collection for all nourished beaches statewide. Subsequent analyses of post-construction nesting revealed loggerhead and green turtles had significantly lower nesting success, or the ratio of nests to total emergences, at 34% and 21% respectively on 30 nourished beaches the first season after sand placement compared to typical nesting patterns on statewide beaches (average of 50% for loggerhead and green turtles). Loggerhead turtles were also found to nest closer to the water after nourishment when compared to nest location prior to nourishment or on non-nourished beaches. The low nesting success and shift in loggerhead nest location on the nourished berm was hypothesized to be related to the altered beach profile, as after nourishment the beach is by design much higher and flatter than the narrower, steeply sloped pre-project beach. Managers then worked with coastal engineers to include a more natural beach profile as part of the construction design by incorporating a more gradual seaward slope and a gentle rise across the berm to the back of the beach. Currently, federal and state biologists are working with agency and academic coastal engineers to precisely assess nesting response (nest or false crawl) the first nesting season after fill placement by sampling the elevation and profile at the nesting female's decision point the morning following the emergence. This monitoring is being conducted on high-density nesting beaches in Brevard, Indian River, St. Lucie, Martin, and Palm Beach Counties for up to three years following sand placement. Cross-profile transects are also being taken on other nourished beaches in northeast, southwest, and northwest beaches to further elucidate how changes in sand distribution during season may affect nesting habitat. The results of this study will be incorporated in project planning to reduce impacts to sea turtles from future nourishment events. Acknowledgements. We acknowledge the efforts of FWC Marine Turtle Permit Holders in collection of all nesting data. Ongoing data collection on nesting decision and beach elevations has been funded by National Fish and Wildlife Foundation Grant # 6001.15.049138, Sea World, and BP Oil.

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