NOAA Technical Memorandum NMFS-SEFSC-631

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

10 to 16 April 2011
San Diego, California, USA

Compiled by:
T. Todd Jones & Bryan P. Wallace

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

May 2012

NOAA Technical Memorandum NMFS-SEFSC-631

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

10 to 16 April 2011
San Diego, California, USA

Compiled by:

T. Todd Jones & Bryan P. Wallace

U.S. DEPARTMENT OF COMMERCE
John Bryson, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Dr. Jane Lubchenco, Under Secretary for Oceans and Atmosphere

NATIONAL MARINE FISHERIES SERVICE
Samuel Rauch III, Acting Assistant Administrator for Fisheries

May 2012

NOTICE

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

Jones, T. Todd and Wallace, Bryan P., compilers. 2012. Proceedings of the Thirty-first Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NOAA NMFS-SEFSC-631: 306p.

Technical Editor:
Lisa Belskis

Copies of this report can be obtained from:

NOAA Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, FL 33149

Request a hard copy, email: seaturtledocuments@noaa.gov
PDF version available at http://www.sefsc.noaa.gov/species/turtles/publications.htm

or

National Technical Information Service
5301 Shawnee Rd
Alexandria, VA 22312
(703) 605-6050, (888)584-8332
http://www.ntis.gov/

PRESIDENT'S REPORT

The President's Report may be found in its entirety in the Marine Turtle Newsletter 130:30-33, 2011 entitled 'President's Report for the 31st Annual Symposium on Sea Turtle Biology and Conservation 'The Next Generation of Research and Conservation', 10-16 April 2011, San Diego, California, USA.'

by Jeffrey Seminoff, President, ISTS

http://www.seaturtle.org/mtn/archives/mtn130/mtn130p30.shtml

COMMITTEES, CHAIRS, AND KEY ORGANIZERS

San Diego Coordinator	Ingrid Yañez
Symposium Coordinator	Donna Broadbent
Internet Communications Coordinator	Michael Coyne
San Diego Symposium Registration	Michael Coyne, Scott Handy, Sarah Lucas, Tina Fahy
Fund Raising	Jeffrey Seminoff, Elena Finkbeiner
Program Chairs	T. Todd Jones, Bryan P. Wallace
Program Committee Coordinator	DuBose Griffin
Program Committee	Stewart Allen, Ana Barragán, Peter Dutton, Tomo Eguchi, Nancy Fitzsimmons, Allen Foley, Mariana Fuentes, Matthew Godfrey, Heidi Gjertsen, Mark Hamann, Craig Harms, Chris Harvey-Clark, Lucy Hawkes, Sandra Hochscheid, Asuka Ishizaki, Michael Jensen, T. Todd Jones, Rebecca Lewison, Kate Mansfield, Zoe Meletis, Jeffrey Moore, Ronel Nel, Barbara Schroeder, Jeffrey Seminoff, Kelly Stewart, Amanda Southwood Williard, Mark Swingle, Manjula Tiwari, Jesús Tomás, Bryan Wallace, John Wang, Blair Witherington
Poster Session Chairs	Robin LeRoux, Aliki Panagopoulou
Travel Committee Chair	Alexander Gaos
Travel Regional Chairs	Karen Eckert (English-speaking Caribbean), Angela Formia (Africa), Alejandro Fallabrino (South America), Emma Harrison (Mexico, Central America, and Spanish-speaking Caribbean), Aliki Panagopoulou (Europe), Nicolas Pilcher (Asia/Pacific), ALan Rees (Middle East), Kartik Shanker (South Asia), Bryan Wallace (USA and Canada)
Student Judges Committee	Lisa Campbell, Matthew Godfrey, Jeanette Wyneken
Student Judges	Karen Arthur, Larisa Avens, Ray Carthy, Paolo Casale, Emma Harrison, Craig Harms, Jennifer Keller, Mike James, Cynthia Lagueux, Kate Mansfield, Catherine McClellan, Zoe Meletis, Terry Norton, Dave Owens, Andrea Phillott, Nick Pilcher, Peter Pritchard, Kim Reich, Erin Seney, Kelly Stewart, Tony Tucker, Roldan Valverde, Thane Wibbels
ISTS Awards Committee	Karen Arthur (Chair), Nancy Fitzsimmons, David Godfrey, David Owens, Chloe Schauble
ISTS Resolutions Committee	Marydele Donnelly, Scott Eckert, Jack Frazier
Student Committee	Lisa Komoroske, Alexander Gaos
Proceedings Compilers	T. Todd Jones, Bryan P. Wallace
Printed Program	T. Todd Jones, Bryan P. Wallace, Jeffrey Seminoff, Ingrid Yañez
Live and Silent Auction Chairs	Jennifer Homcy, Marina Zucchini
Auctioneer	Rod Mast
Public Relations	Jean Beasley, Katie Wedermeyer
Volunteer Coordinator	Lauren Saez
Vendor Coordinator	Rachel Tuck
Activity Coordinators	Emma Harrison, Zoe Meletis
Education Coordinators	Barbara Andrews, Frances Kinney
The Thing Coordinator	Katherine Comer Santos
San Diego Visitors Guide	Cali Turner Tomaszewicz

Wild & Scenic Film Festival	Giuliana Schroeder, Barbara Andrews
Regional Meeting/Workshop Coordinator	Kama Dean
Africa Regional Meeting	Manjula Tiwari, Jacques Fretey, Angela Formia
East Asia Regional Meeting	Yoshimasa Matsuzawa
Eastern Pacific Hawksbill Initiative (ICAPO) Meeting	Alexander Gaos, Ingrid Yañez
Indian Ocean & Southeast Asia Regional Meeting	Maggie Muurmans, Rahayu Zulfiki, SMA Rashid, Lalith Ekanayake
IOSEA Marine Turtle Meeting	Douglas Hykle
IUCN Marine Turtle Specialist Group Annual Meeting	Roderic Mast, Nicolas Pilcher, Brian Hutchinson
Mediterranean Regional Meeting	Paolo Casale
Pacific Islands Region and Partners Meeting	Irene Kelly
Pacific Leatherback Turtle Conservation Fund Meeting	Asuka Ishizaki
RETOMALA XVIII (Latin America) Meeting	Alan Zavala, Juanpablo Muñoz, Carlos Mario Orrego
Science of Advocacy Meeting	J. Nichols, Todd Steiner
WIDECAST (Caribbean) Regional Meeting	Karen Eckert
Freshwater Turtle & Tortoise Symposium	Chuck Shaffer
NMFS Scientific Research and Enhancement Permits	Amy Hapeman
3rd Workshop on Data Analysis in Marine Turtle Research	Tomo Eguchi
3rd Workshop on Sea Turtle Stable Isotope Research	Karen Arthur, Kim Reich, Bryan Wallace
Marine Turtle Conservation Fund (MTCF) - Grant Writing Workshop	Earl Possardt
Marine Turtles, Hooks, and Related Lesions Workshop	Mariluz Parga
Public Participation in Turtle Conservation Workshop	Samantha Burgess
San Diego Schoolchildren Education Workshop	Frances Kinney, Barbara Andrews
San Diego Teacher Education Workshop	Frances Kinney, Barbara Andrews
Sea Turtle Medicine Workshop	Heather Harris
Student Professional Development Workshop	Lisa Komoroske

EXECUTIVE COMMITTEE

President	Jeffrey A. Seminoff
President-Elect	Ana Barragán
Past President	Kartik Shanker
Treasurer	Terry Meyer
Secretary	Manjula Tiwari

BOARD OF DIRECTORS AND THEIR END OF TERM

Ana Rebeca Barragan	2011
Naoki Kamezaki	2011
Jean Beasley	2012
Marydele Donnelly	2012
Didiher Chacon	2013
Scott Eckert	2013
Jack Frazier	2014
Mark Hamann	2014
Cynthia Lagueux	2015
Roldan Valverde	2015

SPONSORS AND CONTRIBUTORS

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

Lead Sponsors

NOAA Fisheries Service
U.S. Fish and Wildlife Service
Western Pacific Regional Management Council
The Ocean Foundation
Disney's Animal Programs
Sea World – San Diego
National Fish and Wildlife Foundation
San Diego Gas and Electric
Unified Port of San Diego

Sponsors

California Academy of Sciences
Chula Vista Nature Center
CLS America
Earthwatch Institute
Eastern Pacific Hawksbill Initiative (ICAPO)
International Community Foundation
Monterey Bay Aquarium
Ms. Hawksbill
Pro Peninsula Fund
ProTECTOR
San Diego Airport Authority
San Diego State University
South Asia Cooperative Environment Programme
SirTrack
Telonics, Inc.
Wildlife Computers

Coffee Break Sponsors

Leatherback Trust
Desert Star Systems
CLS America
Wildlife Computers

ISTS Room Sponsors

Syed Abdullah, Dave Allison, Kathryn Craven, Nancy FitzSimmons, Karen Frutchey, Thomas Gray, Janet Hochella, Cindy Lewis, Beth Marcus, Kellie Pendoley, Debbie Sobel, Jessica Thompson, Colette Wabnitz

Vendors

AG-GUA
AHI Enterprises
Bioko Biodiversity Protection Program (Drexel Unv.)
Boone's Georgia Jumper
Boyd Lyon Sea Turtle Fund
CARINAM
Center for Biological Diversity
CLS America, Inc.
Chelonian Research Foundation
Conservation International
Desert Star Systems
Earthwatch Institute
Eco
Everlasting Nature of Asia
Instituto de Fomento Pesquero
Inwater Research Group Inc.
Karumbe
Lotek
Manta Publications
Marinelife Alliance
Masirah
Mediterranean Association to Save the Sea Turtles
National Marine Fisheries Service
Oceana
Paso Pacifico
Pro Peninsula Fund
San Diego Turtle and Tortoise Society
Sea Turtle Restoration Project
SeaWorld – San Diego
SEE Turtles
SirTrack Ltd
Telonics, Inc.
The Leatherback Trust
NTV MSNBC
WIDECAST
Western Pacific Management Regional Council
Wildlife Computers
Zonk Galleries

STUDENT AWARDS

There were 181 student presentations – 58 papers and 123 posters with $5,500 US awarded to 12 recipients. The awards committee was composed of Lisa Campbell, Matthew Godfrey, and Jeanette Wyneken. Student judges: Karen Arthur, Larisa Avens, Ray Carthy, Paolo Casale, Emma Harrison, Craig Harms, Jennifer Keller, Mike James, Cynthia Lagueux, Kate Mansfield, Catherine McClellan, Zoe Meletis, Terry Norton, Dave Owens, Andrea Phillott, Nick Pilcher, Peter Pritchard, Kim Reich, Erin Seney, Kelly Stewart, Tony Tucker, Roldan Valverde, and Thane Wibbels. The awards were financed by the International Sea Turtle Society. (Note that as in previous years, the judges decided not to award prizes in certain categories, based on their ranking system)

Breeding Biology

Best Oral Presentation

Anthony Rafferty, Pilar Santidrián Tomillo, James Spotila, Frank Paladino, Richard Reina. Embryonic death is linked to maternal identity in the leatherback turtle (*Dermochelys coriacea*). (Monash Univeristy) $500

Runner Up Oral Presentation

Jeanne Garner, Tomo Eguchi, Duncan MacKenzie, Scott Jacques. Evaluating steroid hormone data in association with reproductive parameters in a population of endangered leatherback sea turtles and the application to conservation and management. (Texas A&M University) $250

Best Poster Presentation

Hannah B. Vander Zanden, Karen A. Bjorndal, Alan B. Bolten. Nutrient transport by green turtles. (University of Florida) $500

Conservation through Social, Economic, Cultural, & Legal Pathways

Best Oral Presentation

Courtney Shephard. Optimizing U.S. Endangered Species Act protection by integrating recovery planning, Section 7 Consultations, and incidental take authorizations: A sea turtle case study. (Duke University). $500

Foraging, Physiology, & Movements

Best Oral Presentation

Simona Ceriani, James D. Roth, Daniel Evans, Llewellyn M. Ehrhart. Satellite tracking confirms the use of stable isotopes to infer foraging grounds of loggerhead turtles (*Caretta caretta*) nesting on Florida's East coast. (University of Central Florida). $500

Runner Up Oral Presentation

Alexander R. Gaos, Rebecca L. Lewison, Ingrid L. Yañez, Wallace J. Nichols, Andres Baquero, Michael Liles, Mauricio Vasquez, Jose Urteaga, Bryan Wallace, Jeffrey A. Seminoff. Satellite telemetry reveals novel insights into the biology and conservation of hawksbill turtles (*Eretmochely imbricata*) in the eastern Tropical Pacific. (San Diego State Univeristy). $250

Foraging, Physiology, & Movements

Best Poster Presentation

Morgan Young, Michael Salmon, Richard Forward. Visual wavelength discrimination by the loggerhead turtle. (Florida Atlantic University). $500

Health & Rehabilitation

Best Poster Presentation

Virginie Plot, Jean-Patrice Robin, Thomas Jenkins, Sabrina Fossette, Jean-Yves Georges. Physiological state and condition in nesting leatherback turtles in French Guiana. (Université Strasbourg) $500

Population Assessment

Best Oral Presentation

Brian M. Shamblin, Mark G. Dodd, Kristina L. Williams, Michael G. Frick, Terry M. Norton, Stephanie Ouellette, Rebecca Bell, Douglas M. Hoffman, Debra Barnard-Keinath, Gale G. Bishop, Scott Coleman, Stacia Hendricks, Tammy Smith, Campbell J. Naim. Genetic mark-recapture of the female loggerhead population nesting in Georgiam 2008-2009: Abundance, nest site fidelity, and relatedness. (University of Georgia). $500

Best Poster Presentation

Vanessa Bezy, Roldan A. Valverde. Comparison of methodologies for estimating the nest density of olive ridley arribadas at Ostional, Costa Rica. (UNC – Wilmington). $500

Threats

Best Oral Presentation

Qamar Schuyler, Kathy A. Townsend, Justin Marshall. To eat or not to eat? The roles of choice and vision in ingestion of marine debris by sea turtles. (University of Queensland). $500

Best Poster Presentation

Leigh Ann Harden, Amanda S. Williard. Using spatially explicit predator-prey model to investigate bycatch risk of terrapins in crab pots. (UNC – Wilmington). $500

ISTS AWARDS 2011

Award certificates were designed by Dawn Witherington.

President's Award

Margie Stinson

Ed Drane Award for Volunteerism (new award)

Ed Drane

Life Time Achievement Award

Sally Murphy

Karen Bjorndal

Peter Pritchard

Champions Awards

Jepson Prince

Sinkey Boone

Colum Muccio

Grass Roots Awards (new award)

Ingrid Yañez

KEYNOTE PRESENTERS

Peter C. H. Pritchard
The Eastern Pacific: Where the Turtles are all Different

Karen A. Bjorndal
Planning Our Future: Expanding the Known, Learning the Unknown, and Minimizing the Unknowable

VIDEO PRESENTATIONS - WILD AND SCENIC FILM FESTIVAL

Your Unknown Killings
Jayesh Shirakhane

Port of San Diego, NOAA Project
Barbara Moreno

The Heartbreak Turtle Today
Sea Turtle Restoration Project, presented by Carole Allen

The Jurassic Journey
John Dutton

Between the Harvest
Scott Drucker

Saving Sea Turtles of Sri Lanka
Thushan Kapurusinghe

Kurma
Arun Krishna

Sanctuary in the Sea: a Gulf of the Farallones Experience
Bob Talbot

Sea Turtle Conservation with Grupo Tortuguero
Roger Roth, presented by Wallace J. Nichols

TABLE OF CONTENTS

Page #

Conservation Through Social, Economic, Cultural, and Legal Pathways

Page #

Foraging, Physiology, and Movements

Page #

Health and Rehabilitation

Population Assessment

Page #

Threats

Special Session: Finding Common Ground in Fisheries Management

Session Organizers: Stewart Allen (Moderator; National Marine Fisheries Service [NMFS] Pacific Islands Fisheries Science Center), Asuka Ishizaki (Western Pacific Regional Fishery Management Council), T. Todd Jones (NMFS Pacific Islands Fisheries Science Center), Jeff Seminoff (NMFS Southwest Fisheries Science Center), and Bryan Wallace (Conservation International).

For the first special session at the 31st Annual Symposium on Sea Turtle Biology and Conservation, eight panelists of various expertise and perspectives gathered together in search of pathways to common ground in fisheries bycatch management. Sea turtle bycatch in fisheries is one of the many threats to sea turtles, and the development of effective management frameworks to reduce fisheries bycatch has been a primary thrust of sea turtle conservationists worldwide. Still elusive, however, is the mechanism by which the primary stakeholders can reach a common, trusting dialogue in their mutual efforts to promote sustainable fisheries. In the United States, like elsewhere, these interested parties include State and Federal fisheries management agencies, the fishing industry, environmental groups, seafood consumers and the general public.

The panel featured **Marydele Donnelly** (Sea Turtle Conservancy), **Pete Dupuy (**California Commercial Fisherman), **Mark Helvey (**NMFS Southwest Regional Office), **Ray Hilborn** (University of Washington), **Steve Kennelly** (New South Wales Department of Primary Industries, Australia), **Sean Martin** (Hawaii Longline Association), **Dale Squires** (NMFS Southwest Fisheries Science Center), and **Todd Steiner** (Turtle Island Restoration Network).

With a wide group of panelists and an engaging moderator Stewart Allen, the special session attracted a large number of symposium participants. The panel highlighted the complexity of perceptions that surround sea turtle bycatch in fisheries, and shed light on how solutions may be derived. Throughout the discussion, it became clear that one of the roadblocks to common ground is the disagreement about the problem at hand, and the difficulty of defining the scale of the problem.

From one perspective, 90% reduction of sea turtle bycatch achieved in the Hawaii longline fishery may be seen as a success, whereas another may view that a problem persists until zero bycatch has been achieved. On one hand, the focus of the problem may be on the number of turtles caught, whereas another may view it from the broader perspective of sustainable fisheries, or within a system of costs and benefits associated with global food supply. Some may see technological fixes and economic solutions as the key to solving sea turtle bycatch issues, whereas another may see such solutions as inadequate if there is a lack of recognition by all players that overfishing—or even overpopulation— is the problem. But then again, recent scientific analyses using a comprehensive database on abundance and status of fish stocks suggest that overfishing may not be as big of an issue as previously estimated, and is an issue that is being addressed by ongoing fisheries management. These are just some of the views expressed by the panelists during the session, but also reflect the types of opposing views underlying conservation issues.

However, not all were about disagreements. A strong theme that resurfaced many times during the session was the need to make decisions grounded in good science. Panelists agreed that selective use of scientific information, or data collection and analysis conducted only to support one's own position and agenda was certainly not favored. Nevertheless, sound science and its collective acceptance by stakeholders were considered a necessary tool for reaching common ground. Panelists also recognized that no fisherman wants to catch turtles.

The following abstracts were submitted by the panelists in preparation of the special session. Panelists were asked to address one or more topics from a list of questions pertaining to their experience, perceptions of bycatch issues, and pathways to common ground. The abstracts were used to structure the introductory portion of the session, which set the context for the remainder of the panel discussions.

MARYDELE DONNELLY*

Sea Turtle Conservancy

Challenges in dealing with sea turtle bycatch issues in fisheries management.

As efforts to address the enormous challenges of sea turtle bycatch in fisheries management evolve, finding common ground to address these issues and improve our success is key. Here, I share some of the lessons I have learned about reducing sea turtle bycatch during the last 26 years. Keep in mind that this list is far from complete. These topics are intended to stimulate thought and discussion as we strive to understand the forces that drive bycatch and ways to address this problem.

The first major challenge is that sea turtles and other bycaught species are not the primary concern for fishery managers and fishermen.

- Fishery management is based on the economics of fisheries.
- Many fishermen do not understand the intrinsic value of bycaught animals nor their role within marine ecosystems, but they do not want to catch sea turtles and other non-target species because they reduce fishing efficiency, create extra work, and may result in fishery closures.

Collaboration among all stakeholders is essential to reducing bycatch.

- The participation of fishermen in reducing bycatch through gear modification or changes in fishing is absolutely critical. Fishermen today are generally far more willing to collaborate than in the past.
- Stakeholder workshops and meetings foster the exchange of information, seeing the world through the eyes of others, and developing better understanding.
- Bycatch reduction needs to be holistic so that protection for sea turtles does not come at the expense of other species. The fisherman who deal with multiple species interest groups are ahead of the sea turtle conservation community in this regard.
- When possible, allowing trust to develop between industry and conservationists facilitates solutions….this is most easily accomplished with artisanal fisheries.
- Lessons learned, and successes and failures must be shared.

Affecting bycatch reduction is based on carrots and sticks.

- Carrots are obviously preferable to sticks as they foster long-term success.
- Supporting economic advantages through bycatch reduction can be effective, i.e., sustainable eco-tourism or substitute work, but this is not yet widespread.
- There's growing, albeit insufficient, global interest in maintaining healthy marine ecosystems and developing less wasteful fisheries, but the high seas suffer from the tragedy of the commons.
- Market niches for species-safe products are a great idea -- sustainable seafood labeling is generally failing but sometimes fulfills its promise.
- Access to US markets is often predicated on bycatch reduction – is this stick sustainable?
- Legal instruments which help to conserve and protect imperiled species are valuable but often do not exist.
- Failure to address bycatch issues can result in more onerous international commitments, such as CITES listings.

Although the United States has made important advances in sea turtle bycatch reduction, it deserves a near-failing grade.

- The U.S. National Marine Fisheries Service manages fisheries and safeguards protected resources like sea turtles, which creates a conflict of interest. Despite obligations under the ESA, this dual responsibility regularly harms threatened and endangered species.
- Cumulative impacts on turtle populations are largely ignored.
- NMFS is a master of dragging out regulatory changes. Regulations take far too long to develop, i.e. finfish trawl requirements for TEDs have been under development since 2001.
- The impetus for most changes in U.S. fishing regulations and gear modifications to better protect sea turtles is the result of conservation community advocacy and legal action. Much of this work requires many years.
- U.S. observer programs are insufficient to identify problem fisheries in a timely manner.
- Political pressure inappropriately influences decisions which should be based on science.

Individuals Really Matter

- Within our community many individuals have been the driving force to affect change. I have been inspired by the commitment, hard work and vision of so many, not only in our conservation and research community but also among fishing and coastal communities.

PETE DUPUY*

California Commercial Fisherman

Q: What is your experience regarding sea turtle bycatch in fisheries?

It is hard for me to describe my experience with bycatch in my fishery because I do not have a problem. In over 40 years of fishing, I have never caught a leatherback sea turtle with a hook.

Q: When involved in or discussing sea turtle bycatch in fisheries, what is at stake for you?

For me, there is a lot at stake when discussing sea turtle bycatch. I have already lost two fishing permits, as well as millions of dollars, as the debate continues on the best way to sustain the sea turtle population. My income comes from commercial fishing, and some of the sea turtle regulations have affected where and how I can make my living.

In 2004, I spearheaded a conservation investment through the Federation of Independent Seafood Harvesters (FISH) to the Mexican conservation group ASUPMATOMA. I gathered payments to aid in their Pacific leatherback turtle recovery efforts in Baja California, Mexico. ASUPMATOMA, as well as five Mexican nongovernmental and governmental groups protected the nesting sites for leatherback turtles in Baja California.

Q: How would you describe your perspective of sea turtle bycatch in fisheries to your peers?

I do not have a problem with sea turtle bycatch in my fishery. However, I admit I don't know what exactly is going on in other countries that could be affecting the population. I, as well as many other fishermen, feel as if we are not responsible for the endangered status of these sea turtles. We also feel that a unilateral approach of closing the fisheries will not address the sea turtle population problem.

Q: What are some challenges in dealing with sea turtle bycatch issues in fisheries management?

Politics. In my experience politics have interfered with true science. There are examples where research used in one part of the world has been applied to the Pacific, without further follow-up or examples. I have seen countless times where facts have been twisted to reach an agenda.

It is hard to know exactly what is affecting the sea turtle population. Sea turtles are migratory and travel through the high seas. Their breeding habitat can lie in one nation's water, while their development could lie somewhere else. There is no central authority governing over the sea turtle population, which makes it hard to create the required level of conservation.

Q: What is an example of an effective approach in reducing fisheries bycatch?

Fishing gear is like a tool. In some places it is advantageous to use gill nets and in other places it is better to use long lines. In 1996, I switched from gill nets to long lines. I have found that using modified long line gear, developed by the National Marine Fishery Service, is beneficial for not only my business, but also reduces bad bycatch.

Q: What is an example of a successful approach in finding common ground in reducing fisheries bycatch?

An effective approach to conserving the sea turtle population would be to look at the history of the sea turtle. I believe more research needs to be done to find out what really happened to their population. I can remember in 1963 when I was driving on an old road in Baja California and saw about 200 sea turtles pushed out of a broken down truck to rot in the desert. That is when I knew the sea turtle was in trouble.

MARK HELVEY*

National Marine Fisheries Service, Southwest Regional Office

Pelagic and coastal marine fisheries, like all food production systems, come with associated ecological costs including unintentional interactions with threatened and endangered species. Conservation efforts to minimize and reduce this bycatch during fishing operations, especially sea turtle bycatch, have led to the successful implementation of technological fixes and operational reforms in many fishery sectors worldwide. While these efforts continue to be improved, sea turtle conservation remains threatened by fisheries that will require ongoing vigilance as well as the development of new global strategies.

Sea turtle conservation and marine ecosystem health in general will remain challenged by a growing world population. The FAO estimates that today's population of 6.8 billion people will reach 9.1 billion in 2050 and nearly all of the population growth will occur in developing countries. The additional population growth of 2.3 billion people as well as rising incomes is expected to require an increase in food production by 70 percent. Feeding a third more mouths than present translates into a long-lasting reliance on the oceans as a key source of animal protein.

In 2009, marine fisheries supplied the world with about 80 million tons of seafood for various sustenance, dining, and health purposes. While the global production from marine fisheries has stabilized over the past decade, pressure to exploit the oceans will remain. This demand also provides a valuable source of income and livelihood to millions of people. In 2008, almost 45 million people worldwide were directly engaged, full time or part time, in aquaculture and fisheries. Fisheries, and especially marine fisheries, provide the greater number of jobs, aided by a global fleet size of about 4.3 million vessels, 59 percent of these powered by engines. The combination of employment opportunities and fishing mobility suggests that marine fishing effort levels will stay constant. Similarly, illegal, unreported and unregulated fishing will continue to threaten the long-term sustainable management of world fisheries and the conservation of sea turtles and other threatened taxa.

Probably the greatest risk to marine ecosystems and sea turtles specifically, comes from the small-scale fisheries sector. These fisheries contribute more than half of the world's fish catch and nearly all of which is used for direct human consumption. Small-scale fisheries occur primarily in the coastal areas of developing countries where poverty and hunger are widespread leading to a continued dependence on marine wildlife as a source of food and income. There is a general lack of reliable and accessible information for this sector suggesting that targeted and non-targeted catches tend to be greatly underreported.

While current ecosystem-based fisheries management regimes to protect sea turtles and other migratory megafauna will adapt to shifts in fishing strategies and advances in bycatch reduction measures, the greatest challenge to sea turtle protection will be effective fisheries governance in the small-scale fisheries sector. A shift to rights-based fisheries may be a reasonable governance strategy but its utility will depend on how well this or other management schemes are embedded within the broader context of human development in the poverty-stricken communities of small-scale fisheries. Certainly, assisting these communities in addressing their non-fishery problems to solve their fishery-related ones will enable this sector to assist in fishery resource sustainability and sea turtle recovery. The question then begs whether addressing the social and cultural conditions of small-scale fisheries along with fishing rights as a global initiative is an appropriate starting point for finding common ground in sea turtle conservation?

RAY HILBORN*

University of Washington

By the mid 2000s there was a deep divide in those working in marine fisheries management and conservation about the status and future of fisheries. On the one hand scientists working within the fisheries management process, primarily in fisheries agencies, generally felt that the management systems were leading to sustainable fisheries. They did recognize that overexploitation had been common in the preceding decades and that there was considerable variability in the actual success at reducing fishing pressure where it had been excessive. The other perspective, held primarily by people not directly involved in the fisheries management process, was that fishing pressure was excessive almost everywhere and that few fisheries were sustainably managed.

This divide was highlighted by the press release for a paper by Worm et al. in 2006 in Science that argued that if current trends continued all commercial fish stocks would be collapsed by 2048. This led to a series of rebuttals and discussions, and in one of the follow-up events, Boris Worm and I appeared on a NPR radio show. After that joint appearance we began a discussion on why we had such different perspectives.

We formulated three hypotheses. The first hypothesis was that one's perspective depended on where we had worked. Boris had worked in Europe and Eastern Canada, places that had been subjected to considerable overfishing. I had worked on the west coast of the U.S. and Canada, and in New Zealand and Australia, where sustainable management was more common. The second hypothesis was that it depended on what we saw as the objective. Ecologists like Boris see the pristine ocean as the reference point, whereas those working within the fisheries management system see the biomass that produces maximum sustainable yield as the natural target for fisheries management. The third hypothesis was that one's perspective depended upon what part of marine ecosystems you were most familiar with. Academic marine ecologists primarily work in estuaries, bays and the very near shore, whereas those in the fisheries management system primarily use data from the continental shelves. Generally human impacts of all forms are more extreme in bays, estuaries and the near coastal ocean.

A major critique of the “all fish gone by 2048” paper was that it used the history of catch to infer trends in abundance and status of stocks. Boris and I agreed that we should see what actual abundance trends were and resolved to build a data base of abundance trends as measured either by scientific surveys, or by stock assessments that use not only catch, but surveys, age and size distributions and tagging. We obtained funding from the National Center for Ecological Analysis and Synthesis (NCEAS) to fund a meeting of 21 scientists representing a range of perspectives on the status of fisheries, including several of the authors of the original 2006 Science paper.

The group, with several graduate students and post-docs doing much of the data base work, assembled close to 200 stock assessments, representing most of the major commercial catch of the U.S., Europe, Canada, Australia and New Zealand, and about 30 research survey time series. Over the course of 4 meetings and 2 years we asked a range of questions of these data including (1) what is the trend in abundance of the stocks, (2) what is their status relative to unfished levels and levels that would produce maximum sustained yield, and (3) how hard are they now fished and what are their prospects for recovery under current fishing pressure.

What we found is that overall stocks were stable, not declining. About 2/3 of stocks were below levels that would produce maximum sustained yield, and about 1/3 would be classified as overfished by U.S. standards. We found the exploitation rates had been reduced considerably, and now about 2/3 of stocks were fished at rates low enough that rebuilding to MSY was expected, and only about 17% of stocks were fished so hard that fishing would lead to a long term biomass that would be classified as overfished.

STEVE KENNELLY*

New South Wales Department of Primary Industries, Australia

There have been many success stories during the past few decades in reducing bycatch of many different species, using a diversity of fishing methods in a variety of fisheries and locations. One might expect that the diversity of approaches, gear types, species and fisheries involved would make it difficult to identify any overarching summary of how one might go about solving bycatch problems in a given fishery. However, the converse is true –a simple framework describing how bycatch problems are resolved has proven to be quite consistent across many examples throughout the world.

This framework involves industry and researchers each applying their respective expertise to the particular problem. It is comprised of five key steps:
(1) Quantifying bycatch (mostly via observer programs) to identify the main bycatch species and their sizes;
(2) Developing alterations to existing fishing gears and practices that minimize the mortality of these species/sizes;
(3) Testing these alternatives in appropriately-designed field experiments;
(4) Gaining acceptance of the new technology throughout the particular fishery and, most importantly;
(5) Relaying the solution to the interested stakeholders who first raised the issue as a concern.

At all stages of this framework, but most importantly at its beginning and end, it is crucial that ALL interested parties (fishers, environmental groups, government officials and scientists) engage positively to identify, resolve and then communicate the bycatch problem and its solution. The following case studies provide examples of the application of this framework in a variety of situations.

Reducing charismatic bycatch

One of the first success stories in reducing bycatch began in the 1960’s in relation to the bycatch of dolphins in the eastern Pacific tuna fishery. This fishery involves vessels from several countries and has 100% observer coverage but its purse-seine operations caused the deaths of huge numbers of dolphins throughout the 1960’s and early 70’s. These mortalities were then reduced to be virtually negligible due to the development of better fishing practices (in particular, the “Backdown” maneuver) and fishing gear (the Medina panel) which allows dolphins to escape unharmed. These techniques are now used throughout the eastern Pacific tuna fishery, resulting in very few dolphins killed in its operation.

Other charismatic species have received a great deal of attention in terms of reducing their bycatch, including turtles throughout many of the fisheries in the world, especially the shrimp trawl fisheries in the Gulf of Mexico and elsewhere. There has been a great deal of work done on turtle excluder devices (TEDs) which are now mandatory in most of these fisheries.

Reducing the bycatch of non-targeted species

A major fisheries issue over the past few decades has concerned the bycatch of the juveniles of other, less charismatic, but nevertheless very important species. The prawn trawl fisheries of New South Wales, Australia, target school and king prawns. Amongst the catch of these prawns were large numbers of juvenile mulloway, snapper, bream and other species of commercial and recreational importance which were discarded dead or in poor condition. We found that the Nordmore grid and the composite square mesh panel worked well in these fisheries to reduce the bycatch of small fish whilst maintaining (and even increasing) catches of prawns as well as enhancing the quality of the prawns landed. These modifications have been adopted in many shrimp trawl fisheries throughout the world, saving millions of juvenile fish per year.

Reducing the bycatch of unwanted conspecifics

Almost every fishery in the world experiences the bycatch and discarding of conspecifics of the species that is being targeted - especially undersized juveniles. An example from South Australia concerns a trawl fishery whose market prefers prawns above a certain size. We developed a full square mesh codend that had highly selective properties and allowed only prawns above the critical size to be caught. Other examples include the various European grid systems developed to reduce the bycatch of undersized cod, haddock and saithe. These involve grids that are sloped backwards allowing small fish to escape whilst larger fish pass down along the grid and to the back of the codend.

The bycatch and discarding of conspecifics is also an issue in most of the world's hook-and-line recreational fisheries. Quite often when anglers catch undersized fish of their target species, the fish may swallow the hook which can kill them after release. Research estimating the mortality rates of such fish compared to mouth-hooked and control fish have indicated that, for some species, simply cutting the line of a swallowed hook can lead to better survival rates after release. Other recent developments in hooks include designs allowing the easy removal if swallowed, and the stop-swallow, a modification that stops the fish from swallowing the hook.

Perceived, not real, bycatch problems

There are other bycatch problems in fisheries that are problems of perception, rather than actual problems affecting fish. These often occur as a result of people believing that there is a large bycatch associated with a method simply due to reputation – not due to the actual operation of the gear in the field. An example from Australia concerns a fishery that uses a small Danish seining method to catch prawns in deep pools in rivers where they are known to aggregate. When the public see the setting of any net in a river, they often associate the method with other net fisheries that catch large quantities of bycatch and complain over its use. In reality, however, this particular seine fishery involves a very fast set-and-retrieval time (of approx. 5 minutes) with very little bycatch and negligible mortality of the few fish caught. A simple observer survey of this fishery quantified this result and an education campaign helped to alter the perceptions of local communities and so resolve the issue.

Conclusion

The above examples illustrate how a relatively simple (and inherently scientific) framework has proven to be effective in ameliorating many of the world's most problematic bycatch. I conclude that it is well worth considering such a process when new bycatch issues emerge, irrespective of the fishery, fishing gear or species involved.

SEAN MARTIN*

Hawaii Longline Association

Q: What is your experience regarding sea turtle bycatch in fisheries?

Direct experience in commercial fishing and science-based fishery management for 40 years, including:

- Albacore trolling from 1971 to 1981, 10 years fishing w/o sea turtle bycatch.
- Bigeye tuna longline captain from 1981 to 1985, 4 years w/o sea turtle bycatch.
- Owner/manager 6 tuna longline vessels from 1981 to present, 30 years w/o sea turtle bycatch.
- Owner/manager commercial and recreational fishing gear, bait, ice companies.
- Founder/Board Director and President of the Hawaii Longline Association that includes shallow-set and deep-set longline segments of the limited-entry fishery.
- Western Pacific Regional Fishery Management Council: Chairman 3 years, Member 8 years and 13 years as Advisor. During this period, the 2004 lawsuit, closure and reopening of the Hawaii swordfish fishery occurred. Active participation in the process of formulating management measures that have greatly reduced sea turtle bycatch in the shallow-set segment of the longline fishery.
- Western and Central Pacific Fishery Commission on the US delegation Commissioner for the past 3 years.

Q: When involved in or discussing sea turtle bycatch in fisheries, what is at stake for you?

Fishermen do not intend to catch turtles. Our livelihoods depend on responsible fishing, ecosystem-based management and the production of sustainable seafood. The reputation of the Hawaii longline fishery and its seafood products in the market is critical to our long-term commercial success or failure. What's at stake? Simply put, it's my livelihood. What is also at stake is the world's best model of a well-managed, responsible longline fishery that produces sustainable seafood.

Q: What are some challenges in dealing with sea turtle bycatch issues in fisheries management?

There are many. For domestic fishery management under NOAA and the Council process we operate under the Magnuson Stevens Fishery Conservation and Management Act. This means science-based, transparent and ecosystem-based management. Our greatest challenge is when management deviates from the science and applies the precautionary principle in an arbitrary and capricious manner. The precautionary approach should instead be driven by the science and the uncertainty or confidence limits we have in the science, not on political or emotional intent.

For international fisheries management, the greatest challenge is that while our fishery management system is science-based with commitment to monitoring and enforcement, the fleets of other countries in the Pacific fishery do not operate under the same management regime or concern over responsible fishing. International fishery management is more complex and currently less effective because of the range of national economic interests, commitment to responsible fisheries management and concerns over environmental impacts. One example is fishery observer coverage. If you want to know the magnitude of sea turtle bycatch, you must have impartial fishery observers on vessels. Hawaii is less than 3% of the total Pacific longline fishery effort, but produces over 80% of all observed effort for the entire Pacific fishery. While our observer program is the largest in the Pacific (100% for shallow-set fishery and minimum of 20% for the deep-set segment), the 2010 target level for all vessels in the WCPFC is merely 5% and is currently less than 1%.

Q: What is an example of an effective approach in reducing fisheries bycatch?

The management regime for the Hawaii longline fishery is the model for science-based responsible fishery management. It includes a set of measures that have proven effect in significantly reducing sea turtle bycatch in this fishery.

- 1991-First Limited Access Pelagic Fishery in US. Capped the number of boats.
- 1991-First US Fishery to require daily Logbook Reporting.
- 1994 First US Fishery to require Vessel Monitoring by satellite tracking 24/7.
- Monitoring Landings. Scientists have documented that logbooks are accurate.
- Mandatory Protected Species Workshops. Annual requirement for fishing permits.
- 2004- Mandatory Gear for Safe Turtle Handling. Nets, dehooking devices, etc.
- 2004-Mandatory Fishing Gear. Circle hooks (18-0 <10% offset) and mackerel-type bait in the shallow-set fishery. Proven effective in reducing sea turtle bycatch.
- 2004-Monitoring Fishing Impacts. Achieved most intensive program in Pacific longline fishery. 100% observer coverage on swordfish trips, 20% for tuna trips.
- Annual Hard Cap on Turtle Bycatch. 16 leatherbacks and 17 loggerheads. If either species cap is reached, the fishery is closed for the rest of the year.

DALE SQUIRES*

National Marine Fisheries Service, Southwest Fisheries Science Center

Sea turtle bycatch reduction can make an important contribution to the conservation of sea turtles. Nonetheless, sea turtle reduction by itself, and when conducted unilaterally by individual nations, is insufficient. Sea turtle bycatch reduction instead needs to be part of a multilateral and holistic approach to conservation that addresses all sources of mortality in a least-cost approach.

This holistic approach includes (1) effective beach conservation to protect nesting females, their eggs, and critical breeding habitat to maximize hatchling production; (2) enhancement of at-sea survival of juveniles and adults at critical foraging areas and as they move into different developmental habitats by dealing with large-scale, commercial fishing fleets; and (3) reduction of subsistence, small-scale and artisanal coastal fishers' takes of turtles, perhaps the most intractable component.

Most species of sea turtles are transboundary, so that their movements take them through a gauntlet of fisheries in the exclusive economic zones of multiple countries and on the high seas. Unilateral bycatch reduction by one nation that also reduces the target species catch, such as swordfish or shrimp, and where imports of these target species fill the consumption gaps, simply transfers the sea turtle mortality to another nation. Sea turtle mortality can worsen on net, consumer welfare declines due to less locally caught fresh swordfish or shrimp, local communities can suffer from fewer employment opportunities and less economic activity of fishing fleets and their suppliers and processors, and producer welfare similarly declines as profits fall for fleets, their suppliers, and processors. Moreover, harpoon-caught swordfish cannot substitute in consumption for swordfish from other gear types because of their substantially higher price. These shortcomings demonstrate the failure of unilateral conservation, and instead clearly point the way toward sea turtle bycatch reduction taken by all nations acting cooperatively. These shortcomings further highlight the ultimate failure of time-area closures that simply shut down fleets and create consumption gaps filled by imports, and instead clearly reinforce the need for bycatch reduction measures that do not reduce the target species catches, such as the use of circle rather than J-hooks for swordfish longlining, line cutters, and other sea turtle handling techniques.

As conservation resources are limited, programs generating the greatest turtle mortality reduction per dollar yield the largest conservation benefit, i.e. the greatest "conservation bang for the buck." A recent study by Gjertsen examined Pacific leatherback conservation costs in terms of a standard female leatherback and showed that nesting site conservation yielded the least-cost outcome. For the same cost, 10 times as many adult female leatherbacks are generated through the nesting beach project compared to the Hawaii regulations, and 100 times as many leatherbacks compared to the gillnet closure.

Economic incentives can also contribute to effective sea turtle bycatch reduction, and in general can complement social norms that enhance conservation. Economic incentives guide fishers, consumers, and others to address all costs and benefits from consumption and production, even if not presently captured by market values, so that private pursuit of gain aligns with the public interest.

Environmental taxes and fees are one approach that makes both producers and consumers bear the "external costs" of sea turtle mortality that markets otherwise ignore. These fees create incentives to reduce sea turtle mortality by raising its cost. When these fees are applied to sea turtle conservation, such as financing nesting site conservation or subsidizing improved gear for harvesters from developing countries, there is a "double dividend." Through the efforts of the International Seafood Sustainability Foundation, the North American tuna processors, Bumble Bee, StarKist, and Chicken of the Sea, along with European MW Brands, now self-levy such a "double dividend" fee on themselves for longline caught tunas and annually apply the proceeds to nesting site conservation around the globe.

In contrast to a tax on harvest or sea turtle bycatch, and without direct control of avoidance, a limit on the number of sets per vessel cannot induce economically efficient avoidance and activity levels. A command-and-control policy such as a limit on effort allowed also induces inefficiency because it does not account for the differences among vessels in costs and ability to avoid bycatch.

Incentives can also be created that encourage fishers to innovate and to test newly invented innovations. Subsidies can be offered for experimentation or the new gear can be subsidized or provided free with trade-in of the old gear. Such an approach was instrumental in addressing dolphin bycatch from tuna fishing. Some form of bycatch rights, such as Dolphin Mortality Limits but for sea turtles, are seemingly attractive, but can be more difficult to apply because turtles are rare events plus costly comprehensive observer programs are required for monitoring, control, and surveillance.

Instead of vessel-level policies, policies can be applied to the conduct or performance of the industry as a whole rather than the individual vessels within it. A bycatch limit could be imposed on the industry as a whole without specifying individual vessel limits, such as for the Hawaiian longline shallow set fishery. Industry-based policy approaches can have several advantages, particularly in the presence of uncertainty. Alternatively, an aggregate bycatch quota could be coupled with fines or reward to all vessels in the industry if industry-wide bycatch exceeds or falls below the aggregate limit. Vessels within the industry are treated as a single group, and policies impose limits, sanctions, or rewards on the basis of the performance of the group as a whole. Industry-based policies are also subject to disadvantages, such as the incentives for free-riding behavior and the "race to fish."

TODD STEINER*

Turtle Island Restoration Network

For fisheries, sea turtles are the "canary in the coal mine" that we ignore at our own peril.

Current and past efforts to reduce bycatch of sea turtle and other protected species has primarily focused on technological fixes such as turtle excluder devices in shrimp trawl fisheries, and circle hooks in longline fisheries. These single-species "solutions" seek to allow industrial fishing to continue at current levels of effort while attempting to reduce impact on protected species such as sea turtles and marine mammals.

This approach often shifts pressure off one protected species onto another, while ignoring negative impacts on habitat and other species, often including prey of the species we seek to protect and restore. For example, a specialized longline hook that prevents a turtle capture is an additional hook available to snag an endangered seabird or hammerhead shark, while TED-equipped trawls may still harm seagrass beds, important foraging habitat for green turtles, and reduces availability of prey for the crab-eating Kemp's ridley turtles.

I argue that in the long run, our energy and resources should be focused on ecosystem approaches to solve the problem of overfishing—which will bring relief to bycatch species and target species as well. I recognize that techno-fixes can relieve pressure on critically endangered species and can buy time for these species in the short run, but these are only half-measures. In many cases, this alone will not lead to recovery and removal of these species from their endangered status, the stated goal of the Endangered Species Act, the very law that drives current efforts to protect sea turtles from fisheries interactions.

Common ground can only be reached when all sides agree that there is:

(A) in fact, a true problem;
(B) that a science-based proposed solution is likely to succeed; and
(C) that the solution is equitable (and can benefit fishers and society).

In order to succeed, all of us must recognize and accept our individual and collective role in the problem. In my experience, the fishing industry often fails to accept, and the general public is generally unaware of the following well-established facts:

1. Overfishing by humans is one of the fundamental causes of the decline of marine species (Jackson ***et al.*** 2001; Pauly *et al*. 2002).
2. Global fish stocks are in major decline (Watson and Pauly, 2001; Jackson ***et al.*** 2001; Worm and Myers, 2003), and current levels of global fisheries are <u>not</u> sustainable.
3. There are "too many vessels chasing too few fish" (or more accurately, there is too much technology being used to chase too few fish). The lost economic benefit to fishers (and society) caused by overfishing (calculated for yr. 2004 by the World Bank) was estimated at ~$50 billion (95% confidence interval = US $26-$72 billion). For example, technological advances allow more than a billion longline hooks to be set annually and factory trawlers to fish in almost every marine habitat.

Fishers are not alone. We all fail to recognize our role in overfishing and turtle mortality. Consumers drive demand for seafood that leads to overfishing, and if the public is willing to accept the cost, the problems will persist. The public must make informed decisions about what and how much seafood they purchase.

Scientists must become more active in educating the public, and influencing public policy. Scientists hold a special well-respected role in society. If they believe their responsibility ends with scientific publications read by a few of their colleagues, and fail to advise the public of the significance of their research, meaningful policy changes will not be forthcoming.

Solutions to bycatch reduction must seek to secure healthy marine ecosystems. In addition to using all the best available bycatch reduction "devices," the solutions must include: (1) significant reduction of global fishing effort; (2) no-fishing marine preserves; (3) time-area closures; and (4) banning the use of the most destructive fishing technology; and (5) adequate enforcement.

Special Session: Oil Spills, Cold-Stunning, and Sea Turtles

448 TURTLES IN THE FREEZER: NECROPSY AND POPULATION ASSESSMENT OF GREEN SEA TURTLES STRANDED DEAD IN ST. JOSEPH BAY, FLORIDA, USA, DURING THE JANUARY 2010 MASS COLD-STUNNING*

Larisa Avens[1], Craig Harms[2], Eric Anderson[2], Lisa Goshe[1], April Goodman[1], Wendy Cluse[3], Matthew Godfrey[3], Joanne Braun-McNeill[1], and Brian Stacy[4]

[1] NOAA, National Marine Fisheries Service, SEFSC Beaufort Laboratory, Beaufort, NC 28516, USA
[2] North Carolina State University College of Veterinary Medicine, Center for Marine Sciences and Technology, Morehead City, NC 28557, USA
[3] North Carolina Wildlife Resources Commission, 512 North Salisbury St., Raleigh, NC 27604-1188, USA
[4] NOAA/National Marine Fisheries Service/Protected Resources, Marine Animal Disease Laboratory, University of Florida, College of Veterinary Medicine, Aquatic Animal Health Program, Gainesville, FL 32608, USA

Cold-stunning events, where sea turtles experience a sudden drop in water temperature, are unable to physiologically compensate, and become debilitated, are not uncommon along the U.S. Atlantic and Gulf coasts during autumn and winter. However, unusually harsh weather conditions during January of 2010 resulted in an unprecedented event in the state of Florida, where approximately 5,000 sea turtles (predominantly juvenile green turtles) cold-stunned and stranded. Although the majority of these turtles stranded alive, were rehabilitated, and released, approximately 20% did not survive, providing a unique opportunity for assessment of a relatively random cross-section of the affected population. As a result, National Marine Fisheries Service researchers in Beaufort, North Carolina, worked with collaborators from the North Carolina State University College of Veterinary Medicine and the North Carolina Wildlife Resources Commission, as well as numerous volunteers, to receive and conduct full necropsies on 448 sea turtle carcasses (with 97% of those being green turtles) originating from the St. Joseph Bay region of the Florida panhandle. Morphometrics were taken, sex was determined, organ systems were thoroughly evaluated to document any anomalies, as well as to establish baseline weights, and samples were collected for genetic, stable isotope, and skeletochronological analyses. For the 434 green turtles evaluated, size ranged from 18.1 to 78.5 cm straightline carapace length (SCL); however, mean SCL was 36.3 cm (SD±10.4) indicating the predominance of the smaller juvenile size classes. Sex was determined for all but 3 turtles whose internal organs were missing due to scavenger damage and the ratio of females to males was 2.45:1. The size distributions of female and male SCL were not significantly different ($p>0.50$ Mann-Whitney Test) and sex-specific differences in other morphometrics such as front and rear flipper length, plastron length, body depth, and weight were also not found ($p>0.50$ Student's t-Test). Incidence of fibropapilloma (FP) lesions was 6% and although the sex ratio for the turtles exhibiting FP did not differ from the non-FP turtles ($p=0.66$ Fisher Exact Test), FP turtles were significantly larger than the population as a whole ($p<<0.001$ Wilcoxon Rank Sums Test), with a mean size of 55.6 cm SCL (SD±7.6). Analysis of data and samples from this effort is ongoing to allow further characterization of the affected population, with specific attention to age structure and body condition relative to other US foraging populations.

ST. JOSEPH BAY: POCKET OF COLD TURTLES

Lisa Belskis[1], Wendy Teas[1], Rhonda Bailey[2], Nancy Evou[3], Amber Hoffman[4], Secret Holmes[5], Lydia Staggs[5], and Allen Foley[6]

[1] NOAA Fisheries Service-SEFSC, Miami, Florida, USA
[2] Florida Fish and Wildlife Conservation Commission, St. Petersburg, Florida, USA
[3] NOAA Fisheries Service-SEFSC, Panama City, Florida USA
[4] Florida Fish and Wildlife Conservation Commission, Tequesta, Florida, USA
[5] Gulfworld, Panama City Beach, Florida, USA
[6] Florida Fish and Wildlife Conservation Commission, Jacksonville, Florida, USA

In early January 2010 St Joseph Bay was the center of a mass cold stunning event in the Florida Panhandle. The Bay is surrounded by a hook of land with a single opening to the Gulf of Mexico located to the far northwest. This known foraging area for green sea turtles has seen previous cold-stunning events but none to this magnitude. Over 1,800 turtles stranded in the general area of St Joseph Bay and other nearby bays and sounds most of which within 10 days of extended cold weather. This presentation highlights the efforts of many working together to manage such a massive event. Here we present the species composition and size classes of affected cold-stunned turtles providing their fate after stranding. We will also look at whether there is a correlation between the number and size of strandings versus the duration of cold temperatures.

FLORIDA'S COLDEST WINTER IN 30 YEARS AND THE EFFECTS OF COLD STUNNING ON SEA TURTLES

Andrea Bowman, Lynne Byrd, Andy Stamper, Gretchen Lovewell, and Emma Jugovich

Mote Marine Laboratory, Sarasota, Florida, USA

Record low temperatures in Florida affected nearly 5000 sea turtles in the winter of 2010. Thousands of sea turtles died across the state while many others suffered short and long term effects due to the prolonged record cold temperatures. Mote Marine Laboratory's Sea Turtle Rehabilitation Hospital admitted 63 sea turtles exhibiting signs of cold stunning. Turtles admitted to the hospital came from both the east coast as well as Mote's primary response area on the west coast of Florida. We present three case studies that represent distinct categories of injury due to the cold stunning event. These cases include frostbite, peristalsis and an immune compromised fibropapilloma turtle with signs of human interaction and depredation. Rehabilitation progress and recovery was closely monitored, well documented and presented here.

OCCURRENCE OF A SEA TURTLE CONGREGATION NEAR LOUISIANA CHANDELEUR ISLANDS FOLLOWING THE DEEPWATER HORIZON OIL SPILL

Dena D. Dickerson[1] and Trish Bargo[2]

[1] US Army Corps of Engineers, Engineer Research and Development Center, 3909 Halls
[2] East Coast Observers, P.O. Box 6192, Norfolk, VA, 23508, USA

Immediately following the Deepwater Horizon Mississippi Canyon 252 (DHMC252) oil spill in the Gulf of Mexico on 20 April 2010, the State of Louisiana initiated efforts to dredge and construct a 128 mile long sand berm to protect the coastal Louisiana marshes from oil. The US Army Corps of Engineers issued a

provisional permit for 45 miles of berm construction along the offshore coastline to the east and west of the Mississippi River delta outflow. The eastern section of the barrier berm project required hopper dredging at Hewes Point sand borrow site at the east end of the Chandeleur Islands. Hopper dredging is known to potentially entrain sea turtles while suctioning dredged material. All known methods for protecting sea turtle during dredging operations were implemented as specified by the permit provisions. Included in these protection methods were the use of both capture and non-capture trawling techniques to relocate and disperse sea turtles from the path of the dredging operations. Two capture and two non-capture trawlers were used during the 15 days of dredging at Hewes Point. Both capture and non-capture types of trawling operations sweep nets in front of the dredge to disperse turtles from the path of the dredge. The capture trawling uses closed net bags (30 minute towing times) to capture sea turtles for relocation 3 to 5 miles away from the dredging project site. The non-capture trawling uses nets with the bag end open so as to not capture turtles and bycatch but to disturb and disperse turtles from the path of the working dredges. During 9-23 July 2010, a total of 194 sea turtles (185 loggerheads (50 – 107-cm, SCLn-t), 8 Kemp's ridley (50 – 64-cm, SCLn-t), and 1 green turtle (57-cm, SCLn-t)) was captured at Hewes Point borrow site (approx. 13 turtles/24 hours) by the two capture-style trawlers and relocated at least 3 miles away. Of the 185 loggerheads, 85 were < 72-cm (SCLn-t), 66 were 72-82cm (SCLn-t), 34 were > 82-cm (SCLn-t), and 8 were adult male (80.6 – 89.3 SCLn-t). Eleven (11) were recaptured after being relocated at least 3 miles. During this time, at least 4 satellite tracked turtles from other studies off south Texas and south Florida were documented using this same location near the Chandeleur Islands (seaturtle.org). This high concentration of sea turtles off the Chandeleur Islands has not been previously documented and may represent an unusual occurrence as a result of the DHMC252 oil spill or it may be a newly identified congregation of sea turtles. Further investigation is needed of the sea turtle occurrence and habitat utilization at the Hewes Point borrow site and throughout the Louisiana Chandeleur Islands. Documentation of this congregation of sea turtles should be considered for implementation of fishing regulations such as Turtle Excluder Devices on trawling vessels near the Chandeleur Islands.

TRACKING "DAWN" INTO THE HORIZON OIL SPILL

Daniel Evans[1], Cristina Ordoñez[2], and Emma Harrison[3]

[1] Sea Turtle Conservancy, Gainesville, Florida, USA
[2] Sea Turtle Conservancy, Bocas del Toro, Panama
[3] Sea Turtle Conservancy, San Jose, Costa Rica

From 2003-2010, the Sea Turtle Conservancy, formerly the Caribbean Conservation Corporation, has tracked 20 adult female leatherbacks from nesting beaches located along the Caribbean coast of Costa Rica (Tortuguero & Gandoca) and Panama (Chiriquí Beach). All PTTs, expect two MK-10A Ridgemount Units by Wildlife Computers, were attached dorsally to the female turtles during nesting using a custom-fitted harness made of nylon webbing and polyvinyl tubing, and designed to be released within approximately two years. The two MK-10As were attached directly to the dorsal ridge with wire cables and were designed to be released within approximately 1 year. Tracking duration ranged from 23 days to over 522 days, with an average of 216 days. Seventeen of the 20 tracks provided sufficient tracking data to establish a migratory route out of the Caribbean; of these 13 were extensive enough to suggest possible foraging areas. Of these, six were tracked to the Gulf of Mexico by traveling between the western tip of Cuba and the Yucatan Peninsula of Mexico. The remaining 11 leatherback turtles were tracked traveling from the Caribbean Sea into the northern Atlantic Ocean, through one of three passages: either between Cuba and Haiti (3), between the Dominican Republic and Puerto Rico (6), or between the British Virgin Islands and Anguilla (2). Within the Gulf of Mexico, five leatherbacks stayed within the eastern part of the Gulf off the coasts of Florida and Alabama, while the sixth traveled into the western Gulf of Mexico. In June of 2010, STC tracked a leatherback turtle named "Dawn" from her nesting beach at Chiriquí Beach, Panama, into the Gulf of Mexico during the oil spill. Her track followed similar observed tracks in previous years, which lead right into the oil slicks off the coasts of Alabama, Mississippi, and Louisiana. Dawn's movements did not seem to change once she entered areas with visible oil slicks as represented by NOAA oil spill data layers. Between July 23 and September 27, 2010, Dawn entered into the oil spill area two separate times. There have been recorded sightings of leatherbacks throughout the Gulf of Mexico, as well as flipper tag recoveries from females tagged on nesting beaches in Caribbean Central America. Our tracking research was the first to suggest that these animals may be foraging rather than just migrating through the Gulf of Mexico. In 2007 we concluded that

the Gulf of Mexico may represent a significant foraging ground for leatherbacks from the Caribbean coast of Central America and identified oil drilling as a potential threat to these turtles while in the Gulf of Mexico. Our continued tracking and the Deepwater Horizon oil spill in the Gulf of Mexico have supported these conclusions. Our continued research and conservation program at Chiriquí Beach, may reveal information about the survival of turtles who were in the Gulf of Mexico in 2010 and potentially exposed to oil. It is possible that monitoring programs at nesting beaches might observe reduced survival or reduced nesting success of turtles exposed to oil.

REPORT ON A MASSIVE HYPOTHERMIC STUNNING EVENT OF SEA TURTLES IN FLORIDA DURING JANUARY 2010*

Allen Foley[1], Dean Bagley[2], Rhonda Bailey[3], Lisa Belskis[4], Beth Brost[3], Nancy Evou[5], Robert Hardy[3], Shigetomo Hirama[6], Amber Hoffman[7], Meghan Koperski[8], Anne Meylan[3], Karrie Minch[9], Lorna Patrick[10], Jane Provancha[11], Sue Schaf[12], Barbara Schroeder[13], Brian Stacy[14], Wendy Teas[4], Robbin Trindell[15], and Blair Witherington[6]

[1] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Jacksonville Field Laboratory, Jacksonville, Florida, USA
[2] University of Central Florida, Department of Biology, Orlando, Florida, USA
[3] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, Florida, USA
[4] National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, Florida, USA
[5] National Marine Fisheries Service, Panama City Laboratory, Panama City, Florida, USA
[6] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Melbourne Beach Field Laboratory, Melbourne, Florida, USA
[7] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Tequesta Field Laboratory, Tequesta, Florida, USA
[8] Florida Fish and Wildlife Conservation Commission, Imperiled Species Management, Tequesta Field Laboratory, Tequesta, Florida, USA
[9] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Indian River Field Laboratory, Melbourne, Florida, USA
[10] U.S. Fish and Wildlife Service, Panama City, Florida
[11] Innovative Health Applications, Kennedy Space Center, Florida, USA
[12] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Marathon Field Laboratory, Marathon, Florida, USA
[13] National Marine Fisheries Services, Office of Protected Resources, Silver Spring, Maryland, USA
[14] National Marine Fisheries Service, Office of Protected Resources, Marine Animal Disease Laboratory, University of Florida, Gainesville, Florida, USA
[15] Florida Fish and Wildlife Conservation Commission, Imperiled Species Management, Tallahassee, Florida, USA

Record-breaking cold weather occurred throughout Florida during the first two weeks of January 2010, with many Florida cities setting one or more record low temperatures. However, the most remarkable characteristic of this period of cold weather was its unusual duration. For 12 days, low temperatures in much of central and northern Florida fell below freezing every night and high temperatures in much of southern Florida never surpassed 10°C. This made it one of the longest stretches of unusually cold weather ever recorded in Florida. Water temperatures at an inshore site in east-central Florida (Indian River Lagoon, Brevard County) stayed below 10°C for ten consecutive days and dropped as low as 4°C. Several days into this cold-weather period, hundreds of cold-stunned sea turtles began appearing in Mosquito Lagoon (Brevard County) and St. Joseph Bay (Gulf County), the two sites in Florida where large-scale sea turtle cold-stunning events had occurred periodically in previous years. After more than a week of cold weather, well over 3,000 cold-stunned sea turtles had been found at these two primary sites and about another thousand cold-stunned sea turtles had been found at other sites throughout Florida where sea turtle cold-stunning events had not been previously documented. Overall, 4,615 cold-stunned sea turtles were found in 16 Florida counties during a period of about one week. Green turtles (*Chelonia mydas*) comprised 95% (N = 4,368) of the cold-stunned sea turtles but loggerheads (*Caretta caretta*, N = 111), Kemp's ridleys (*Lepidochelys kempii*, N = 73), and hawksbills (*Eretmochelys imbricata*, N = 63) were also found. As far as we know, this is the first time that more than a few hawksbills have been involved in any cold-stunning event. The cold-stunned hawksbills were mainly found in southernmost Florida (Florida Keys, Monroe County). Most (83%) of the cold-stunned sea turtles were alive when found and this was true for all the species. Previous sea turtle cold-stunning events in Florida typically involved one to several hundred sea turtles and were almost always at only one site (either Mosquito Lagoon or St. Joseph Bay). The largest previous event occurred in St. Joseph Bay during January of 2001 and involved 401 sea turtles. The logistics necessary to retrieve, transport, document, treat, hold, tag, and release several thousand sea turtles almost simultaneously were daunting. We identified 107 organizations ranging from various governmental agencies, to university-affiliated programs, to conservation groups, to businesses, to individual citizens that provided equipment, supplies, personnel, or facilities to assist in the response to this event. As with previous cold-stunning events in Florida, the most current event also provided the opportunity to learn more about these sea turtles. For example, 43 adult/near-adult-sized green turtles (straight line carapace length 80-108 cm) were found cold-stunned in the northern Banana River or southern Mosquito Lagoon. Large green turtles had not been previously known from these areas. About 7% (109/1,648) of the green turtles found cold-stunned in St. Joseph Bay had fibropapilloma-like tumors. Only two of the 388 green turtles (0.5%) found cold-stunned in this area in 2001 had tumors.

SPATIAL AND TEMPORAL DISTRIBUTIONS OF SARGASSUM DOMINATED SURFACE-PELAGIC DRIFT COMMUNITIES IN THE NORTHERN GULF OF MEXICO DURING 2010

Robert Hardy[1], Chuanmin Hu[2], and Blair Witherington[3]

[1] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Saint Petersburg, Florida, USA
[2] University of South Florida, College of Marine Science, Saint Petersburg, Florida, USA
[3] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Melbourne Beach, Florida, USA

Surface pelagic drift communities in the Gulf of Mexico serve as critical developmental habitats for neonate sea turtles, as well as many species of pelagic fish. This ephemeral ecosystem is typically dominated by the pelagic macroalgae *Sargassum* spp. The highly dynamic nature of this habitat makes it difficult to locate and quantify directly. To identify and measure this habitat remotely, we analyzed data from Earth-observing satellites. We applied the Floating Algae Index (FAI), developed by Hu (2009), to 30-m resolution Landsat TM and ETM+ imagery from the northern Gulf of Mexico. This effort provides the first high-resolution quantification of the spatiotemporal distribution of Sargassum-dominated drift communities in the region, which includes the BP MC 252 oil spill area, April—August 2010. The FAI identifies the presence *Sargassum* based on the difference between reflectance at band 4 (825 nm) and a linear baseline interpolated between bands 3 (660 nm) and 5 (1650 nm). We searched all available Landsat scenes collected in 2010 over the northern GOM waters for the presence of *Sargassum*. Pixels exhibiting high FAI values were digitized semi-automatically, and results were summarized in a spatial database. Our results show that *Sargassum* is present earlier in the year and in higher amounts in the northwestern Gulf of Mexico (off the Texas coast) than in the central and eastern GOM, where *Sargassum* appeared in late spring and persisted into the winter. The results also show persistent *Sargassum* lines and patches throughout the West Florida shelf during summer and fall. These results provide a synoptic measure of surface pelagic habitat availability, which may serve as baseline data to understand and quantify potential impacts of climate change and natural disasters (e.g., oil spills) on the GOM ecosystem.

POTENTIAL IMPACTS OF THE DEEPWATER HORIZON OIL SPILL ON THE RECOVERY OF THE KEMP'S RIDLEY

Selina S. Heppell

Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon USA

The Deepwater Horizon spill in the Gulf of Mexico affected hundreds, possibly thousands, of sea turtles. Direct effects of oil and oil dispersants were monitored through strandings and retrieval of turtles by volunteers in the Gulf; indirect effects of unmonitored fishing activities prior to area closures and possible deaths due to oil slick burning were less

well-documented. The endangered Kemp's ridley sea turtle has been recovering at a rate of approximately 15% per year since the mid-1990s, based on nest counts in Mexico and Texas. Reductions in this recovery rate due to the spill depend largely upon the intensity of the oil spill mortality and any residual mortality or sub-lethal effects that may occur in future years. Model simulations suggest that the population's "momentum" from years of dedicated conservation effort on the nesting beaches and changes in at-sea mortality should be sufficient to carry the population through this perturbation. However, lingering effects of the oil on juvenile survival or rates of reproduction could impede recovery significantly. An increase of 10-20 years in expected recovery time could occur if the mortality rate was severe and affected older life stages or if the impact decay rate (reduction in the mortality rate over the years subsequent to the spill) is low. While these results are heuristic rather than predictive, largely due to a lack of basic demographic data on at-sea survival and growth rates, the models do indicate expected changes in nest abundance and time lags in the population growth rate that should be monitored for over the next decade. This work illustrates the strong need for improved monitoring of sea turtle vital rates (specifically at-sea mortality) to allow diagnosis of population change, as emphasized by the recent report by the National Research Council.

SEA TURTLE NEST TRANSLOCATION EFFORT IN THE FLORIDA PANHANDLE AND ALABAMA, USA, IN RESPONSE TO THE DEEPWATER HORIZON (MC-252) OIL SPILL IN THE GULF OF MEXICO*

Sandra L. MacPherson[1], Robbin N. Trindell[2], Barbara A. Schroeder[3], Lorna A. Patrick[1], Dianne K. Ingram[1], Karen P. Frutchey[4], Jane A. Provancha[5], Ann Marie Lauritsen[1], Bruce S. Porter[1], Allen M. Foley[2], Anne B. Meylan[2], Blair E. Witherington[2], and Michelle K. Pico[6]

[1] U.S. Fish and Wildlife Service
[2] Florida Fish and Wildlife Conservation Commission
[3] National Marine Fisheries Service
[4] University of Hawaii Joint Institute for Marine and Atmospheric Research & National Marine Fisheries Service
[5] Innovative Health Applications, LLC
[6] National Fish and Wildlife Foundation

In response to the Deepwater Horizon (MC-252) Oil Spill, between June 26 and August 18, 2010, 274 sea turtle nests laid on Florida Panhandle and Alabama, USA, beaches were collected near the end of incubation and transported to the Atlantic coast of Florida for the final days of incubation and subsequent release of hatchlings into the Atlantic Ocean. Daily nesting surveys were conducted throughout the nesting season to mark all observed nests. Nests were excavated after approximately 50 days of incubation when transport of the incubating eggs was less likely to result in the loss of viable embryos. Eggs were handled under strict protocols that involved placing them into specially prepared foam boxes and transporting them in a climate-controlled critical care vehicle to the Atlantic coast. Once there, nests were held in a climate-controlled facility at the Kennedy Space Center until incubation was completed. Nests were monitored there by biologists, and as hatchlings emerged, they were collected each night and transported to a nearby dark beach where they were released. These extraordinary measures were taken in direct response to an unprecedented human-caused disaster. Protocols for this effort were developed with careful consideration of all relevant scientific information, balanced with the logistical challenges of rapidly gearing up for and identifying and training staff and volunteers to assist with the potential worst-case scenario of collecting and moving up to 800 nests from 430 kilometers of Gulf of Mexico coastline to the Atlantic coast. This effort involved substantial manipulation of eggs and hatchlings and, therefore, definite but unquantifiable risks. Under normal conditions, these measures would not have been justifiable. However, the environmental disaster in the Gulf of Mexico required that such measures be taken to prevent hatchlings from Florida Panhandle and Alabama beaches from swimming into oil and dispersants or encountering contaminated *Sargassum* in their developmental habitat in the open sea. Nest translocations were suspended in mid-August once reevaluation criteria for this effort were met. At that time, Federal and State wildlife agencies determined that oiling risks to hatchlings emerging from nests on Florida Panhandle and Alabama beaches had diminished and that the risks associated with continuing nest translocations likely outweighed the risks of letting hatchlings emerge into Gulf of Mexico waters. Over 14,700 hatchlings emerged from translocated nests and were released on the Florida Atlantic coast. Late-term embryo mortality potentially attributable to the actual nest translocation effort was approximately 2 percent. The ultimate fate of the hatchlings released from translocated nests is uncertain; however, their survival without intervention was highly unlikely due to the amount of oil and increased response activities in the Gulf during the 2010 nesting season. Numerous partners and hundreds of staff and volunteers, including the dedicated

sea turtle permit holders in both the Florida Panhandle and Alabama, were involved in this rescue effort. This effort would not have been possible without their participation.

ARABIAN GULF OIL SPILL 1991 – LESSONS LEARNT*

Nicolas Pilcher

Marine Research Foundation, Sabah, Malaysia

In January 1991 as the Iraqi army retreated out of Kuwait, hundreds of oil wells were set alight and stop valves which released oil to the sea were left open. An estimated eleven million barrels of crude spilled into the Gulf, and moved in a southerly direction, overrunning delicate saltmarsh, mangrove and intertidal zones in Kuwait, Saudi Arabia, Bahrain and Qatar. Lying in the path of some of the spill were four key islands which supported some of the Gulf's most important nesting aggregations of green and hawksbill turtles. Efforts were set up to patrol the mainland and islands for distressed fauna, and debilitated oiled turtles were tended to in the Jubail Wildlife Rehabilitation Center, where they were cleaned and fed until the oil spill danger had passed. With little previous experience of oiled turtles, and in the limited-communication scenario of the early 1990s with no email, we developed cleaning and feeding protocols of our own. Many cleanup methods were tried, but the best solution was simply to let nature do the cleanup herself, with no interference from anthropogenic efforts. Sheep's wool, suction cups, barriers, diversions, drags, and a suite of other inventive solutions failed to do the job, and in a few months nature had accomplished what manmade efforts had clearly failed at cleaning. Naturally-occurring bacteria, evaporation, sinkage, and natural assimilation had the greatest impact on oil removal. The nesting beaches were no strangers to oil, having accumulated oil from spills caused during the Iran-Iraq war and due to natural seepage. Little or no impact was noted on the oiled rocky shores which turtles crossed to reach nesting sands, even in the >40oC temperatures. Only a handful of oiled turtles stranded and most of these were alive, and no short- or long-term impacts were noted on nesting turtle populations.

WORKING "OUTSIDE THE BOX" – CHALLENGES SAVING SEA TURTLES DURING THE BP SPILL*

Christopher A. Pincetich[1], Wallace J. Nichols[2], Carole Allen[3], and Todd Steiner[1]

[1] Sea Turtle Restoration Project, Forest Knolls, California, USA
[2] California Academy of Sciences, San Francisco, California, USA
[3] Sea Turtle Restoration Project, Houston, Texas, USA

The rapid evolution of the Deepwater Horizon explosion into the largest oil spill in U.S. History presented a myriad of challenges to sea turtle conservation efforts. Government agency, university, and non-profit organizations responded quickly to assist the cooperative Unified Area Command emergency response management group. However, lines were quickly drawn defining those "inside-the-box" and those "outside-the-box" of decision-making and response actions allowed through the Unified Area Command. The Sea Turtle Restoration Project worked on many levels during the BP spill crisis both on-the-ground in the Gulf of Mexico and remotely from Texas and California. Efforts by STRP and many non-profit organizations, large and small, to work "inside-the-box" directly on field operations were not successful in many cases for a variety of reasons that we will explore. Consultations with experts both inside- and outside- guided STRP towards successful actions halting BP's controlled burns, modifying BP operations to include sea turtle observers and rescue equipment on *in situ* burn teams, and reinitiating Endangered Species Act assessment of the Gulf of Mexico shrimp fishery. STRP actions to join, support, and employ local fishermen in on-water sea turtle rescue, prevent the release of Kemp's ridley hatchlings into the Gulf, and delay the opening of commercial shrimping in Texas waters would have saved the lives of many sea turtles, but were unsuccessful. Working "outside-the-box" also allowed STRP to freely share photos, videos, and live personal interviews to engage the public and the media on the plight of the sea turtles. Many lessons were learned by conservation organizations during and after the BP spill that should be used to improve response efforts in the future, and will be discussed.

JANUARY 2010 COLD STUN: TURTLES IN THE NORTH CENTRAL INDIAN RIVER LAGOON AND FATE OF 60 TURTLES SUBSEQUENTLY TRACKED*

Jane A. Provancha[1], Eric A. Reyier[1], Karrie Minch[2], Resa Cancro[1], Russ H. Lowers[1], Doug. M. Scheidt[1], Carly M. Garreau[1], Karen Holloway-Adkins[1], and Shanon L. Gann[1]

[1] Innovative Health Applications, LLC, Medical and Environmental Support Contract, Kennedy Space Center, FL 32899
[2] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Indian River Field Laboratory, Melbourne, Florida

The January 2010 record-breaking cold weather in Florida produced the largest documented hypothermic stunning event for sea turtles, other poikilotherms, and manatees. Water temperatures within Brevard County lagoons were below 10°C continuously for ten days. This extensive duration of cold within the northern Indian River Lagoon (IRL) led to the cold-stunning of over 2100 sea turtles. Long term KSC turtle netting studies indicate that this area has the lowest turtle catch per unit effort compared to all other Florida in-water studies. The cold stunned turtle numbers were nearly 10 fold higher than any previous for this area. The vast majority of affected sea turtles, 97%, were green turtles (*Chelonia mydas*), a few were loggerheads (*Caretta caretta*) and one was a hawksbill (*Eretmochelys imbricata*). In terms of location, 76% were from Mosquito Lagoon and Banana River, and 15% were from north central Indian River on or near Kennedy Space Center (KSC). An unprecedented, massive rescue response ensued from January 6th to January 14th and was headquartered out of the Merritt Island National Wildlife Refuge on KSC. This IRL event resulted in a 22% mortality rate. The response team was overwhelmed within 3 days, due to turtle numbers, rehabilitation space limitations and continued regional climate constraints. These factors pressured conservation managers to release 63% of Brevard County turtles to warmer waters 90 to 200 kilometers away. Ultimately, 50% of all north and central IRL turtles were released in the Atlantic Ocean in South Florida. Only 3% of the turtles stunned in Mosquito Lagoon were released back into that lagoon. Although the unprecedented volume of stunned turtles provided valuable insight from an ecological and population standpoint, the critical condition of most individual turtles did not ethically allow for the myriad of sampling options common to in-water research projects. The event resulted in large numbers of adults from all basins, particularly the northern Banana River (8% adults from the 500+ turtles). Sixty turtles released back into these lagoons were tracked in cooperation of Florida Fish and Wildlife Conservation Commission (FWCC) and rehabilitation facilities. A multiagency passive acoustic array of over 150 receivers extends the IRL from Ponce Inlet to St Lucie Inlet and several outside the inlets. NASA-IHA supplied 50 new transmitters and Mote Marine Laboratory donated 10. The 60 turtles (standard carapace lengths 27 to 93cm) were released back into the Mosquito, Banana, and Indian Rivers (25, 26, and 9 respectively). Data downloaded to date show the movements of 50 turtles with detection periods ranging from 1 to 259 days (average = 97 days). Five turtles were recorded moving outside of the IRL along the Atlantic coast. One was confirmed dead within one month of release and nine may have bypassed the array, had battery failures or died. Additional downloads over the coming months may improve our interpretations. Pressure sensors were included on several tags for the larger Banana River turtles that met our expectations of utilizing the deep dredged basins on KSC.

INTRODUCTION TO THE SPECIAL SESSION ON OIL SPILL, COLD STUNNING, AND SEA TURTLES*

Barbara A. Schroeder[1], Allen M. Foley[2], and Blair E. Witherington[2]

[1] National Oceanographic and Atmospheric Administration, National Marine Fisheries Service
[2] Florida Fish and Wildlife Conservation Commission, Florida Wildlife Research Institute

Sea turtle mass strandings and unusual mortality events have been reported from around the world and attributed to various causes, including low water temperatures, fisheries bycatch, and harmful algal blooms, such as red tide. During 2010, extreme cold temperatures in Florida and a massive oil spill in the Gulf of Mexico resulted in the need to mount rapid, sustained, and complex response efforts to aid and document sea turtles affected by these unprecedented events. Low temperatures during the winter of 2011 necessitated similar responses again in Florida, Texas, and northeast Mexico. Investigation of and response to unusual or mass stranding events requires extensive coordination and complex and rapid assessment and decision-making. This special session focuses on the extraordinary response efforts during the recent cold-stunning events in the U.S. and the massive oil spill in the Gulf of Mexico. Efforts undertaken and lessons learned during the Arabian Gulf oil spill in 1991 will also be discussed.

RECORD COLD STUNNING, POPULATION GROWTH, AND FIBROPAPILLOMATOSIS (FP) IN GREEN SEA TURTLES IN TEXAS*

Donna J. Shaver[1], Cynthia Rubio[1], Jennifer Shelby Walker[1], and Peter H. Dutton[2]

[1] National Park Service, Padre Island National Seashore, P.O. Box 181300, Corpus Christi, Texas, U.S.A., 78480-1300
[2] National Marine Fisheries Service, Southwest Fisheries Science Center, 3333 North Torrey Pines Court, San Diego, California, U.S.A., 92037

Every few years, hypothermic stunning of sea turtles is documented on the Texas coast. Record-setting hypothermic stunning events occurred during early 2010 and early 2011, when 464 and about 1,517 sea turtles were found, respectively. These tallies were far more than documented during any other hypothermic stunning events recorded in Texas since the Sea Turtle Stranding and Salvage Network (STSSN) was established in 1980. The 464 found during the 2010 event included 459 green (*Chelonia mydas*), three loggerhead (*Caretta caretta*), one hawksbill (*Eretmochelys imbricata*), and one turtle of unknown species. During the 2011 event, about 1,517 green, one loggerhead, and one hawksbill were found. During both events, most of the turtles were found in south Texas, in and near the Laguna Madre, which is one of the most important developmental habitats for green turtles in the northwestern Gulf of Mexico. A few were found on the upper Texas coast. Many were found on the middle Texas coast during 2010, but relatively few were found there during 2011. During 2010 most (453) were found inshore (bays, passes), but 11 were found offshore (Gulf of Mexico beachfront). Similarly, during 2011, the vast majority were found inshore. Of the 464 found during 2010, 160 (35%) were located alive and 304 (65%) were found dead. In contrast, during 2011, about 1,028 (68%) were found alive and about 489 (32%) were found dead. Many of dead turtles were found towards the end of the events and/or in areas that were difficult to access. Live turtles were taken to rehabilitation facilities. Most survived and were released. The sea turtle species most affected by hypothermic stunning in Texas is the green turtle. Hypothermic stunning is the most significant source of green turtle strandings in Texas. Most of the green turtles found were juveniles. The numbers of juvenile green turtles inhabiting south Texas waters are increasing rapidly, so it is expected that the numbers of turtles affected by hypothermic stunning will continue to increase. Organized search efforts and assistance of the public are needed to ensure that turtles are quickly found, brought to rehabilitation, and saved during these events. Fibropapillomatosis (FP) had not been documented in green turtles in Texas prior to 2010. The first documented was a stranded turtle found on 26 May. From 26 May-17 November 2010, five stranded green turtles (including that individual) were found with external tumors and tested positive for FP based on PCR tests. FP is currently a minor stranding factor in Texas. Three of the five had other factors that likely contributed to their stranding (two with boat propeller injuries and one entangled in fishing line and rope). Genetic analysis indicated that the five juveniles with FP were most likely from the local population as opposed to “exotic” immigrants, since the mtDNA

haplotypes matched those identified among the local foraging population. Forty-seven (about 3.1%) of the turtles found during the 2011 hypothermic stunning event had FP.

INVESTIGATION OF SEA TURTLE UNUSUAL MORTALITY EVENTS IN THE EASTERN UNITED STATES: 2001-2010*

Brian Stacy[1], Allen Foley[2], Jennifer Muller[3], Terry Norton[4], Leanne Flewelling[5], Spencer Fire[6], Varis Ransi[7], Charles Manire[8], Christina Trapani[9], Susan Barco[9], and Barbara Schroeder[10]

[1] National Marine Fisheries Service, Office of Protected Resources, Marine Animal Disease Laboratory, University of Florida, Gainesville, Florida
[2] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Jacksonville Field Laboratory, Jacksonville, Florida
[3] Marine Animal Disease Laboratory, University of Florida, Gainesville, Florida
[4] Georgia Sea Turtle Center, Jekyll Island, Georgia
[5] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, Florida
[6] NOAA National Ocean Service, Marine Biotoxins Program, Charleston, South Carolina
[7] NOAA National Centers for Coastal Ocean Science, Silver Spring, Maryland
[8] Mote Marine Laboratory and Aquarium, Sarasota, Florida
[9] Virginia Aquarium Stranding Response Program, Virginia Beach, Virginia
[10] National Marine Fisheries Services, Office of Protected Resources, Silver Spring, Maryland

Criteria developed for the recognition of marine mammal unusual mortality events (UMEs) have been applied over the last decade to detect similar events for sea turtles along the Atlantic and Gulf of Mexico coasts of the United States. Of the seven criteria used in determining a marine mammal UME, three have been commonly invoked to identify a sea turtle UME. These are a marked increase in the magnitude or a marked change in the nature of morbidity or mortality as determined from strandings, a marked change in when strandings are occurring, or a finding that a marked number of strandings exhibit similar or unusual pathologic findings, behavior patterns, clinical signs, or general physical condition. This presentation considers six sea turtle UMEs primarily involving loggerheads (*Caretta caretta*), green turtles (*Chelonia mydas*), and Kemp's ridleys (*Lepidochelys kempii*) that have been investigated to various degrees. Events occurred in 2000 and 2001 (south Florida), 2005 (southwest Florida), 2006 (northeast Florida), 2009 (northeast Florida), 2009 (Chesapeake Bay), and 2010 (northern Gulf of Mexico). Known or suspected etiologies based on these investigations have included harmful algal blooms, fisheries interactions, parasites, and climatic events. The paucity of available carcasses in good postmortem condition, chronicity of illness at the time of stranding, and inadequate knowledge of poorly characterized or novel biotoxins have limited some investigations. Although the cause(s) of some events remain unknown, a characterization of strandings that includes necropsy findings allows for reasonable, general conclusions to be reached. The weight of evidence supporting either an anthropogenic or natural cause for a sea turtle UME has significant implications on judicious management decisions, such as those pertaining to fisheries or to research or health surveillance priorities. Information found to be useful in refining differential diagnoses and in guiding UME investigations have included nutritional condition at stranding, gastrointestinal contents, evidence of disease, pertinent oceanographic data, concurrent mortality of other species, analytical biotoxin results, and concurrent fisheries activity. Early identification of events and consistent, thorough data and sample collection from animals are critical.

NATURAL RESOURCE DAMAGE ASSESSMENT FOR THE DEEPWATER HORIZON OIL SPILL*

Laurie Sullivan[1] and Tom Brosnan[2]

[1] NOAA ORR/Assessment and Restoration Division, 777 Sonoma Avenue, Ste 219A Santa Rosa, CA 95404
[2] NOAA ORR/Assessment and Restoration Division, 1305 East West Hwy, Silver Spring, MD 20910

The U.S. Oil Pollution Act authorizes certain federal agencies, states, and Indian tribes — collectively known as natural resource trustees — to evaluate the impacts of oil spills, ship groundings, and hazardous substance releases to identify potential injuries to natural resources and lost public uses resulting from the spill. For the Deepwater Horizon Oil Spill, although the cleanup activities may eliminate or reduce the risks to human health and the environment, they do not restore the injuries or lost use. Through the Natural Resource Damage Assessment (NRDA) process, the trustees identify the extent of resource injuries, the best methods for restoring those resources, and the type and amount of restoration required to account for those injuries.

RESPONSE OF FLORIDA SEA TURTLE PERMIT HOLDERS TO THE GULF OIL SPILL

Kennard Watson[1], Wendy Jones[2], Mark Nicholas[3], Bruce Drye[4], Brad Smith[5], Barbara Eells[6], Seth Farris[7], Brail Stephens[7], Jessica McKenzie[8], Bill Wargo[9], and Sharon Maxwell[10]

[1] St. Andrew Bay Resource Management Association, Panama City, Florida, USA
[2] Tyndall Air Force Base, Panama City, Florida, USA
[3] Gulf Islands National Seashore, Pensacola, Florida, USA
[4] St. George Island Volunteer Turtlers, St. George Island, Florida, USA
[5] St. Vincent Island National Wildlife Refuge, Apalachicola, Florida, USA
[6] Sea turtle permit holder, Mexico Beach, St. Joseph Beach, and Indian Pass, Florida, USA
[7] University of Florida Tagging Team, Gainesville, Florida, USA
[8] Friends of S. Joseph Bay Preserves Turtle Patrol, St. Joseph Peninsula, Florida, USA
[9] Alligator Point Sea Turtle Patrol, Alligator Point, Florida, USA
[10] South Walton Turtle Watch, Freeport, Florida, USA

The Deepwater Horizon oil rig exploded in April 2010 just as the sea turtle nesting season was set to begin in the Gulf of Mexico. The oil spill fouled marshlands and beaches along the northern gulf coast, eventually reaching the Florida panhandle, which supports predominantly loggerhead nesting but also scattered nesting of leatherback, green, and Kemp's ridley turtles. Panhandle beaches extend roughly 200 miles from Franklin County near Apalachicola westward to Escambia County near Pensacola Beach. During June and July 2010, Pensacola Beach and the Gulf Islands National Seashore experienced significant incursions of liquid oil, while beaches to the east experienced mostly weathered oil in the form of tar balls. This paper will describe the role of Florida sea turtle permit holders in protecting turtles on panhandle beaches during the spill. Activities included relocating 262 turtle nests to the Kennedy Space Center on Florida's east coast and coordinating with thousands of cleanup workers who operated day and night on the beach. Recommendations will be provided on ways to improve coordination between the permit holders, regulatory agencies, and cleanup contractors in the event of future spills.

INTEGRATION OF SEA TURTLE EXPERTISE INTO OIL SPILL RESPONSE PLANNING AND MITIGATION: EXPERIENCES FROM DEEPWATER HORIZON

Sarah Wilkin[1], Michael Ziccardi[2], Teresa Turk[3], Robert Hoffman[4], Yvonne Addassi[5], and Barbara Schroeder[6]

[1] National Marine Fisheries Service, Southwest Regional Office, Long Beach, CA 90802 USA
[2] Oiled Wildlife Care Network, Wildlife Health Center, University of California, Davis, CA 95616 USA
[3] National Marine Fisheries Service, Office of Science and Technology, Silver Spring, MD 20910
[4] National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, FL 33701 USA
[5] Office of Spill Prevention and Response, California Department of Fish and Game, Sacramento, CA 94244 USA
[6] National Marine Fisheries Service, Office of Protected Resources, Marine Mammal and Sea Turtle Conservation Division, Silver Spring, MD 20910

When determining the best means to recover oil following a spill, considerations regarding incidental interactions with wildlife can be (but are not always) part of the decision matrix. During the Deepwater Horizon oil spill, significant contacts and protocols were developed over the course of the response to better integrate sea turtle experts into the response framework, resulting in several significant achievements. Best Management Practices were developed to reduce the potential impacts of oil recovery and clean-up operations on sea turtles and other wildlife. A protected species observer program was implemented that integrated biologists with other responders to provide advice, documentation, and the potential for intervention if interactions with wildlife were observed. Finally, coordination between biologists and the Alternative Response Tool Evaluation System resulted in evaluation of proposed technologies for their potential to harm sea turtles prior to field deployment of the equipment. This presentation will discuss these activities and provide recommendations for additional ways that sea turtle biologists can engage with the oil spill response community to minimize and mitigate risks from oil recovery actions.

EFFORTS TO RESCUE OILED TURTLES AT SEA DURING THE BP DEEPWATER HORIZON BLOWOUT EVENT, APRIL—SEPTEMBER 2010*

Blair Witherington[1], Barbara Schroeder[2], Shigetomo Hirama[3], Brian Stacy[4], Michael Bresette[5], Jonathan Gorham[5], and Robert DiGiovanni[6]

[1] Florida Fish and Wildlife Conservation Commission and Inwater Research Group, Florida USA
[2] NOAA Fisheries, Office of Protected Resources
[3] Florida Fish and Wildlife Conservation Commission, Florida USA
[4] NOAA Fisheries and University of Florida
[5] Inwater Research Group, Florida USA
[6] Riverhead Foundation

Between 20 April and 12 July 2010, oil flowed into the Gulf of Mexico during the Macondo Well blowout that followed the sinking of the BP Deepwater Horizon platform. The source of oil was located approximately 50 NM from land, southeast of the Mississippi River delta, in about 1500 m of water. During this period and afterward until 21 September 2010, an extensive response effort included the rescue of oiled sea turtles. One month into the spill event, few visibly oiled turtles had reached land where they could be observed and documented. Scientists from NOAA and Florida FWC proposed that the life stage most affected by oil would be pelagic/oceanic juveniles living within the *Sargassum* surface drift community. Efforts to locate juvenile turtles at sea began using craft from Louisiana Wildlife and Fisheries, and switched to a fleet of charter sportfishing vessels. By late July, six vessels out of three ports in Louisiana, Alabama, and Florida, were conducting regular searches within approximately 70 NM from land. Searches were guided by remote sensing data indicating oil sheen, sea-surface temperature fronts, and water color, and by aerial reconnaissance for visible *Sargassum* with oil. On the water, search vessels focused on *Sargassum* patches and lines with evidence of oil. To estimate detectability, distances of observed turtles from transect search lines were recorded.

Where possible, turtles were captured using long-handled (4 m), wide-hooped (1 m) dip nets. During this rescue effort, crews on rescue vessels observed 1050 sea turtles and of these, 520 were captured (including 2 dead). Of the captured turtles, 394 showed visible signs of external oil, ranging from light smudges to complete coverage. The vast majority of turtles were juveniles, 14—32 cm straight carapace length (SCL) comprising four species (in order of frequency): Kemp's ridley (*Lepidochelys kempii*, n=451), green turtles (*Chelonia mydas*, n=311), hawksbills (*Eretmochelys imbricata*, n=20), and loggerhead sea turtles (*Caretta caretta*, n=17). Two post-hatchling loggerheads (SCL 6.5—6.7 cm) were captured, and 78 subadult/adult loggerheads (> 50 cm SCL) were observed (2 captured). Four green turtles and 11 Kemp's ridleys were observed to be of subadult or adult life stages. Vessel crews observed 21 adult leatherbacks (*Dermochelys coriacea*) in the spill area, and the remaining observed turtles (n=135) could not be assigned to species. The turtles that predominated within the spill area were of a vulnerable life stage (small juveniles) living within areas that collect floating oil. Ongoing assessments seek to quantify the number of turtles affected by the BP spill.

AN OVERVIEW OF OILED WILDLIFE RESCUE AND REHABILITATION PLANNING IN THE US: SEA TURTLES AND THE DEEPWATER HORIZON OIL SPILL*

Michael Ziccardi[1], Sarah Wilkin[2], Teresa Rowles[3], and Barbara Schroeder[3]

[1] Oiled Wildlife Care Network, Wildlife Health Center, University of California, Davis, CA 95616 USA
[2] National Marine Fisheries Service, Southwest Region, Long Beach, CA 90802 USA
[3] National Marine Fisheries Service, Office of Protected Resources, Marine Mammal and Sea Turtle Conservation Division, Silver Spring, MD 20910

This paper will provide an overview of how oiled wildlife response activities fall under the Unified Command during oil spills in the United States, background data on how oil has impacted sea turtles in previous spills, and the general planning activities of the Marine Mammal/Sea Turtle Group under the Wildlife Branch for the Deepwater Horizon oil spill. This will include discussion on the development of four primary care centers for sea turtles for the five state region (as well as planning for secondary and overflow facilities), completion and revision of animal care protocols, a review of key activities of the Group (including issues related to Controlled burns, translocation of sea turtle nests, and at-sea collection of live turtles) and a synopsis of the intake, release and necropsy data.

Special Session: Next Generation of Genetics Research

APPLICATIONS OF "NEXT GENERATION" SEQUENCING AND SNP GENOTYPING FOR POPULATION GENETICS AND PHYLOGEOGRAPHY STUDIES*

Phillip A. Morin

Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA, USA

For over two decades the primary tools for population genetics and phylogeography studies have been sequencing of short (≤1000bp) fragments of the mitochondrial genome, and genotyping of microsatellites. Both approaches have limitations due the small amount of the genome that is surveyed, and highly variable and generally unknown mutation patterns. Over the last few years, genomic methods have been revolutionized by highly parallelized "next generation" sequencing, and the use of single nucleotide polymorphisms (SNPs) for nuclear locus genotyping. SNPs are the most common type of genomic variation, and new technologies allow rapid, efficient and cost effective genotyping of dozens to hundreds (or even thousands) of loci to assay neutral variation, and even to detect genes under selection. NGS technologies are now being applied to obtain whole mitochondrial genomes from hundreds of individuals for population studies, providing greater power to infer phylogeographic patterns. NGS also provides a platform for rapid nuclear SNP discovery, across the genome or from pre-selected genomic regions. I will provide an overview some of these technologies, and their recent applications to population genetic and phylogeographic questions at the SWFSC.

INSIGHTS INTO MATING SYSTEMS AND OPERATIONAL SEX RATIOS OF SEA TURTLES GAINED THROUGH GENETIC FINGERPRINTING*

Kelly Stewart, Peter H. Dutton

Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA, USA

Genetic techniques have been instrumental in helping us to answer questions about sea turtle biology including the validation of natal homing, identifying stocks, and determining relatedness between individuals. The ability to identify an individual based on its genotype (or fingerprint) has revolutionized the study of sea turtles worldwide. Here we describe methods currently in use that take genetic fingerprinting even further and allow us to answer some of the more elusive questions about sea turtle life history. These analyses depend on sampling a number of siblings (hatchlings) as well as a known mother. Topics of genetic tagging, multiple paternity, operational sex ratios and reproductive success of male turtles will be discussed with detailed examples given for each topic, as well as the implications for population demography and management.

POPULATION STRUCTURE OF GREEN TURTLE ROOKERIES IN THE SOUTHERN GREATER CARIBBEAN REVISITED: INFERENCES FROM MITOGENOMIC SEQUENCES*

Brian M. Shamblin[1], Karen A. Bjorndal[2], Alan B. Bolten[2], Zandy M. Hillis-Starr[3], Ian Lundgren[3], Eugenia Naro-Maciel[4], Campbell J. Nairn[1]

[1]Daniel B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia 30605, USA
[2]Archie Carr Center for Sea Turtle Research, University of Florida, PO Box 118525, Gainesville, Florida 32611, USA
[3]National Park Service, Buck Island Reef National Monument, 00820 Christiansted, United States Virgin Islands, USA
[4]College of Staten Island, City University of New York, 2800 Victory Boulevard, Staten Island, New York 10314, USA

Analyses of mitochondrial control region polymorphism have supported the presence of several demographically independent green turtle rookeries globally and in the Greater Caribbean region. However, extensive sharing of common control region haplotypes confounds assessment of the scale of population structure among some rookeries in the Caribbean, particularly those of Aves Island and Suriname. Moreover, considerable overlap of genetic markers among rookeries also introduces uncertainty into estimates of rookery contributions to mixed foraging aggregations. To determine whether informative variation occurred outside of the established control region fragment, we screened additional portions of the mitochondrial genome (the entire mitochondrial genome less the repetitive element in the control region and bases 1-250) of several green turtles. These turtles carried partial control region haplotype CM-A5 and represented the rookeries of Buck Island, United States Virgin Islands (USVI); Aves Island, Venezuela; Galibi, Suriname; and Tortuguero, Costa Rica. We identified five single nucleotide polymorphisms (SNPs) that subdivided CM-A5 into four mitogenomic haplotypes partitioned among regions. All populations shared a common mitogenomic variant that was present at 100% frequency in the Suriname rookery. Eighty-four percent of Tortuguero-nesting CM-A5 turtles carried a mitogenomic haplotype with two derived mutations that were also shared with haplotypes CM-A20 and CM-A21 from Tortuguero. Significant haplotype frequency differences support demographic distinction of Aves and Suriname, highlighting the need to manage the smaller Aves rookery as a distinct management unit. Aves Island and Buck Island shared three mitogenomic haplotypes, suggesting that the Aves Island rookery may have been the ultimate source of the lineages currently nesting in the USVI. However haplotype frequency divergence between these rookeries suggests that they are also demographically independent. The USVI rookeries therefore likely represent a distinct management unit, but this inference requires corroboration from additional samples from the significant green turtle nesting sites on the East End beaches of St. Croix. Sequence determination at SNPs identified by the present study in foraging green turtles should improve the resolution of mixed stock analyses with respect to haplotype CM-A5. SNP discovery is underway for the two remaining common haplotypes in the Greater Caribbean region, CM-A1 and CM-A3.

MAKING CONNECTIONS: TOWARDS A COLLABORATIVE GLOBAL ASSESSMENT OF GREEN SEA TURTLE POPULATION STRUCTURE

Michael Jensen[1], Peter H. Dutton[1], and Nancy FitzSimmons[2]

[1]Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA, USA
[2]Institute for Applied Ecology, University of Canberra, Australia

The Endangered Species Act (ESA) of 1973 includes all seven species of marine turtles. It focuses on recognizing the biological and ecological importance of discrete population segments (DPS). According to the act a DPS must be “markedly separated from other populations of the same taxon” it must also exhibit ecological or biological significance in comparison to other population segments of the species. A DPS can be viewed as a group of related

stocks or MUs, or sometimes a single stock if it forms a discrete population and is significant to the biological species as a whole. Analysis of mtDNA from different turtle rookeries allows us to identify genetically differentiated breeding stocks, typically referred to as Management Units (MUs). While, these MUs are important for conservation planning they do not take into account the full scope of the marine turtle habitat and they do not necessarily fall under the definition of a DPS. The inability to clearly define green turtle stock boundaries has made it difficult to recognize appropriate demographic units for conservation purposes. This research aims to assemble a global set of green turtle genetic data from both nesting and feeding assemblages. A combination of published and a collaborative effort to join as yet unpublished data is used. Here we present preliminary results from approximately 4,400 mtDNA sequences from more than 80 green turtle rookeries and discuss the phylogeographic-level divergence of mtDNA across the global distribution used to provide the genetic support needed for identifying populations or groups of populations as a DPS. At the same time this research provides the necessary reference library of breeding stocks needed to accurately analyse feeding ground composition (using Mixed Stock Analysis). This will eventually provide the necessary information about dispersal, and help identify the boundaries of marine turtle stocks.

THE ANALYSIS OF LONG FRAGMENTS OF MITOCHONDRIAL DNA IMPROVES THE UNDERSTANDING OF THE GENETIC STRUCTURE OF LOGGERHEAD SEA TURTLE'S (*CARETTA CARETTA*) IN THE MEDITERRANEAN SEA*

Luis Cardona

Department of Animal Biology, University of Barcelona, Spain

Traditionally, a short fragment (380 bp) of the D-loop of the mitochondrial control region has been used for genetic studies for sea turtles like the loggerhead (*Caretta caretta*). However, the recent development of new primers for amplifying a longer fragment (815 bp) offers the possibility of a better resolution for genetic studies of this species. Samples from 243 different nests from the main nesting beaches in the Mediterranean, including published data, were genotyped and analysed for both short and long fragments in order to compare the performance of the two markers. Long mtDNA fragments revealed the existence of 12 different haplotypes present in the region, whereas only nine haplotypes were revealed by short fragments, and some common haplotypes were split in several new haplotypes. This resulted in a slight improvement for individual assignments to natal nesting grounds (11.52% vs. 13.58% of unique haplotypes with short and long fragments, respectively). However, the most important benefit in using the long fragment is a much better understanding of the genetic structure of the area. Long fragments allowed a major differentiation between populations and a major definition of haplotype structure with network trees revealing a new group of haplotypes. Relationships between haplotypes can be used to infer studies on historical processes leading to their current genetic and geographic distribution. Benefits also emerged when analysing the relationship between pairwise genetic (Fst) and geographic distances. Principal Component Analysis (PCA) based on long fragments increased the number of genetic groups observed and improved the accuracy of geographical differenciation of such groups. The genetic variability explained by the short fragment resulted in only two clearly differentiated groups of nesting grounds (Calabria and the other locations), whereas the analysis of the longer fragment unveiled a higher degree of hidden genetic variability, with Libya as a prominent third differentiated unit. Overall, the use of long fragments of mtDNA increased the capability to detect new haplotypes, improved the efficiency in detecting unique haplotypes hence facilitating individual assignation to the natal region and increased the resolution when defining genetic units related to certain geographic locations. These results underline the necessity to work with long fragments in the future, becoming a potential tool for the study of genetic structuring and for the implementation of management and conservation plans worldwide.

PRELIMINARY RESULTS ON GLOBAL GENETIC STRUCTURE AND PHYLOGEOGRAPHY OF OLIVE RIDLEYS (*LEPIDOCHELYS OLIVACEA*)*

Anelise Torres Hahn

Pontificia Universidade Católica do Rio Grande do Sul, Brazil

The olive ridley turtle (*Lepidochelys olivacea*) has a global distribution across tropical and sub-tropical oceans, and is one of the most abundant marine turtle species. It is closely related to the Kemp's ridley (*Lepidochelys kempii*) and the origin of both species is believed to be related to the closure of the Isthmus of Panama, about 3.5 to 5 million years ago. In this work we expand the previous study of Bowen *et al*. (1998) on the global phylogeography of olive ridley turtles using longer sequences of the mitochondrial DNA (mtDNA) control region and fifteen microsatellites loci. Samples from the paper cited above were re-sequenced, and a further 263 samples were sequenced from nesting sites in Brazil (n=99), French Guiana (n=36), East Pacific (n=59) and Australia (n=69), for a total of 324 olive ridley sequences, plus four sequences from Kemp's ridley turtles. Furthermore, these samples were also genotyped for 15 microsatellite loci. The mtDNA revealed 29 olive ridley haplotypes, five haplotypes for the Atlantic Ocean (AT), nine for the Indo-Pacific (IP) region and 14 for the East Pacific (EP) and finally one haplotype for the Kemp's ridley turtles. A phylogenetic analysis showed four different clades for olive ridley turtle, two within the IP, one within AT, and one within the EP. A haplotype network showed a close relationship between a central haplotype found in Sri Lanka and Australia rookeries and haplotypes from Atlantic and East Pacific oceans. Olive ridleys show moderate to high genetic differentiation among regional rookeries separated by more than 500 km (pairwise Fst was significant and varied from 0.1 to 0.88), but low genetic differentiation among rookeries located within this distance (e.g. Surinam/French Guiana and Tiwi Island/McCluer Island (Australia) (pairwise Fst from 0 to 0.04). Costa Rica/Mexico (without Baja California) even separated by more than 500km, are not genetically distinct. The microsatellite analyses showed lower levels of genetic structure among regional nesting sites than did the mtDNA. Pairwise Fst values varied from 0 to 0.04 among populations within the IP, from 0 to 0.08 among rookeries from AT, and from 0 to 0.02 among rookeries from EP. When we compare the pairwise Fst among the oceans, the pairwise Fst vary from 0.03 to 0.18 among rookeries from IP and AT, from 0.04 to 0.24 among IP and EP, and 0.07 to 0.28 among AT and EP. Results from the software Structure indicated that our data support four genetic clusters that were also associated with Oceanic basins, and Kemp's ridley samples comprised a unique cluster. The longer sequences of mtDNA, combined with additional samples from new olive ridley nesting sites revealed stronger structure between some nesting areas than previously reported, although this differentiation is still lower than for most marine turtle species. The microsatellites analyses showed lower structure between these rookeries and higher levels of gene flow.

STOCK STRUCTURE OF CARIBBEAN HAWKSBILLS: LONGER VS. SHORTER MTDNA SEQUENCES*

Robin LeRoux[1], Alberto Abreu[2], and Peter Dutton[1]

[1]Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA, USA
[2]Instituto de Ciencias del Mar y Limnol, Unidad Académica Mazatlán, Mexico

Hawksbill turtles, listed as Critically Endangered by the International Union for the Conservation of Nature (IUCN 2010), are widely distributed throughout the Caribbean. They are a species of conservation concern based on global population declines during the past century. In recent years, molecular techniques have played a significant role in defining priorities for conservation and informing management for a variety of marine species. Mitochondrial DNA (mtDNA) techniques, which characterize maternal lineages within and among species, have been useful in distinguishing sea turtle population stock structure where fixed or significant differences in haplotype frequencies occur. In this study, we expanded the geographic and technical scope of genetic surveys for Caribbean hawksbill rookeries by using new primers to resolve 740 bp of the mtDNA control region. Specimens used in previous studies and analyzed at 384 bp, along with several new rookeries were analyzed at 740 bp in order to determine if increasing the length of mtDNA sequences results in increased genetic variation and if the capacity to detect population differentiation is improved. With the longer sequences we identified new haplotypes and were able to differentiate populations that were previously grouped based on 384 bp sequences. Power analysis revealed that the additional variation provided by the longer sequences did not necessarily improve the overall power to detect population differentiation, since Caribbean hawksbill rookeries appear to be highly structured (high F_{ST} levels) and the 384bp data sufficiently robust to detect structure. However, we identified two variants of a common haplotype which resulted in a dramatic frequency shift between two rookeries that were indistinguishable with the shorter sequences.

DETECTING GREEN TURTLE POPULATION STRUCTURE IN THE PACIFIC USING SINGLE NUCLEOTIDE POLYMORPHISMS (SNPS)*

Suzanne Roden, Peter Dutton, Philip Morin

Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA, USA

We developed and applied a set of nuclear single nucleotide polymorphisms (SNPs) to detect genetic stock structure among Pacific *C. mydas* nesting populations. Sampled populations included Galapagos n=56, Mexico n=74, Hawaii n=136, and Taiwan n=12, to represent eastern, central, and western Pacific regions. A combination of single independent loci and linked loci combined as haplotypes were used for a total of 19 independent markers. Our nuclear markers confirmed significant differentiation between populations in the three Pacific regions. In addition, we discuss the value of SNP markers as an addition to the use of mitochondrial DNA and as an alternative to other nuclear DNA markers such as RFLP and microsatellites in *C. mydas* population studies.

WHOLE MITOGENOMIC SEQUENCES FOR FURTHER RESOLUTION OF UBIQUITOUS DLOOP HAPLOTYPES IN PACIFIC GREEN TURTLES*

Amy Frey, Peter H. Dutton, Phil Morin

Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA, USA

There are some haplotypes in pacific green turtles that are found at multiple nesting sites. It can be challenging when turtles are caught in fisheries and happen to have one of those common haplotypes, to determine what stock they came from. In an attempt to address this issue, we decided to look at the whole mitochondrial genome. For our pilot study we selected 20 samples from the western pacific (Federated States of Micronesia), 20 samples from the central pacific (French Frigate Shoals), 20 samples from the eastern pacific (Ecuador), 10 samples from the Atlantic and Mediterranean (St. Croix, and Cyprus) and an additional 6 samples with each of the two most commonly found haplotypes CmP20 in the western pacific, and CmP4 in the eastern pacific. Our study is going to focus on the samples run with a CmP20 haplotype. We ran a total of 14 samples from throughout the western paicific with a CmP20 haplotype. When these samples were sequenced with the longer primers, LCM15382 and H950g, they split from one to two haplotypes, CmP20.1, and CmP20.3, although there are currently 5 varients of the CmP20 haplotype. When we looked at the whole mitochondrial genome the 14 samples broke into 8 haplotypes. The pilot study showed potential for whole mitochondrial genomes to help further clarify pacific green turtle stocks and assist in identifying where turtles accidentally caught by fisheries may have come from.

Breeding Biology

A DECADE OF CONSERVATION AND RESEARCH BY LOCAL STUDENTS AT PACUARE NATURE RESERVE, COSTA RICA

Eylen Zuñiga Acuña and Mariana Malaver Montenegro

Ecology Project International, San Jose, Costa Rica

One of the biggest challenges that most sea turtle research and conservation projects face at nesting beaches in Costa Rica is dealing with threats such as hunting of nesting females and excessive collection of eggs by local people. Any conservation project that works independently, without involvement of the local community, can only study the resource in question, without actively conserving it. Since 2000, Ecology Project International (EPI) has implemented its Sea Turtle Ecology Program at one of the most important leatherback (*Dermochelys coriacea*) nesting beaches on the Caribbean coast of Costa Rica, conducting conservation activities at Pacuare Nature Reserve (PNR) that involve groups of students from nearby communities. More than 2400 students and 30% of the high schools, from the three main educational districts in the area, have participated in this program. Students work with research assistants from the Endangered Wildlife Trust to patrol the beach, and with the data collected they develop simple projects to investigate aspects of leatherback nesting behavior.The information recorded by EPI students since 2000 allows us to monitor morphological trends in the population, provides evidence for behaviors reported in the literature and can also be compared with scientific data collected by other organizations studying leatherbacks on the Caribbean coast of Costa Rica and Panama. A total of 2616 nesting females have been observed by students; 177,336 eggs have been protected and all the information presented in this paper are answers to scientific questions that have been proposed by students, such as leatherback growth rates; the average number of eggs laid per clutch; preferred emergence times, etc. From the information generated we have confirmed that individuals from the population nesting at PNR are also using other nesting beaches in Costa Rica and Panama, which highlights the importance of coordinated conservation action at an international level. With this presentation we hope to emphasize the importance of involving local communities in turtle conservation efforts worldwide. Students who have participated in the EPI Sea Turtle Ecology Program have helped us to disseminate information in their communities and are now more motivated to get involved in other conservation campaigns.

TAGFINDER: A DECISION AID AND FIELD REFERENCE FOR TAGGING STUDIES

J.P. Alexander[1], Sarah Hirsch[2], Kristen Mazzarella[2], and Tony Tucker[2]

[1] TurleGeek.com
[2] Mote Marine Laboratory, Sarasota, FL, USA

TagFinder is a computer program designed to facilitate queries of a previously uploaded sea turtle database or a selection thereof while in the field. Having portable access to a turtle tagging history in the field can be a crucial aid to tagging studies. A female's prior encounter history can determine whether a female is a viable candidate in a tracking study, or a good prospect for attachment of datalogger devices with a high probability of re-encounters of the same individual. In addition, TagFinder can aid searches for partial tag numbers in cases where only a partial tag number was readable and help minimize human error in reading and recording tags. These requirements were design specifications in creating a simple query tool as a software development project that could be field implemented in 2011. The software was not intended as a fully relational database project, since the project required only a text string search of a flat file representing a user-specified subset of a main database. The host portion of TagFinder leverages Microsoft ActiveSync to coordinate the transfer of sea turtle tagging history data from a parent database to a handheld device for use later on the beach during tagging studies. Using an HP iPAQ Pocket PC, a field worker enters a search query on selected database fields to review all of the matching sea turtle tag history records. As currently implemented, a user-specified set of columns of data can be searched, including a unique ID for the turtle, LFF, RFF, PIT, and a remarks field. Additionally, records can be filtered by encounter date. As a developmental project, the TagFinder application was derived from Mote Marine Laboratory's tagging database. However, many of these standard fields are shared by any tagging project. Thus, the application offers a starting framework for tagging projects elsewhere that may wish to adapt it, so long as a database was cross compatible into Microsoft Access, OpenOffice Base, or a SQL Server database. TagFinder runs on Windows Mobile 5.0 and other handheld devices that run Windows Mobile 5.0 should be able to run TagFinder. Future developments include: selection of query columns, selection of display columns, and possible coordination with other projects in the region. TagFinder is freely available for download and testing at www.turtlegeek.com.

METABOLIC WARMING IN HAWKSBILL TURTLE NESTS AT MONA ISLAND, PUERTO RICO

Karla Barrientos-Muñoz[1], Cristian Ramirez-Gallego[1], Carlos E. Diez[2], and Robert P. van Dam[1]

[1] Chelonia Inc, PO Box 9020708, San Juan, PR 00902-0708
[2] Programa de Especies Protegidas, Departamento de Recursos Naturales, PO Box 366147, San Juan, PR 00936

Metabolic activity of development during incubation raises nest temperature above that of the surrounding sand. During the 2009 and 2010 hawksbill nesting season at Mona Island, we simultaneously measured nest temperature and adjacent sand ambient temperature for ten nests per season. Calibrated Onset Waterpro temperature dataloggers were placed within hawksbill nests as they were being laid, paired with additional dataloggers at ~1m lateral distance from the nest dug into the sand at the same depth. The dataloggers recorded temperatures every hour and were retrieved after hatchling emergence from the nests. Incubation durations, nest size, nest depth, and overhanging vegetation were recorded for each nest. Nest metabolic heating was calculated by subtracting paired measurements of nearby sand temperature from nest temperature. Metabolic nest heating exhibited a typical profile of intense heating just prior to nest emergence. For the middle-third incubation periods, the critical time for sex determination, nest metabolic heating for 10 nests examined during 2009 averaged 1.13 degrees C (range 0.52 to 1.90 degrees C). Nest metabolic heating correlated slightly with nest size ($R2= 0.147$, nest size range 93 to 192 eggs, $n= 9$ nests). Vegetation type showed no correlation with nest metabolic heating, even though vegetation type is known to have an effect on absolute hawksbill nest temperatures on the beaches of Mona Island. Knowlegde of metabolic nest heating profiles are essential when attempting to relate ambient (sand or air) temperatures to conditions inside turtle nests, for example when trying to estimate sex ratios of emerging hatchlings in relation to pivotal temperatures. Ambient air and sand temperature profiles of Mona Island's nesting beaches are presented and, using the metabolic heating measured in this study, are related to the known pivotal temperature for this breeding population in order to generate estimates of sex ratios in hawksbill hatchlings produced throughout the year.

EFFECT OF RELOCATING NESTS OF *LEPIDOCHELYS OLIVACEA* IN HATCHERY ON THE INCUBATION TEMPERATURE AND SURVIVAL OF HATCHLINGS IN EL VALLE, CHOCÓ (COLOMBIA)

Karla Barrientos-Muñoz and Cristian Ramírez-Gallego

Colombian Sea Turtle, Medellín, Colombia

El Valle is considered the most important nesting beach in South America for *Lepidochelys olivacea*. In El Valle, the main threat is nest predation, reaching 100%. Therefore, we consider nest transfer an important alternative for protecting clutches. Being cognizant of the impacts that clutch manipulation may have, we evaluated the possible variables that might influence hatchlings survival (evaluated as emergence and hatching success) and incubation temperature. It is important to develop this work because it aims to identify threats and benefits of these transfers on the

reproductive ecology of the turtle, hatching success and survival of nests and how these variables can help to establish a conservation plan that benefits the species with the participation of local communities, who make a direct use of the resource and are the only ones who can ensure the conservation of *L. olivacea* in El Valle. During the 2008 (from August to December) nesting season, we documented several aspects of the colony of *Lepidochelys olivacea* from El Valle beach on the Colombian Pacific coast. In addition, we evaluated the results of a management program, which transferred and protected nests during this season, and compared them to previous years. The range of incubation temperatures was 26.9 °C C and 27.6°, with a mean of 27.3°C, yielding 65 days of incubation and the estimated hatching success rate based upon 25 of the 164 transfered nest was 77.6%. The results from the management program indicated that although the emergence success of the nests in high in comparison to others reported for sea turtles, the program's installations have probably produced skewed sex ratios, at least in the three years in which this has been evaluated.

GREEN TURTLE (*CHELONIA MYDAS*) NESTING ON ATOL DAS ROCAS, BRAZIL

Claudio Bellini[1], Armando J. B. Santos[2], and Paulo C. R. Barata[3]

[1] Projeto Tamar-ICMBio, Natal – RN, Brazil
[2] Fundação Pró-Tamar, Fernando de Noronha – PE, Brazil
[3] Fundação Oswaldo Cruz, Rio de Janeiro - RJ, Brazil

Five sea turtle species nest in Brazil: green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), loggerhead (*Caretta caretta*), hawksbill (*Eretmochelys imbricata*) and leatherback (*Dermochelys coriacea*). All of them nest on the mainland coast, but only green turtles nest on oceanic islands. Trindade Island in eastern Brazil is their main nesting site in the country; nesting also occurs in north-eastern Brazil on Atol das Rocas (Rocas Atoll), the second largest green turtle rookery in the country, and in the Fernando de Noronha Archipelago. Green turtle nesting on the mainland are sparse and occur in relatively small numbers. Atol das Rocas (3°51'50"S, 33°48'20"W), the single atoll in the South Atlantic, and a surrounding area of the sea are protected since 1979, when the Federal Marine Biological Reserve of Atol das Rocas was created. In 1989/1990 Projeto TAMAR-ICMBio, the Brazilian sea turtle conservation program, started monitoring green turtle nesting on Atol das Rocas, where about 1.5 km of nesting beaches are located. Here we present data concerning the nesting seasons between 1989/1990 and 2007/2008. In that period, two nesting seasons were not monitored (1997/1998 and 1998/1999), and five seasons (1989/1990, 1990/1991, 1991/1992, 1999/2000 and 2006/2007) were only partially temporally monitored. The other twelve seasons were entirely monitored. The main objectives of this study were: (1) to measure the annual number of green turtle nests on Atol das Rocas, taken as an index of the population size; (2) to obtain estimates of biological parameters regarding the nesting process. Data are presented on the annual number of nests during the study period, curved carapace length of nesting females, temporal distribution of nesting in each season, clutch frequency, internesting interval, remigration period, and, only for the seasons between 1992/1993 and 1996/1997, clutch size, hatching success and incubation period.

NESTING BEACH SELECTION OF LOGGERHEADS (*CARETTA CARETTA*) IN MAPUTALAND, SOUTH AFRICA

Wayne Brazier and Ronel Nel

Nelson Mandela Metropolitan University, Port Elizabeth, Eastern Cape, South Africa

Loggerheads, like other marine turtles, are philopatric returning to nest on the same stretch of beach from which they hatched. They migrate thousands of kilometres from their foraging grounds to these nesting beaches. In Maputaland, South Africa, there are clear high and low density nesting areas and over 80% of nesting loggerhead females return within 5 km of their previous nest site. If this is compared to the available 56km of nesting beach used by these loggerheads, then it is evident that these nest site selections are not random. Once in the general vicinity of the nesting beaches, another more precise cue is thought to be used for specific nesting beach selection. These more precise cues are the focus of this study. Morphodynamic features of the nesting beaches are relatively homogenous within the nesting range and therefore are not expected to be linked to nesting beach cues. A possible hypothesis investigated here include olfactory stimulus whereby the adult females use a scent emanating from the nesting beaches to select a nesting site. Nutrients and freshwater were measured in the groundwater at significant points along the nesting range. These nutrients will be carried in the groundwater to the surf where they may be used as selection cues. The use of conspecific communication in the form of Rathke's gland secretions was also investigated. Light measurements were also recorded within the nesting range to determine the effect of ambient light and artificial light on nesting numbers. Identifying the set of cues that are responsible for specific nesting beach selection is difficult due to the life history of marine turtles although uncovering this mechanism will contribute to conservation of nesting beaches as well as to this endangered species.

THE EFFECTS OF ARTIFICIAL INCUBATION ON OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) HATCHLINGS

Lucie S. Brown[1], Catherine E. Hart[2], and Annette C. Broderick[3]

[1] Centre for Ecology and Conservation, School of Biosciences, University of Exeter, Tremough Campus, Treliever Road, Penryn, Cornwall TR10 9EZ, UK
[2] Los Grupos Ecologistas de Nayarit A.C., Rincon de Guayabitos, Nayarit, Mexico
[3] Marine Turtle Research Group, Centre for Ecology and Conservation, School of Biosciences, University of Exeter, Tremough Campus, Treliever Road, Penryn, Cornwall TR10 9EZ, UK

Artificial incubation of sea turtle eggs has become an alternative method of conservation practice in a considerable proportion of sea turtle conservation projects along the Pacific coast of Mexico. This is due to the high levels of illegal poaching and predation of nests which prevents turtle conservation projects from leaving nests in-situ, or relocating eggs to a hatchery. The aim of this study was to compare the effects of different incubation methods on hatch and emergence success, and fitness of offspring from nests of olive ridley sea turtles (*Lepidochelys olivacea*). Incubation methods of relocated clutches were assessed at El Naranjo beach, Nayarit, Mexico, during August and September of the 2010 nesting season. Clutches were assigned to one of three incubation methods; hatchery (n=8), polystyrene (n=8) and plastic (n=8) containers. Hatchling fitness was assessed by measuring run speed and calculating condition index at emergence, and after 12 and 24 hours. We present data on the hatch and emergence success, and hatchling fitness of offspring produced from each of the incubation treatments and suggest management methods that would improve offspring production and fitness.

TOO COOL TO FAIL?*

Cathi L. Campbell[1], Thane Wibbels[2], Cynthia J. Lagueux[3], and William A. McCoy[3]

[1] Wildlife Conservation Society, Bronx, NY, USA
[2] University of Alabama at Birmingham, Birmingham, AL, USA
[3] Wildlife Conservation Society, Pearl Lagoon, RAAS, Nicaragua

Rising ambient temperatures due to climate change has raised concerns for reproductive viability on sea turtle nesting beaches. We have monitored beach temperatures for four hawksbill nesting seasons in the Pearl Cays, Nicaragua. We buried temperature loggers on several cays at typical hawksbill nesting sites, in the sand and in nests. Preliminary results showed relatively low beach sand temperatures, probably due to high rainfall, suggesting a predominately male biased sex ratio of hatchlings. A predominately male producing population has important implications for the Caribbean hawksbill metapopulation. We will present the final results and discuss the long-term implications for local and regional hawksbill populations.

SEA TURTLE NEST MANAGEMENT: EXAMINING THE USE OF RELOCATION AS A MANAGEMENT TOOL ON THREE SOUTH CAROLINA BEACHES, USA

Gretchen Coll[1], DuBose Griffin[2], Martin Jones[1], and Norman Levine[1]

[1] College of Charleston, Charleston, South Carolina, USA
[2] South Carolina Department of Natural Resources, Charleston, South Carolina, USA

In South Carolina, nest relocation is considered a management tool of last resort and is used to increase hatchling productivity in nests that if left in situ would wash away. This study examined the use of nest relocation on three South Carolina beaches: Edisto Beach State Park, Folly Beach and Fripp Island. Study objectives were 1) quantify the percent of nests relocated and the number of wash-overs on initial nest sites of relocated nests, in situ and relocated nests, 2) compare hatch and emergence success between in situ and relocated nests, 3) analyze the impact of wash-over events on hatch and emergence success, 4) determine whether decisions to relocate were warranted and 5) calculate potential costs and benefits of relocation. Data were collected by the Edisto Beach State Park, Folly Beach and Fripp Island nest protection projects. Data were collected during daily monitoring of initial nest sites of relocated nests, in situ and relocated nests for wash-over and washed away events. Nest counts and nest success parameters for South Carolina were extracted from the Sea Turtle Nest Monitoring System provided by Seaturtle.org. A number of initial sites ($n = 45$), in situ ($n = 15$) and relocated nests ($n = 21$) were impacted by tidal events. No significant differences were detected between in situ and relocated hatch ($p = 0.702$) or emergence success ($p = 0.944$) for project beaches combined. On Fripp Island, relocated nests ($n = 18$) had significantly higher hatch ($p = 0.004$) and emergence success ($p = 0.044$) than in situ nests ($n = 9$). There were no significant differences between in situ and relocated hatch and emergence success on Edisto Beach State Park or Folly Beach. Analysis of statewide data in 2009 found nests with four or more wash-overs had significantly lower hatch success ($p = 0.000$) than nests with zero wash-overs. Therefore, four or more wash-overs were used to evaluate nest management outcomes for project beaches. A majority of the nests ($n = 84$) were correctly managed with a small percentage unnecessarily relocated ($n = 14$) while others should have been relocated ($n = 12$). Analysis of the cost of relocation found 1715 eggs were unnecessarily relocated and an estimated 780 eggs should have been relocated. Analysis of the benefit of relocation found 2715 eggs hatched from relocated nests with four or more wash-overs at initial sites and/or initial site washed away and 2356 hatchlings emerged from relocated nests with four or more wash-overs at initial sites and/or initial site washed away. This study based on the cost/benefit analysis suggests that the use of relocation, when employed correctly, is still an important nest management tool, especially for beaches that suffer from severe erosion and tidal inundation.

EFFECT OF MULTIPLE PATERNITY ON HATCHLING PERFORMANCE OF *CHELONIA MYDAS* IN MARUATA, MICHOACAN, MEXICO*

Libny Ingrid Lara-De La Cruz[1], Ken Oyama[1], and Omar Chassin-Noria[2]

[1] Centro de Investigaciones en Ecosistemas (CIEco), Universidad Nacional Autónoma de México (UNAM)
[2] Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo

A great variation in the frequency of multiple paternity has been detected between and within species of marine turtles. Several hypotheses have been postulated to explain the causes of this variation. However, the effects of multiple paternity on the performance of turtle hatchlings have been poorly explored. The objectives of this study were: (i) to analyze the frequency of multiple paternity; (ii) to determine the fertilization order within the reproductive tract; and (iii) to estimate the performance of hatchlings (i.e., shell symmetry, weight and vigor) associated to turtles with different frequency of multiple paternity. The oviposition order of six nest was conserved until the day of its emergence. We found that the analyzed clutches were fertilized by three to five males without a specific fertilization order within the reproductive tract. This evidence suggests that the sperm used for the fertilization of eggs is a mixture of seminal fluids present inside the genital tract of the female. It was found that there were not significant differences between weights, length and vigor or asymmetry of different male hatchlings, the differences were significant just for asymmetry values, concluding that there is no evidence of multiple paternity effects on the performance of hatchlings.

Acknowledgements: we would like to thank International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and International Sea Turtle Symposium for the donations to support our participation in the meeting in San Diego, California, USA.

GEOMETRIC MORPHOMETRICS, SYMMETRY AND SUPERNUMERARY SCUTES IN THE GREEN TURTLE (*CHELONIA MYDAS*) IN MICHOACÁN, MÉXICO

Libny Ingrid Lara-De La Cruz[1], Luis Felipe Mendoza-Cuenca[2], Ken Oyama[1], and Omar Chassin-Noria[2]

[1] Centro de Investigaciones en Ecosistemas (CIEco), Universidad Nacional Autónoma de México (UNAM)
[2] Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo

One of the most important roles of turtle's shells is protection; its form and symmetry could influence individual fitness. A typical carapatial scutation in *Chelonia mydas* consists of a median longitudinal series of five unpaired elements (vertebral scutes), flanked on each side by four series of bilaterally paired scutes (costal scutes) and bordered exteriorly by another eleven series of bilaterally paired scutes (marginal scutes). Situated anteriorly between the first pair of marginals is a nuchal. Situated posteriorly between the last pair of marginals is a pair of supracaudals. The objectives of our study were: to identify turtles with supernumerary shell scutes, to compare variation in carapatial scutation between adults and hatchlings and to conduct a geometric morphometrics and symmetry analysis to determine if supernumeray shell scutes affect shell shape. We counted the shell scutes of 645 hatchlings from 14 nests and 101 adult females from Maruata, Michoacan, Mexico. Forty percent of the hatchlings and 42.5% of the adult females had supernumerary scutes, mainly at the vertebral ones. Geometric morphometrics and asymmetry analyses showed significant differences in shell form and asymmetry between the hatchlings of different nests. Nevertheless the hatchlings with supernumerary scutes were not significantly different from those with normal scutes, in form or in asymmetry. Our results suggest that the presence of supernumerary shell scutes does not affect the shell shape.
Acknowledgements: we would like to thank International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and International Sea Turtle Symposium for the donations to support our participation in the meeting in San Diego, California, USA.

PHENOLOGY OF GREEN TURTLE NESTING SEASON: A REGIONAL ANALYSIS IN THE SOUTH-WEST OF INDIAN OCEAN (SWIO)*

Mayeul Dalleau[1], Simon Benhamou[2], Stéphane Ciccione[3], Gilles Lajoie[4], and Jérôme Bourjea[5]

[1] Université de la Réunion, 15 avenue René Cassin, BP7151 97715 Saint-Denis Cedex9, La Réunion, France
[2] Cnrs - Cefe, 1919 route de Mende 34293 Montpellier Cedex 5, France
[3] Kélonia, 46 rue du Général de Gaulle 97436 Saint-Leu, La Réunion, France
[4] UMR Espace-Dev - Université de la Réunion, 15 avenue René Cassin, BP7151 97715 Saint-Denis Cedex9, La Réunion, France
[5] Ifremer, rue Jean Bertho BP 60 97 822 Le Port Cedex, La Réunion, France

Worldwide populations of sea turtles exhibit various reproductive seasonality patterns: year-round nesting with peak, year round nesting without peak, discontinuous seasonal nesting. While studies suggest that sea turtles have evolved to nest when sand temperature is suitable for egg incubation, no analyses have been made to date in our region. In the South West of Indian Ocean (SWIO), 25 years of daily nesting tracks counts have generated an incredible amount of data providing invaluable information. In addition of being a surrogate of population trend, nesting track counts can contribute to knowledge on turtles nesting phenology. In our case, data have been collected on strategically located islands showing year-round nesting with peak for green turtles (*Chelonia mydas*): Europa in the south of the Mozambique channel, Glorieuses and Mohéli in the north of the channel, Juan de Nova intermediately located in the

middle of the channel and Tromelin outside the channel. Except for the Comorian island of Mohéli, these islands belong to the french “Eparses Islands." Despite being very remote one from the other, Europa and Tromelin both present a greater proportion of nesting females in austral summer, between December and January. On the other side, islands of the northern part of the channel, Glorieuses and Mohéli, show a peak in May-June. Other northern islands such as Mayotte (France) and Aldabra (Seychelles) are also known to show quite similar pattern. In Juan de Nova, despite scarce data and few nesting individuals, the peak also seems to appear in May-June like northern islands but dislike southern Europa. While the temporal patterns of the nesting peaks in these islands may at first sight appear spatially unconnected, we show that there is a clear relation between nesting phenology and environmental variables, particularly temperature (air, sand and sea surface). Our results suggest that ocean and climate dynamics in the region clearly influence the phenology of the nesting peak. Such an hypothesis is consistent with other studies, although the originality of our work rely on the fact that it has been conducted on multiple sites at a broad regional scale. The existence of long term time series and the growing availability of environmental and oceanographic data will allow more studies of this kind. Understanding the biological mechanisms driving the time of the nesting peak is a challenge of great importance in the context of global warming. The capacity of sea turtles to adjust the timing of nesting, through plasticity and/or adaptability, is a key of their response to climate change.

SEA TURTLE CONSERVATION PROGRAM AT CHAGAR HUTANG BEACH, REDANG ISLAND, MALAYSIA

Lionel H. Sebastian Daraup, Juanita Joseph, and Liew H. Chark

Sea Turtle Research Unit, Institute of Oceanography, University Malaysia Terengganu, Kuala Terengganu, Malaysia

Chagar Hutang (5°49' N, 103°0' E) a 350 m beach at the most northern tip of Redang Island is one of the important nesting grounds for green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles in Malaysia. Conservation of sea turtles on this beach started since 1993 by the Sea Turtle Research Unit (SEATRU) of Universiti Malaysia Terengganu. In the early years, all nests incubated at Chagar Hutang were purchased from licensed egg collectors. A total of USD160, 000 were spent (1993-2004) in the purchase alone. Finally, in 2005 the Terengganu Government decided to declare this beach as a turtle sanctuary, hence giving SEATRU full authority on the nesting beach. Monitoring of sea turtles on the beach was conducted the whole year with the help of volunteers. This study presents the overall sea turtle nesting at Chagar Hutang for 2009. A total of 54 recruit green turtles and 4 recruit hawksbill turtles were tagged throughout the nesting season. Female turtles were recorded making 545 visits at night between 5th January and 4th November 2009, which resulted in 386 green turtle nests and 20 hawksbill turtle nests. The nesting season of green turtles in Redang Island occurs from January to November 2009 with peaks in July and August period. Hawksbill turtle only came to nest from January to September 2009, with no significant peak nesting month. The mean incubation period for green and hawksbill turtles were 54 and 53 days respectively. The mean value of CCL for the nesting green turtle was 99 cm (n=388, ±4.40) with CCW of 87 cm (n=388, ±3.81). The nesting hawksbills averaged 86 cm (n=20, ±1.52) in CCL and 75 cm (n=20, ±1.95) in CCW. Green turtles produced smaller clutch sizes and shorter inter-nesting interval compared to the hawksbills. A total of ten egg clutches were gone due to predation from monitor lizard. The range of remigration intervals observed for the 28 re-migrant green turtles were one to four years. The highest concentration for nest site favoured was at sector 30 and 31. Out of an estimated total of 35,512 eggs laid on the beach, 4458 eggs were predated by army ants, ghost crab and larvae of scuttle flies. Microfungi were found on the exterior of unhatched eggs in sea turtle nests at Chagar Hutang. Fortuitous egg mortality provided a nutrient source for common soil mycobiota (*Fusarium* sp. and *Aspergillus* sp.) and served as a focus for the progressive spread of fungal hyphae to adjacent viable eggs. The overall average hatching success and emergence success for both species were 72% and 64% respectively. Besides carrying out conservation-oriented research on sea turtles, SEATRU conducts many turtle outreach programs at tertiary levels, school children, and the public at large which indirectly help in sea turtle conservation.

ASSESSING HAWKSBILL HATCH SUCCESS ON LONG ISLAND, ANTIGUA, WEST INDIES*

Mark Ditmer[1] and Seth Stapleton[2]

[1] Conservation Biology Graduate Program, University of Minnesota, St. Paul, Minnesota, USA
[2] Jumby Bay Hawksbill Project, Long Island, Antigua, West Indies AND Conservation Biology Graduate Program, University of Minnesota, St. Paul, Minnesota, USA

Current understanding of the factors which influence hatch success of hawksbill sea turtles (*Eretmochelys imbricata*) is disparate and based on relatively short-term studies. With global populations of hawksbills at critically low levels, evaluating the parameters that may affect hatch success and determining management approaches to improve hatch rates are paramount to long-term species survival and recovery. Here, we use data collected by the Jumby Bay Hawksbill Project (JBHP) during the 2003 – 2008 research seasons to investigate hatch success. The JBHP has used saturation tagging protocols since 1987 to research the reproductive and nesting ecology of a colony of hawksbills on Long Island, Antigua, West Indies. Habitat data, which reflect the island's varied beach habitats, are collected at egg deposition. Following emergence, nest contents are exhumed and categorized to evaluate hatch rates. We summarize and analyze hatch success using a mixed model analysis, employing AICc for model selection. We incorporate a suite of environmental covariates, including distance to vegetation edge, distance to high water line, sand grain size, percentage of organic material in the nesting substrate, and vegetative cover. We consider several additional variables, such as individual nesting experience, number of nests previously deposited by that individual within season, and deposition date. Preliminary results suggest that percent organic content, sand grain size, and location on the beach are important determinants of hatch success. We review our findings in the context of previous studies, discuss on-going research including more rigorous sand sampling, and present recommendations to create beaches more conducive to successful hawksbill nesting.

INFLUENCE OF LOGGERHEAD EGG AGGREGATION ON SURVIVAL: WHY DO SINGLE EGGS BURIED INTO NATURAL SAND DIE WITHIN A FEW DAYS

Jara Domínguez[1], Adolfo Marco[1], Rosa García-Cerdá[2], Elena Abella[1], Sara Vieira[3], and Luis Felipe López-Jurado[2]

[1] Estación Biológica de Doñana, CSIC, Seville, Spain
[2] Department of Biology, Universidad de Las Palmas de Gran Canaria, Spain
[3] Faculdade de Ciências e Tecnologia, Universidade do Algarve, Portugal

The incubation is an essential life period for oviparous species that very often experiences a high mortality. In some reptile species the number of eggs that develop together in the incubation chamber affects survival and hatchling phenotype. Sea turtle eggs develop in underground locations on sandy beaches in large masses that usually have more than 80 eggs. Natural egg mortality seems to vary among species and for the sensitive leatherbacks, external eggs seems to survive better than internal ones within the nest. In the present study we have evaluated whether aggregation have a beneficial effect on loggerhead egg incubation on sandy substrates as well as the spatial distribution of dead eggs within the nest for this species. In Cape Verde, nest incubation monitoring during several seasons (2008-2010) and over several hundreds of loggerhead nests either protected from predators on the beach or relocated to hatcheries show a typical mortality around 75-80 %. Clutch size for this population averages 85 eggs. However when we experimentally incubated single eggs (N=24) on incubators buried in wet sand (29.9 ºC), mortality was total. Most eggs died during the first days of incubation. Single eggs incubated in wet vermiculite in the same incubators and at the same temperature had a mean survival of around 95 %. Spherical masses of 13-14eggs (N=4) incubated on the incubators inside natural sand in the laboratory also suffered a high mortality that averaged 82 %. Survivors were always located in the center or the bottom of the small egg masses. Death eggs had embryos at different developmental stages and 22 % of them were almost fully developed. To evaluate in the field whether mortality also depends on egg position within the nest we analyzed 27 nests relocated to a hatchery immediately after laying. At day 45 of incubation the nests were opened and all eggs were individually extracted and observed. The position within the nest, and different

external characteristics that indicates the viability of embryos were recorded. Then, eggs were reburied into the nest chamber and continued their successful incubation. Egg survival averaged 90 % but the distribution of dead eggs was no homogeneous within the nests ($P<0.01$). Only 3 % of eggs located in the center of the nest were dead. However, mortality was of 11 % of eggs located on the sides or the bottom of the nest and 15 % of eggs located on the top of the nest. To increase the volume/surface ratio of the relocated nests may improve their hatching success. Large clutch size on sea turtles is related to their explosive reproductive strategy and the large adult/hatchling size ratio. Large egg masses also are important to facilitate the emergence of hatchlings from the nest to the beach surface. Additionally it seems that large egg aggregations are necessary for a successful incubation on nesting beaches. We discuss possible causes to explain why eggs that had most of their surface with physical contact with the substrate died.

NESTING MONITORING OF THE HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) IN THE TERENDAK ARMY CAMP ROOKERY IN THE STATE OF MALACCA, MALAYSIA

Grace Duraisingham and Arvind Devadasan

WWF-Malaysia Hawksbill Turtle Conservation Project, Malacca, Malaysia

The coastal state of Malacca in Malaysia has the highest record of hawksbill turtle nesting on Peninsular Malaysia, second only to the Sabah Turtle Islands which has the highest recorded nesting in South East Asia. Nesting records from the year 2000 – 2009 show an average of 17.6% nests in the state of Malacca are laid on the Terendak Army Camp Rookery. In 2008, WWF-Malaysia started a full-time nesting monitoring program, working together with the Department of Fisheries and local licensed egg collectors to patrol this approximately 2km stretch of beach. Active nightly beach patrols start at 2030hrs to 0500hrs at the Terendak Army Camp beach (2º16’59.25”N 102º05’33.99”E) during the peak nesting months of May through August. Nesting female hawksbill turtles encountered are tagged with inconel tags that have serial numbers beginning with the initials MY or IF, on both the fore flippers between the first and second scale. Measurements of curved carapace length (CCL) and curved carapace width (CCW) are also recorded for each female using a tailor’s tape measure. All egg clutches are translocated to a hatchery on the adjacent beach of Padang Kemunting, approximately 4km away by land. From 2007 to 2010, WWF-Malaysia tagged a total of 42 individual hawksbill turtles nesting on the Terendak Army Camp rookery. The average recorded CCL and CCW are 76.8cm and 68.7cm respectively. Each nesting female laid an average of 118 eggs. It is observed that with the presence of the beach patrol team who are occasionally accompanied by armed military guards from the beach guard posts, poaching activities has dropped significantly. However, all egg clutches are still translocated into a hatchery as there is no round the clock protection for the egg clutches laid and they will still fall prey to opportunistic poachers who patrol the beaches during daylight hours when there are no licensed egg collectors or beach patrol teams present. The Terendak Army Camp rookery has been identified as a potential in situ nesting site for the hawksbill turtles of Malacca as the nesting beach is protected from most human beach activity and also coastal development in lieu of its location bordering a military base camp. The next step for protection of this pivotal hawksbill nesting beach would be to work together with the army camp officials to provide 24 hour protection along the whole stretch of nesting beach making it viable for a pilot in situ nesting program to be implemented.

THE EIGHTH MARINE TURTLE?*

Carla C. Eisemberg[1], Mark Rose[2], and Arthur Georges[1]

[1] Institute for Applied Ecology, University of Canberra, Canberra, ACT, Australia
[2] Fauna & Flora International, Cambridge, United Kingdom

The pig-nosed turtle (*Carettochelys insculpta*) is the sole survival of a once widespread family (Carettochelyidae). Females of this species are found nesting in many coastal areas of the Gulf Province, Papua New Guinea, including the mouth of the Kikori River, where we studied a population of *C. insculpta* from September of 2007 to March of 2009. This region is a very dynamic system of coastal beaches and sand islands created by wind and wave action. The pig-nosed turtle nests in narrow white sand areas within the central parts of small coastal islands or the upper parts of long

beaches. These islands and sandbanks are protected from most tides and are usually adjacent to mangroves dominated by *Sonneratia ssp* and *Nypa fructicans*, which is the main item of the pig-nosed turtle diet. Both males and females were observed feeding in these areas. Nesting started on the coast at the beginning of October and was over by the end of December (From 11-Oct to 14-Dec in 2007-08 and from 09-Oct to 24-Dec in 2008-09). The pig-nosed turtle has morphological characteristics which make them capable of dealing with coastal environments. Its limbs are paddle-shaped, but still possess movable digits similar to the oldest extinct chelonioid (*Santanachelys gaffneyi*). However, permanent use of coastal areas, where salinity is close to 100% of sea water, would only be possible with very complex specializations, such as salt glands. Since salt glands are probably absent in *C. insculpta*, incursions into the open sea are unlikely. On the Kikori coast, females and hatchlings face a salinity that ranged from 7% to 50% of ocean water. Sufficient rain falls during the dry season and sufficient residual flows remain from the wet seasons to dilute salinities in the estuaries. Females nesting on the coast also avoid the extremely high nesting predation rates that occur from non-human predators in riverine areas. Humans were the only predator responsible for nest mortality in Turuvio Island while monitor lizards (*Varanus indicus*) predated 65% (n = 100) of the nests in riverine areas. Although the pig-nosed turtle cannot be considered *sensu stricto* a marine turtle, the study of its ecology can help to understand the evolution of marine turtles since it may represent a stage of gradual evolution from freshwater to the sea. On the other hand, the similarities they share also make *C. insculpta* vulnerable to the same treats that marine turtles face such as harvesting of nests and adults. Nest survival was exceptionally low on the nesting beaches of Turuvio Island during the nesting seasons of 2007-08 (3.3% of 120 nests were not harvested) and 2008-09 (2.9% of 104 nests were not harvested). Based on matched village and market surveys, trends in nesting female size and assessment of levels of harvest, we estimate the level a decline in this population to be higher than 50% since 1981.

RE-ASSESSMENT OF LEATHERBACK MATING STRATEGIES IN CARIBBEAN COSTA RICA

Christine Figgener[1], Andrey MacCarthy[2], Didiher Chacón[3], and Heike Feldhaar[4]

[1] Department of Behavioural Physiology and Sociobiology, Biocenter of the University of Würzburg, Am Hubland, D-97074 Würzburg, Germany
[2] ISV Leatherback and Pacific Green Sea Turtle Research Project Ostional, Apdo. 2864-3000, Heredia, Costa Rica
[3] Wider Caribbean Sea Turtle Conservation Network (WIDECAST) Costa Rica, Apdo. 2164-3000, San Josè, Costa Rica
[4] Department of Behavioural Physiology, University of Osnabrück, Barbarastraße 11, D-49076 Osnabrück, Germany

Data on courtship, mating, and mating strategies are scarce for Leatherback sea turtles (*Dermochelys coriacea*). All studies involving paternity assessments date back more than 10 years, were limited by small sample sizes, and detected very low rates of multiple paternity among females. Currently, the Leatherback rookeries in the Caribbean are considered stable. Now that the population size is no longer decreasing, we attempted to assess whether previously found single paternities in Leatherback turtles were due to small population sizes (allee effect) or based on a monogamous mating system. We used microsatellite analyses to examine paternal lineages in 35 nests laid by 18 different Leatherback females of the nesting-population in the Gandoca-Manzanillo Wildlife Refuge (REGAMA). Per nest, 10-50% of hatchlings were sampled (mean n =15), and genotyped at five microsatellite loci in order to reconstruct genotypes of the families (females with their offspring) and presumptive fathers. In 22% (n=4) of the families extra paternal lineages were detected, which were assumed to have derived from multiple mating. Families varied in the number of putative fathers within and between clutches. The absolute mating frequency of multiply mated females (MMF), was for MMF-1 2.0 and her effective mating frequency was 1.75; for MMF-2 it was 3.0 and 1.63; for MMF-3 it was 3.0 and 1.93; and for MMF-4 it was 3.0 and 2.41. The mean absolute mating frequency among all sampled females was 1.39. Consecutive clutches of three of the four multiply mated females differed with respect to the patrilines detected. Thus a “new” father was detected in later clutches that was not present in early clutches. This finding suggests that females may mate between nesting events. Three out of the four females showing multiple paternity of clutches were neophytes (first time nesters). The nesting-population in Gandoca showed lower levels of multiple paternity than found in other sea turtle species, but a higher rate of multiple paternity than in previous studies on Leatherback turtles. In conclusion, this suggests that Leatherbacks have a polygamous mating system as observed in most other sea turtle species. My participation at the ISTS is possible thanks to the support of the Leatherback Trust

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

TRENDS IN TURTLE NESTING AT WRECK ROCK, QUEENSLAND, AUSTRALIA 1977-2009

Jaylene B. Flint, Neville C. McLachlan, Bevlyn M. McLachlan, and Benjamin N. McLachlan

Wreck Rock Turtle Monitoring Project, Buderim, Queensland, Australia

Wreck Rock Beach is one of the established long term index beaches for monitoring marine turtle nesting in eastern Australia. Wreck Rock Beach and adjacent Rules Beach is the primary breeding site for the endangered leatherback turtle, *Dermochelys coriacea*, in eastern Australia and Wreck Rock Beach is one of the top five breeding sites for the endangered loggerhead, *Caretta caretta*, for eastern Australia. The beach also supports nesting by a small number of flatback turtles, *Natator depressus*, and green turtles, *Chelonia mydas*. Marine turtle nest monitoring began at this site in 1969 and was formalized in 1977 as part of the Queensland Turtle Conservation Project of the now Queensland Department of Environment and Resource Management (DERM). Since 1996, annual monitoring has been the responsibility of the volunteer group Wreck Rock Turtle Monitoring Project who provide morphometric and biological nesting data to DERM using standardised protocols. Nests are monitored nightly between December and February. From 1969 to 1995, an average of 0-3 leatherback turtle nestings were recorded each year in southern Queensland; however since 1995 no confirmed leatherback nesting has been recorded in this area or in any other site in Australia. The last known nesting of this species occurred at Wreck Rock. The nesting population of loggerhead turtles at Wreck Rock Beach declined from 170 recorded nestings in 1977 down to as low as 30 nestings a year between the late 1990's and early 2000's. Since 2002, there is some evidence that the decline has stabilized and some increase in number of annual nestings is occurring. Reasons for the decline in leatherback turtle nesting sightings in the temperate regions of Australia are unknown. By contrast, the decline in loggerhead turtle nestings each year is speculated to be due to the high levels of fox predation on *C. caretta* clutches recorded in southern Queensland between the late 1960s until the mid 1980s. With the implementation of fox control measures, there have been variable but generally low levels of continuing loss of clutches from fox predation. However, with a predicted 30 year life-cycle phase from hatchling to breeding adult, it may still be another 5 to 10 years before any signs of recovery due to the cessation of this impact are seen. It is only then other impacts such as the minor dog/dingo and varanid predation rate, or the currently unmeasured effects of disease and habitat change may be assessed.

THERMAL DETERMINANTS OF NEST SITE SELECTION IN LOGGERHEAD TURTLES, *CARETTA CARETTA*, AT CASEY KEY, FLORIDA

Lindsey N. Flynn[1], Tony Tucker[2], Edward Van Vleet[1], and Deby Cassill[1]

[1] University of South Florida, St. Petersburg, Florida, USA
[2] Mote Marine Laboratory, Sarasota, Florida, USA

Sea turtle conservation is historically focused on nesting beaches. The nest position at a beach affects embryo incubation period, embryo development and survivorship, hatchling sex ratios, hatching success, and parental fitness. Female decisions about nest site selection contribute conditions that impinge on nest fates and hatching success. Loggerhead turtles live for decades at sea before beginning reproductive migrations. Yet multiple times during a nesting season, females emerge briefly into a terrestrial realm to select nest sites. What are reliable mechanisms a female can employ while operating temporarily in an alien terrestrial environment? Since females will never know outcomes of terrestrial incubation, such cues need not be reliable proxies about anything more than the immediate nesting episode. The key question becomes a search for functional terrestrial cues that a female can sense while briefly outside the marine habitat. We evaluated beach characteristics in relation to nest site selection by loggerhead turtles at a non-nourished beach of Casey Key, Florida from May to August in the 2008 and 2009 seasons. We recorded the presence or absence of rain, wind, clouds, sand coarseness, and sand wetness. Thermal data were collected with both a laser thermometer and thermoprobe thermometer. Thermal beach profile data were obtained from the water, waterline,

beach sand, body pit, nest chamber, eggs, and gular skin of nesting females for measurements along and 1 m adjacent to the actual crawl track. Beach slope was determined with an angle locator. No differences were found in comparisons of laser and thermocouple thermal data. Hence, laser thermal data was used in all statistical analyses. Beach slope was minimal and had no effect on beach thermal profiles or nest site selection, which was contrary to earlier findings reported from Florida's Atlantic coast where slope was significantly steeper. Rain and wind did not significantly affect beach temperatures or nest site selection, but cloud cover did affect beach temperatures and therefore may influence nesting behavior. There was a significant thermal difference between wet and dry sand, dry sand and shell debris, and between the water and several locations along the width of the beach. While the temperature of turtle eggs was significantly different from the body pit, nest chamber and gular skin of the adult turtle, the latter three thermal measurements were not significantly different from one another. The findings suggest that female loggerheads may be matching a sand temperature similar to the gular skin while selecting a nest site location. Loggerheads are sometimes described as "sand nuzzling" during the beach ascent. Could nuzzling be a thermal discrimination phase by females that are assessing different beach characteristics? If so, such behavior might produce differences in nest site selection. This study received a student travel grant enabled by donations from the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service. Travel and presentation support were also enabled by the International Sea Turtle Symposium.

MULTIPLE PATERNITY IN KEMP'S RIDLEY SEA TURTLES ON SOUTH PADRE ISLAND, TEXAS*

Anna Frankel and Dean Williams

Texas Christian University, Fort Worth, Texas, USA

Despite extensive protection of the Kemp's ridley sea turtle, *Lepidochelys kempii*, little is known about the genetic mating system, especially in the population that nests along the Texas coastline. Although the factors affecting the levels of multiple paternity in sea turtles are not well understood, Jensen *et al*. (2006) found a positive relationship between the incidence of multiple paternity and the estimated population size of rookeries, especially for the genus *Lepidochelys*. Jensen *et al*. (2006) hypothesize that large aggregations of females, such as those that congregate offshore before arribada events, result in a "mating frenzy" with subsequent higher levels of multiple paternity. In a study of the olive ridley, Jensen *et al*. (2006) found that 30% of nests at a solitary nesting rookery exhibited multiple paternity, whereas 92% of nests at an arribada nesting rookery exhibited multiple paternity. The only study to date of multiple paternity in the Kemp's ridley, in the high density Rancho Nuevo rookery, estimated that approximately 81% of nests were multiply sired (Kichler *et al*. 1999, Wang 2004). If the incidence of multiple paternity is positively related to nesting female density, as suggested by previous studies, then multiple paternity in Kemp's ridley should be lower on a low density nesting beach on South Padre Island, Texas (SPI) than in the much larger nesting population of Rancho Nuevo, Mexico. We tested this hypothesis by genotyping tissue samples from dead hatchlings and embryos to estimate levels of multiple paternity in Kemp's ridley nests on SPI. During the 2010 nesting season, we collected 156 hatchling tissue samples from 25 nests from approximately 22 females (out of a total of 32 nests and a maximum of 29 females). Each sample was genotyped at 14 microsatellite loci. Models generated by Kichler *et al*. (1999) suggest that the minimum number of samples required to detect multiple paternity is three hatchlings per nest. Preliminary results using full sibship reconstruction as implemented in COLONY indicated that 46% of nests with three or more samples (7 of 15) exhibited multiple paternity. These data suggest that the incidence of multiple paternity at this nesting beach is lower than the higher density nesting colony in Mexico, consistent with the female density hypothesis proposed by Jensen *et al*. (2006). These results will be compared to other data sets to further understand how variation in the incidence of multiple paternity varies among sea turtle species and with differences in population densities.

ANALYSIS OF NEST TEMPERATURES AND FUTURE GLOBAL WARMING EFFECTS ON TWO COASTS OF MEXICO*

Nick Furst[1], Allison Baxter[1], Armando Lorences Camargo[2], Carla Cristina Sanchez Salazar[3], and Katherine Comer Santos[1]

[1] The Science Exchange, San Diego State University, San Diego, CA, USA
[2] Centro Ecológico Akumal (CEA), Akumal, Quintana Roo, México
[3] Association for the Protection of the Environment and the Marine Turtle in Southern Baja (ASUPMATOMA), Cabo San Lucas, Baja California Sur, Mexico

Are sea turtle nests in danger of "baking" in the sand due to global warming? Incubation studies have found the lethal nest temperature to be around 34C. Already there are reports worldwide of sea turtle nests reaching lethal limits and the Intergovernmental Panel on Climate Change predicts an increase of 1.4-5.7 C in earth's air temperatures by the year 2100. Two interns enrolled in The Science Exchange (TSE) program measured sand temperatures at two important nesting beaches in Mexico during July-August 2010 to determine if they were reaching lethal limits. A second goal was to test if sand temperatures were significantly correlated to air temperatures and/or other weather data in order to monitor swings in nest temperatures without using expensive equipment at every in situ nest. We also wanted to predict the effects of global warming on future sand temperatures. The site at San Cristobal beach in Baja California Sur, México represents the northern-most region where olive ridley turtles (*Lepidochelys olivacea*) nest in the Pacific and is monitored by the ASUPMATOMA conservation organization. On the other side of Mexico at Akumal, Quintana Roo, the non-profit group CEA monitors nesting loggerheads (*Caretta caretta*), greens (*Chelonia mydas*), and hawksbills (*Eretmochelys imbricata*). Data loggers were placed at popular in situ nest locations and the hatchery outside the nest cavities. Weather variables were measured from inexpensive Taylor thermometer/hygrometers and from nearby weather stations (www.wunderground.com). Results from both sites indicate that the sand did not reach lethal temperatures during the study period even if you account for metabolic heating (1.7 C). Akumal's mean sand temperature 28.87°C, ±0.55 and San Cristobal's was 28.3 C, ±1.8. Using Pearsons correlations, both interns found that the minimum air temperature was consistently correlated with maximum sand temperatures, although explaining only about two-thirds of the variation (R=.68 at Akumal and .64 at San Cristobal; p*et al*. (2007), we extrapolated with modeled air temperatures to the year 2100, and found that sand temperatures at both sites could reach lethal limits. Conservation recommendations include vigilant monitoring of nest temperatures when night-time temperatures increase. If nest temperatures follow suite as we found in our study, some managers recommend cooling nest temperatures with shade structures or sprinklers. Because of current threats in Mexico such as poaching and habitat degradation, as well future global warming threats, the continued presence of these two conservation groups is critical.

EVALUATING STEROID HORMONE DATA IN ASSOCIATION WITH REPRODUCTIVE PARAMETERS IN A POPULATION OF ENDANGERED LEATHERBACK SEA TURTLES AND THE APPLICATION TO CONSERVATION AND MANAGEMENT*

Jeanne A. Garner[1], Tomo Eguchi[2], Duncan MacKenzie[3], and Scott Jacques[4]

[1] WIMARCS, St. Croix USVI; Texas A&M University, College Station, TX
[2] NOAA/SWFSC, La Jolla, CA
[3] Texas A&M University, College Station, TX
[4] TVMDL, College Station, TX

Although basic biology is similar among the seven species of sea turtle, as well as among different populations of the endangered leatherback sea turtle, each population exhibits unique migration routes, foraging grounds, and nesting biology. The basis for the observed discrepancies in reproductive biology within a particular species has yet to be determined, but is likely related to environmental factors, variation in nutrient availability of the respective foraging grounds (Wallace *et al*. 2006), and variation in endocrine regulation of nesting behaviors and physiology. Rostal *et al*., 2001 conducted the first study of reproductive endocrinology in leatherbacks, correlating steroid hormone trends with

nesting chronology in a Pacific population. This study confirmed that leatherbacks exhibit similar hormone trends to the hard shelled sea turtles with regard to estrogen and testosterone. Therefore, it is suggested that maternal reproductive steroid measurements may provide a powerful tool for answering reproductive questions in leatherbacks, as previously observed in other species. This study has yet to be repeated with additional populations to verify results, or to discern differences that may occur among populations which exhibit different nesting behaviors, size classes, average remigration intervals, or productivity. Variations in steroid hormones may account for the unique differences observed between Pacific and Atlantic turtles. Therefore, endocrine data for an Atlantic population is invaluable if comparisons are to be made. Analysis in Atlantic turtles will serve to expand our knowledge of leatherbacks as a whole, and provide insights into their unique reproductive physiology. A well-studied population of Atlantic leatherbacks (Sandy Point, St. Croix), provided the opportunity to further validate Rostal *et al*.'s (2001) findings, as well as investigate the unique reproductive parameters observed among leatherback populations. Blood samples were obtained for analysis of testosterone, estrogen, and progesterone. A total of 423 samples were collected from 113 turtles in 2005, with 250 samples collected from 88 turtles in 2006. All individuals were sampled each time a clutch was successfully deposited, and the samples were subsequently centrifuged, frozen, and stored for analysis. Similar levels of testosterone were observed in both Pacific and Atlantic leatherbacks. Levels of estrogen were significantly lower in Atlantic leatherbacks. All hormones were highest with deposition of the first clutch, and declined with each consecutive clutch laid. Progesterone decreased significantly with nesting chronology in the Atlantic but not the Pacific population. Estrogen levels varied significantly among neophytes and remigrants. Results suggest that correlating hormone levels with animal size and age may prove a valid method of distinguishing neophyte from remigrant turtles, as well as help identify the physiological basis for the observed difference in nest production between these classes. Any correlation between hormone levels, remigration interval, and reproductive age will be investigated. Relationships among hormone levels and clutch size, clutch number, and hatch success will also be investigated to increase our understanding of physiological factors that may impact hatchling production. Observed changes in hormone levels and significant reproductive parameters will be utilized to develop a predictive reproductive model for Atlantic leatherbacks. The model and associated management implications will be discussed.

TEMPERATURE MONITORING IN OLIVE RIDLEY NESTS (*LEPIDOCHELYS OLIVACEA*) IN DRAKE BAY, COSTA RICA: A USEFUL TOOL FOR HATCHERY MANAGEMENT

Daniel Gonzalez-Paredes[1] and David Melero-Duro[2]

[1] Scripps Institution of Oceanography, University of California San Diego, La Jolla, California, USA
[2] Corcovado Foundation, San José, Costa Rica

Incubation temperature plays an important role in determining sexual differentiation of the embryos, incubation duration and hatching success in sea turtle nesting. When working with hatcheries in sea turtle conservation projects, it is useful to monitor incubation conditions of nests relocated to the hatchery for comparison with natural conditions of in-situ nests on the beach in order to measure the efficiency of the hatchery. By collecting and analyzing the thermal conditions present within the nest, projects will be better suited to incorporate temperature data into management decisions. We studied the thermal nesting ecology of *Lepidochelys olivacea* in Drake Bay, southern Pacific coast of Costa Rica, during 2010 nesting season. The study was conducted in collaboration with the sea turtle conservation project that Corcovado Foundation performs at Drake Beach. We used dataloggers HOBO Pendant placed both in nests relocated to the hatchery and in-situ nests on the beach.These dataloggers were programmed to record temperatures in the middle of the clutch of the studied nests (n=15), and at the same depth of their respective controls, at 1-hour intervals during the incubation period. We monitored olive ridley's incubation temperatures, clutch sizes and hatching successes in order to compare incubation conditions between the hatchery and the beach. Preliminary results indicate that hatching success rates in the hatchery were 7.3% higher than on the beach. And average incubation period in the hatchery was shorter than on the beach (46 and 65 days respectively). In addition, average incubation temperatures during the middle third of incubation recorded in nests located in the sunny area of the hatchery reached 31.2ºC, suggesting a female sex bias in these nests. In contrast, average incubation temperatures monitored during the same period in nests in the shady area of the hatchery reached 29.8ºC, similar to those of in-situ nests. These preliminary thermal findings warrant additional research to improve the thermal efficiency of the hatchery in order to mitigate potential sex bias in hatchlings and evaluate other concerns related with incubation temperatures. Proposed actions include studies such as shadow rate effects on nest temperatures and water-cooling mechanisms for the hatchery. Also, due to interannual climate variability, thermal conditions monitoring should be carried annually. By monitoring nest

temperatures over time, both on beach and hatchery, and relating these to nesting success and sex ratios, it is possible to improve management strategies for hatcheries.

COMING OF AGE: FOUR DECADES OF TAGGING SHEDS LIGHT ON TIME TO MATURITY FOR HAWAIIAN GREEN TURTLES*

Stacy Hargrove and George Balazs

Pacific Islands Fisheries Science Center, NOAA Fisheries, Honolulu, Hawaii, USA

Hawaiian green turtles have been the subject of intensive study on both the nesting beach and foraging grounds for more than four decades. However, the first known tags attached to Hawaiian green turtles occurred nearly 80 years ago in June 1934 when brass tags were placed on 3 adult turtles prior to release at sea near Laysan Island in the Northwestern Hawaiian Islands (NWHI). In June 1950 an unknown number of green turtles were tagged by Vernon Brock (State of Hawaii Division of Fish and Game) in the NWHI using small stainless steel plates fastened to the carapace. The first flipper tags were used in 1965 when a tagging effort focused on basking green turtles was initiated by the US Fish and Wildlife Service in the NWHI. By 1972, more than 800 turtles had been tagged. In June 1973, George Balazs, then with the Hawaii Institute of Marine Biology, commenced systematic surveys and tagging of nesters at East Island, French Frigate Shoals (FFS). Later that year, Balazs began tagging green turtles on their foraging grounds at Kiholo Bay on the Island of Hawaii. During the past four decades more than 15,000 green turtles have been tagged in Hawaii with various types of flipper tags and PIT tags. Metal flipper tags were replaced by PIT tags in 1996. Today, every turtle encountered on the nesting beach or captured on a foraging ground gets a PIT tag in each rear flipper. While metal tags have not been used for nearly 15 years, nesters show up each year at East Island sporting their shiny jewelry from the past. A primary goal of tagging research is to track individual animals throughout the course of their life. With estimates of age at maturity for Hawaiian green turtles ranging from 25-50 years, the amount of time required to see results from tagging studies is equally as long. We will present a summary of green turtles tagged as juveniles on foraging grounds and later recovered on the nesting beach at FFS. During the 2010 nesting season, the 38th consecutive year of monitoring at East Island, 47/231 (20%) nesters still had metal flipper tags. Thirteen of those individuals were originally tagged as juveniles on a foraging ground in the main Hawaiian Islands. Five of the thirteen were documented nesting for the first time in 2010, whereas the other eight had been seen at East Island in earlier years. The time at large for those five turtles ranged from 14.1 to 32.0 years and coincides with earlier estimates for age at maturity of Hawaiian green turtles.

INTER-NESTING HABITAT FOR DRY TORTUGAS LOGGERHEAD SEA TURTLES: ENHANCING SATELLITE TRACKING WITH BENTHIC MAPPING

Kristen M. Hart[1], David G. Zawada[2], Ikuko Fujisaki[3], and Barbara H. Lidz[2]

[1] U.S. Geological Survey, Southeast Ecological Science Center, Davie, FL, USA
[2] U.S. Geological Survey, St. Petersburg Coastal and Marine Science Center, St. Petersburg, FL, USA
[3] University of Florida, Ft. Lauderdale Research and Education Center, Davie, FL, USA

The threatened loggerhead sea turtle *Caretta caretta* is the focus of much attention in the southeastern U.S. due to declining nest numbers and bycatches from commercial longline fishing. Understanding the spatial and temporal habitat-use patterns of these turtles, especially reproductive females in the neritic zone, is critical for guiding management decisions. In an effort to protect resources of presumed importance, the U.S. National Park Service recently created a restricted-use zone, the Research Natural Area (RNA), within Dry Tortugas National Park (DRTO), Florida. To assess marine turtle-habitat use within DRTO, and in the RNA in particular, we used satellite telemetry and identified inter-nesting habitats for seven loggerhead females intercepted and tagged on one of two main nesting beaches in 2008 and 2009. This effort represents the first satellite tracking of DRTO loggerheads, a genetically distinct subpopulation that is one of seven recently proposed for upgrading from threatened to endangered under the U.S. Endangered Species Act. We also used a rapid, high-resolution, digital imaging system to map benthic habitats we

determined to be core-use areas (i.e., 50% kernel density zones). Loggerhead females were seasonal residents of DRTO for 19 to 51 days. Individual inter-nesting habitats were located offshore within 1.9 km (2008) and 2.3 km (2009) of the nesting beach and tagging site. The core area common to all turtles was 4.2 km2 in area, spanned a depth range of 7.6 to 11.5 m, and was located completely outside the RNA. Mapping results revealed the diversity and distributions of benthic cover available in the core-use area, as well as a heavily used corridor to and from the nesting beach. This combined tagging-mapping approach shows great potential for planning and improving the effectiveness of marine protected areas and for developing spatially explicit conservation plans.

INVESTIGATING THE UTILITY OF GROUND PENETRATING RADAR FOR SEA TURTLE NEST DETECTION

Christopher J. Hintz[1], Nicole N. Arkwright[1], and Kenneth J. Hintz[2]

[1] Savannah State University, Savannah, Georgia, USA
[2] George Mason University, Fairfax, Virginia, USA

The largest nesting aggregation of loggerhead sea turtles (*Caretta caretta*) in the Atlantic is in the southeastern United States, where 50,000 to 70,000 clutches are deposited every year, with a mean clutch size of 115 eggs. On Tybee Island, GA (USA) locating, cataloging, and protecting these threatened, and locally endangered, nests is the responsibility of permitted volunteers. To date, the volunteers positively locate nests using minimally-invasive techniques of unearthing the top of the nest. The purpose of this study was to develop a technique for non-invasively locating sea turtle nests using ground penetrating radar (GPR). Utilizing the Mala Geoscience CX-10 GPR, initial experiments included detecting and locating steel cans and artificial sea turtle nests constructed from 100 saline filled water balloons (2-3 cm diameter). Successful blind testing demonstrated the ability of GPR operators to find a hidden artificial sea turtle nest buried in a 4-m2 quadrat. A series of measurements on a known sea turtle nest made 3 days prior to successful initial emergence of hatchlings provided direct validation of the method to detect and locate a sea turtle nest in situ. With further development, the method may allow researchers to non-invasively characterize the size, shape, and buried depth of the clutch aiding conservation efforts for these threatened and endangered species.

TIDAL VENTILATION OF SEA TURTLE NESTS*

Shaya Honarvar and Michael P. O'Connor

Drexel University

Sea turtles bury their nests as much as 70-80 cm deep and the sand above the nest represents an important resistance to respiratory gas exchange. Tidal movements of the water table under the nest can ventilate the nest, reducing hypoxia/hypercapnia. We have previously modeled nest gas exchanges, using previously measured tidal water table movements, and found the effects on nest gas concentrations to be of limited importance. We recently measured tidal water table fluctuations on nesting beaches in Bioko, Equatorial Guinea. Unexpectedly large water table movements suggest that tides can ventilate nests more vigorously than previously estimated. The amplitude and timing of water table fluctuations varied with distance of the nest from the water, with lunar phase, and between successive tides. Amplitude of the tidal water table fluctuations was attenuated with increased distance from the water. Simulations using our measured tidal fluctuations, show the potential to decrease time averaged oxygen deficits and carbon dioxide concentrations by 25-30%. Peak predicted oxygen deficits were also ameliorated, in contrast to predictions with smaller water table fluctuations. Thus, water table movements and potential effects on respiratory gas exchange, metabolism, and developmental rates all increase in nests laid closer to the water. Effects on nest metabolism and development are unclear because tidal ventilation also induces cycles of nest gas concentrations, whose effects on eggs are unexplored. Trough water table levels lagged 2-3 hr behind low tides. Simulations suggest that peak and trough gas concentrations can also be temporally offset from extremes of water table movements. Thus, measuring nest pressures or gas concentrations at the times of low and high tide may obscure the effects of tidal ventilation of sea turtle nests.

PILOT STUDY SHOWS SUCCESS IN RELOCATION OF LEATHERBACK SEA TURTLE (*DERMOCHELYS CORIACEA*) NESTS ABOVE THE BACKSHORE BEACH AT SPNWR

Paul Jobsis[1], Clayton Pollock[1], and Claudia Lumbard[2]

[1] University of the Virgin Islands
[2] US Fish and Wildlife Service

Through conservation, strict enforcement, and the hard work of many dedicated managers and volunteers the number of Leatherback sea turtles nesting at Sandy Point National Wildlife Reserve has increased over the past 30 years. Starting with 20 nesting turtles in 1981 the nesting population has increased dramatically with 208 turtles nesting in 2009. Dynamic erosion patterns coupled with increasing nesting densities may require innovative strategies to maintain this increasing population. Sea level rise and global climate change could also severely limit available nesting and relocation areas further acerbating management. Expanding relocation areas to include the backshore beach within the seaward vegetation would greatly increase the area available for the relocation of imperiled leatherback nests. However, previous studies have shown that relocation into vegetated areas decreases hatch success significantly due to root invasion and hatchling entrapment. Tilling these sandy areas may mitigate these and other soil conditions detrimental to hatch success and have the added benefit of easing the management, oversight and protection of these nests. In a pilot study we tested the effect of tilling the relocation area (1m x 1m x 1m per nest) to remove roots, rocks and other large debris. We compared the hatch success of tilled experimental plots to both natural in situ nests and standard protocol relocated nests on the open (non-vegetated) portions of the beach. In situ nests had a hatch success of 45.4 % ± 5.8 se, n=8; relocated nests using the standard protocol had a hatch success of 52.1 ± 7.9 se, n=8; nests relocated into tilled plots had a hatch success of 52.0% ± 4.2, n=9. None of the nest types showed any statistically significant difference in hatch success. Temperature profiles of the nests in the tilled plots showed a normal temperature profile throughout the nesting period and did not exceed 35 °C. These results support a larger trial of relocation into tilled areas. If future data continues to support these conclusions, then utilizing the backshore beach areas would greatly increase the area suitable for relocation and improve the management oversight and protection of these nests.

THE EFFECT OF AIR TEMPERATURE ON THE INCUBATION PERIOD AND HATCHING SUCCESS OF LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) CLUTCHES IN BROWARD COUNTY, FLORIDA

L. Teal Kawana[1], Curtis M. Burney[1], and Lou Fisher[2]

[1] Nova Southeastern University Oceanographic Center, Dania Beach, Florida, USA
[2] Broward County Environmental Protection Department, Plantation, Florida, USA

The survival rates of pre-emergent sea turtle hatchlings are critically dependent upon temperature. This study aims to determine if changes in air temperature have influenced the incubation time and/or the survivorship of the pre-emergent loggerhead sea turtle (*Caretta caretta*) hatchlings for past sea turtle nesting seasons in Broward County. Air temperature data within the hatching seasons of 1999 to 2009 was obtained from the NOAA National Climatic Data Center's Fort Lauderdale beach station. The loggerhead sea turtle hatching data collected by the Broward County Sea Turtle Conservation Program from the same time period was examined to assess the potential effects of air temperature on the hatching success and the incubation duration. This was performed primarily to determine if any trends or significance exist in the relationships among the aforementioned parameters. More specifically an analysis of trends in mean yearly sea turtle incubation durations was assessed and any correlations between incubation times and hatching success were also examined. Furthermore the relationship between incubation durations and mean seasonal and intra-seasonal air temperature fluctuations was tested for significance. Preliminary results for this study have shown a significant upward trend in the seasonal average incubation durations from 2003 to 2009 (t-test, $p < 0.05$). The mean incubation period for this study was 50.78 + 1.2 (mean + SD). Over the seasons the mean daily air temperature

fluctuated between yearly averages of 23.3 and 26.9 °C and had an overall mean of 25.98 + 1.9 °C (mean + SD). Statistical analyses indicate a significant negative association between the incubation duration and the average daily air temperature (t-test, p << 0.001). Further work pertaining to intra-seasonal analysis continues to be in progress. In Broward County alone, there was a continuous reduction in the number of loggerhead nests deposited each year throughout this study period. Determining if the effects of air temperature have significantly influenced loggerhead sea turtle clutches in Broward County might provide future insights for sustaining the survival rates of sea turtles in this area.

VARIATIONS OF SAND TEMPERATURES AND OF THE PERIODS OF MALE AND FEMALE HATCHLING FLATBACK AND GREEN TURTLE PRODUCTION AT NESTING BEACHES ON BARROW ISLAND AND MUNDABULLANGANA STATION FROM 2004 TO 2008

Gerald Kuchling

Chelonia Enterprises, Subiaco, Western Australia

Temperature data loggers buried at 50cm sand depth at sea turtle nesting beaches on Barrow Island and at Mundabullangana Station in the Pilbara of Western Australia logged sand temperatures from the 2004/05 to the 2007/08 nesting seasons to estimate and compare the periods of male and female hatchling production for Flatback turtles (*Natator depressus*) and Green Turtles (*Chelonia mydas*). The annual proportion of weeks estimated to produce male hatchlings at the monitored beach sites ranged from approximately 50-70% in Flatback turtles and from 30-40% in Green turtles. However, Flatback turtles have a narrower and better defined nesting season than Green turtles. During the thermo-sensitive period of egg incubation of Flatback turtles from early December to mid-March, only 11.2% of weeks showed sand temperatures at nest depth below the pivotal temperature. Since male hatchlings are mainly produced at temperatures below the pivotal temperature it appears that the sex ratio at those nesting beaches is generally heavily skewed towards females. Mundabullangana beach had higher sand temperatures than the Barrow Island beaches. Throughout the monitoring period 70% of all male-producing incubation weeks for Flatback turtles occurred at Bivalve Beach and Terminal Beach on the east coast of Barrow Island. These two beaches are directly adjacent to the development of the Gorgon gas liquefying plant and loading facility. Should nesting turtles avoid these beaches in future due to this development, the Flatback turtle hatchling sex ratio on Barrow Island may shift towards females which already appears to be the dominant hatchling sex. This possible shift will occur parallel and in addition to generally predicted hatchling sex ratio changes towards females due to climate change, which may aggravate an imbalance of the hatchling sex ratio in the future.

MULTIPLE PATERNITY WITHIN THE NORTHERN SUBPOPULATION OF LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*)

Jacob Lasala[1], Kris Williams[2], J. Scott Harrison[1], Mike Frick[2], and David C. Rostal[1]

[1] Georgia Southern University, Statesboro, GA
[2] Caretta Research Project, Savannah, GA

Comprehension of a species mating system is not only important within conservation efforts, but the knowledge is also essential in understanding how populations differ from one another. Specifically, patterns of paternal contributions can skew effective population size and alter genetic variability. Recent studies have suggested that multiple paternity occurs in most species of reptiles but within the Testudines there is a high degree of variation. (Uller & Olsson 2008) Previous studies on the loggerhead turtle (*Caretta caretta*) have shown that within large rookeries (Florida, Australia and Greece) multiple paternity occurs in more than 30% of nests, but what of smaller nesting beaches? The primary objectives of this study are to determine if 1) multiple paternity occurs in Georgia's nesting population, 2) does it differ from previous studies, and 3) if present, to what degree. Secondary objectives are to compare the incidence of multiple paternity over multiple years, instead of the average and determine if the incidence varies over the course of the nesting season (Early, Middle and Late nests). Mothers and offspring were sampled from over 30 nests in 2009 spanning the

entire nesting season on Wassaw Island, GA. The analysis shown below gives further insight into how multiple paternity differs across this species nesting options.

NEST TEMPERATURES AND HATCHLING SEX RATIOS FROM LOGGERHEAD TURTLE NESTS INCUBATED UNDER NATURAL FIELD CONDITIONS IN GEORGIA, USA

Anne Marie LeBlanc[1], K. Kristina Drake[1], Kristina L. Williams[2], Michael G. Frick[2], Thane Wibbels[3], and David C. Rostal[1]

[1] Georgia Southern University, Statesboro, Georgia, USA
[2] Caretta Research Project, Savannah, Georgia, USA
[3] University of Alabama at Birmingham, Birmingham, Alabama, USA

The southeastern United States is one of the world's largest loggerhead rookeries in the world. This nesting population is comprised of at least five distinct regional subpopulations or management units, all of which continue to decline despite federal protection in 1979. As a result, it is imperative for managers to ascertain any discrete and differential life history attributes for each particular management unit. Such data are necessary to better understand the factors that may influence any observable declines or future increases in any of these subpopulations. Our study examines and reports the pivotal nest temperature and temperature-associated sex ratios of one of these subpopulations (Georgia, USA). Our data indicate that rookery beaches north of Florida are important areas for the production and recruitments of male loggerhead hatchlings into the overall western North Atlantic Ocean and nests deposited earliest within a nesting season are primary contributors of male turtles. We suggest that nest monitoring programs grant such nests particular protection to increase their survivability and the production of hatchlings.

EXAMINING THE DEGREE OF NEST SITE FIDELITY OF HAWKSBILLS NESTING ON LONG ISLAND, ANTIGUA, WI

Kathryn Levasseur and Dominic Tilley

Jumby Bay Hawksbill Project, Long Island, Antigua, W.I.

Sea turtles exibit varying degrees of nest site fidelity. Monitoring efforts, such as the Jumby Bay Hawksbill Project (JBHP), have shown the hawksbill turtle (*Eretmochelys imbricata*) to have a particularly high degree of nest site fidelity both within and among nesting seasons. The JBHP has an accumulated 24 years of nesting data collected through saturation tagging protocols, identifying the nesting female responsible for nearly every successful nesting attempt. A 650m-long stretch of natural beach is the primary nesting site, and three adjacent, man-made beaches measuring between 30 and 100m are used secondarily. Several hawksbills have been observed excavating and at times destroying their own previous nests, indicating a remarkable precision in subsequent nest site selection. In this study, we characterize the distributions of individual hawksbill nesting attempts at a fine resolution on Long Island (Jumby Bay) Antigua, WI. We examine (1) the distance between consecutive nesting attempts in individual hawksbills, (2) the intra- and interseasonal range of all recorded nesting attempts of selected individuals, and (3) whether the success of a nesting attempt affects the distance traveled to a subsequent nesting attempt. We discuss two nesting site strategies observed for hawksbills nesting on Long Island, Antigua, and the ecological consequences involved in both strategies.
Our participation in this symposium has been made possible through support from the Jumby Bay Hawksbill Project and generous grants from the International Sea Turtle Society, the Western Pacific Regional Fishery Management Council, the U.S. Fish and Wildlife Service, the U.S. National Marine Fisheries Service, and the International Sea Turtle Symposium.

HAWKSBILL TURTLE CONSERVATION IN EL SALVADOR: THREATS AND OPPORTUNITIES AT THE LARGEST REMAINING NESTING AGGREGATION IN THE EASTERN PACIFIC OCEAN*

Michael J. Liles[1], Mauricio V. Jandres[2], Wilfredo A. López[3], Georgina I. Mariona[3], Carlos R. Hasbún[4], and Jeffrey A. Seminoff[5]

[1] Texas A&M University, College Station, Texas, USA
[2] Instituto de Ciencias del Mar y Limnología de la Universidad de El Salvador, San Salvador, El Salvador
[3] Fundación Zoológica de El Salvador, San Salvador, El Salvador
[4] United States Agency for International Development, San Salvador, El Salvador
[5] National Oceanic and Atmospheric Administration – National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California, USA

While little is known of hawksbill turtles (*Eretmochelys imbricata*) in the eastern Pacific Ocean, existing data suggest that they are highly threatened and in imminent danger of extirpation. The paucity of basic information on this population of marine turtles has been cited as a major impediment to the effectiveness of efforts directed towards its conservation and recovery. Recently, a regional assessment of hawksbill turtles in the eastern Pacific identified El Salvador as the site of highest remaining nesting abundance. However, the distribution of hawksbill turtle nesting and its mortality along the Salvadoran coast are yet to be described. To address this, we collected life-history information of this population, including body size of nesting hawksbill turtles and clutch size, and mortality along nesting habitat at the following three areas in El Salvador where anecdotal reports from coastal residents indicated the occurrence of hawksbill turtle nesting: Los Cóbanos Reef Marine Protected Area (Los Cóbanos), Bahía de Jiquilisco-Xiriualtique Biosphere Reserve (Bahía), and Punta Amapala. In 2008, we recorded 310 nesting events by hawksbill turtles along 25 beaches comprising 51.6 km of nesting habitat, giving an overall mean nesting density of 6.0 nests km-1. Highest nest concentrations were found in Los Cóbanos (mean = 10.1 nests km-1, range = 0-48.6) and lowest concentrations in the Bahía (mean = 5.2 nests km-1, range = 1.3-25.0). Of the 310 nesting events, 106 nests (34% of total) yielding 15,125 eggs were relocated to local hatcheries for protection; remaining nests were extracted for consumption by local egg collectors not participating in the project. Nearly 62% of total nesting activity and the greatest mean clutch size (156.7 eggs) occurred in the Bahía. Morphometric data were collected from 26 nesting turtles that ranged from 74 to 88 cm CCL (mean + SD; 81.6 + 3.6 cm) and 63 to 76 cm CCW (70.1 + 3.4 cm). Between 2004 and 2008 a total of 24 hawksbill turtles died in the Bahía (18 attributed to blast fishing) and in 2008 eight hawksbill turtles died due to bycatch in bottom-set gillnets in Los Cóbanos. While relatively high nesting abundance provides El Salvador with a unique opportunity to advance the slow process of hawksbill turtle recovery in the region, such advances have yet to be realized as egg consumption and fisheries bycatch are instead driving hawksbill turtles toward extirpation. To enhance the protection of nesting beaches, the Salvadoran government recently approved legislation that prohibits the collection and sale of marine turtle products for purposes other than conservation. However, hawksbill turtle bycatch in artisanal fisheries, particularly blast fishing and bottom-set gillnets, has received little attention and is among the most serious threats immediately challenging hawksbill turtle survival in El Salvador. Given the severely depleted status of hawksbill turtles in the eastern Pacific, conservation action by the Salvadoran government is urgently needed to mitigate their incidental capture in artisanal fisheries gear at primary nesting and foraging areas in El Salvador.

LOGGERHEAD NESTING TREND IN THREE BEACHES OF BOAVISTA, CAPE VERDE ARQUIPIELAGO

Ana Liria-Loza, Nuria Varo-Cruz, Maria Medina-Suárez, Saray Jiménez-Bordón, and Luis F. López-Jurado

Department of Biology, Las Palmas de Gran Canaria University, Spain

Nesting beach surveys are the most widely implemented monitoring tool in use by the global sea turtle community and are an important component of a comprehensive program to assess and monitor the status of sea turtle populations. These assessments are necessary to evaluate the effects of recovery and conservation activities that are being implemented at all life history stages. Monitoring techniques employed on nesting beaches range from highly structured standardized sampling to "snapshots" of nesting activity within a nesting season. Very long-term nest counts data (more than twenty years) were analyzed for some turtle populations. These studies show that ten years period is not sufficient to reveal trends within turtle populations because different trends have been observed every 10-11 years. But some of these trends demonstrate also that long-term conservation efforts can reverse nesting declines and offers hope that adequate management can result in recuperation of endangered sea turtle species. In Cape Verde, loggerhead turtles have been hunted since too many years ago. Monitoring and conservation programs of loggerhead population began in 1998, in the south-eastern area of the island of Boa Vista (Reserva Natural das Tartarugas). This area houses the 80% of the total nests of the Cape Verde archipelago, making it the hotspot of this loggerhead population. The long-term efforts carried out in the area provide an excellent opportunity to evaluate the success of this sea turtle conservation action and policies. Nest transect surveys, to record loggerhead turtle nests deposited the previous night, have been conducted daily along three beaches of the south-eastern hotspot of Boa Vista island since 2001. We analyzed 10-year time series (2001-2010) nest-count data of the three beaches (Ervatao, Ponta Cosme and Calheta de Pau) of Boavista Island. The analysis shows annual fluctuation and, in general, an increase in the number of nests during this period. We consider different ecological aspects that may be influencing the results of this population.

EXPONENTIAL GROWTH OF NEST PRODUCTION ON A "LOGGERHEAD BEACH": GREEN TURTLES AND LEATHERBACKS ON THE ARCHIE CARR NATIONAL WILDLIFE REFUGE, FL, USA

Christopher A. Long, Dean A. Bagley, and Llewellyn M. Ehrhart

University of Central Florida, Orlando, Florida, USA

The University of Central Florida Marine Turtle Research Group has been conducting nesting surveys in southern Brevard County since 1982, in the area now known as the Archie Carr National Wildlife Refuge (ACNWR). Since the establishment of the Index Nesting Beach Survey (INBS) program in 1989, the group has followed the INBS protocols on the 21 kilometer Refuge beach. The Refuge was established in large part because of the globally significant level of loggerhead (*Caretta caretta*) nest production there, however over the years it has become a significant green turtle (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) nesting beach as well. Both green turtles (R=0.7949) and leatherbacks (R=0.6894) have shown an exponential increase in nesting activity since 1982. The Carr Refuge accounts for approximately 33% of all green turtle nesting in Florida. The 2010 season was projected to be a high year for green turtles and it exceeded all expectations with a record 4,095 nests, surpassing the previous record of 3,963 in 2007. This record constitutes an increase of nearly 2 orders of magnitude relative to the 47 green turtle nests recorded in 1982. During the 2010 season, 153 nests were marked, and analysis of the reproductive data is ongoing and will be included in the final poster. The longest recapture interval observed in 2010 was from 1994, but in previous years turtles have been documented nesting 24 years after their original encounter. Over the previous decade, leatherbacks averaged 25.2 nests per year on the Refuge, so the 34 nests observed at the ACNWR in 2010 attest to the growth of this rookery. Leatherbacks on the Refuge ranged from 0-2 nests per year in the 1980s to a high of 52 nests in 2007. All leatherback nests were marked, and analysis of the reproductive data is ongoing, with data to be presented on the final poster. The longest term recapture observed in 2010 involved a leatherback tagged originally in 2003. Previously, leatherbacks had

been encountered up to 14 years after their original tagging. In conclusion, the Archie Carr National Wildlife Refuge was created to protect an important loggerhead nesting beach, but the exponential increase in nest production by green turtles and leatherbacks highlights the regional importance of the Carr Refuge for these species as well.

CAUSES OF EXTREME VARIABILITY OF NEST DENSITY AMONG CLOSE AND SIMILAR BEACHES OF BOAVISTA (CAPE VERDE): FROM 1 TO 2000 ANNUAL NESTS PER KM

Adolfo Marco[1], Ana Liria[2], Samir Martins[3], Elena Abella[1], and Luis F. Lopez-Jurado[2]

[1] Estación Biológica de Doñana, CSIC, Seville, Spain
[2] Department of Biology, University of Las Palmas de Gran Canaria, Spain
[3] Cabo Verde Natura 2000, Boavista, Cape Verde

The 70 km of white sandy beaches of Boa Vista island in Cape Verde harbours one of the largest rookeries of the endangered loggerhead sea turtle, *Caretta caretta*. From middle June to early October, approximately 2000 to 4000 females lay up to 20000 nests annually. However, female beach selection, nesting success and nest density strongly varies among beaches and spatial patterns of nest abundance and distribution are relatively constant among seasons. The numbers of nesting activities and nests have been recorded along all beaches of the island during four nesting seasons (2007-2010). To understand the reasons that cause such nesting spatial variability many natural and human related features have been considered. In the south-eastern part of the island (Reserva Natural das Tartarugas), the beaches have the highest nest density that usually exceeds 500 nests per km and hosts around 75 % of total nests of the island. Some beaches during some seasons can even exceed 2000 nests per km. However, on many of these high-density beaches the number of false crawls usually triplicates the number of nests. Furthermore, despite the low percentage of nesting activities that end on effective nesting, hatching success is very low and rarely exceeds mean values of 35 %. The low quality of beaches for incubation does not explain their high nest density. These beaches are very isolated and have the longest distances and worst communication to villages in the island. Towards the west and very close to these high density beaches, there are very similar pristine beaches with very few nesting activities and nest density that in the extreme cases have less than 3 nests per Km. There are no natural factors associated with the beaches that can explain this dramatic shift in nesting density. Factors associated with the marine environment such as dominant local currents or the migration routes from the internesting feeding areas of adults closed to the African continent may be responsible of the sudden decrease of the number of nests. The low nest density beaches are intercalated small beaches that host a relevant number of nests. Populated coastal areas of the northwest area of the island with suitable beaches have also sporadic nesting activity. Northern and eastern beaches have medium variable levels of nesting activity (10-1000 nests per km) and host around 20-24 % of nests of the island. Beaches with high density of nesting and nests are very attractive for eco-touristic activities with sea turtles. Tour operators can guarantee turtle watching on these beaches during most of the nesting season and tourists spend little effort and a short time for watching turtle nesting. The quality of these touristic visits and satisfaction of clients are common. At these areas, ecotourism with turtles can be a powerful tool in sustainable development programs. Local population can get a much better income from alive turtles than from dead ones. And at the same time this environmental service of a wild endangered species can benefit its conservation in the Atlantic.

DON'T LEAVE THE NESTS ALONE!: A CASE STUDY IN ALAS PURWO NATIONAL PARK, EAST JAVA, INDONESIA

Risma I. Maulany[1], Greg S. Baxter[1], David T. Booth[2], and Ricky J. Spencer[3]

[1] School of Geography, Planning, and Environmental Management, The University of Queensland, Gatton, QLD, Australia
[2] School of Integrative Biology, The University of Queensland, St. Lucia, QLD, Australia
[3] School of Natural Sciences, University of Western Sydney, Penrith, NSW, Australia

The role and effectiveness of hatcheries as a sea turtle conservation tool have been debated for some time due to some emerging problems such as inconsistency of hatching rate, effects on the gene pool, lost genetic diversity, and skewed sex ratios. It has been suggested by other studies that the hatchery should only be used for nests at risk in the natural environment. Egg relocation to the hatchery has been routinely carried out in Alas Purwo National Park (East Java, Indonesia) since 1983. This study aims to provide an evaluation of the on-going hatchery practices in the Park through an examination of predation on olive ridley turtle (*Lepidochelys olivacea*) nests. Nests found in natural habitat were randomly allocated into treatment (surrounding by a predator-proof cage) and control nests. An ibutton data logger was placed 40 cm depth in the centre of each nest to measure temperatures and all nests were checked daily for predator incursion. The presence of predators on the nesting beach was monitored by passive soil plots (2 x 3 m) every 500 m along the beach. In 2010, camera traps were set to record the predator activity around selected nests. Beach temperatures in each year were also measured by employing ibuttons in four different areas of the beach. Over two nesting seasons (2009 and 2010) the tracks of the little civet (*Viverricula indica*), palm civet (*Arctogalidia trivirgata*), wild pig (*Sus scrofa*), and monitor lizard (*Varanus salvator*) were found on the beach. Monitor lizard's tracks were the most commonly found in both years and both caged and non-caged nests were mostly raided by monitors. The predation rates of caged and uncaged nests were 100% for both years (N=11 nests in 2009 and N= 19 nests in 2010). Due to logistical considerations, only 2010 data were used in predator survey. The monitor lizards were widely distributed along the beach and more abundant compared to other predators. But they were relatively more abundant in the eastern beach (mean daily tracks in eastern beach: 3.8±0.4; in western beach: 2.79±0.9). The method of protection by using wire cage is ineffective in preventing egg predation by the major nest predators occurring in Alas Purwo due to high costs in materials and labour as well as being impractical to deploy on such a long nesting beach. The beach temperatures in both years were generally high ranging from around 25° C to almost 36° C during the nesting season. Therefore, the current hatchery practices through egg relocation to the hatchery can be justified as the main conservation tool.

INTERNESTING HABITAT AND BEHAVIOR OF OLIVE RIDLEY SEA TURTLES: IMPLICATIONS FOR WEST AFRICAN SEA TURTLE CONSERVATION*

Sara M. Maxwell[1], Greg A. Breed[1], Barry A. Nickel[1], Junior Makanga-Bahouna[2], Edgard Pemo-Makaya[2], Richard J. Parnell[2], Angela Formia[3], Solange Ngouessono[4], Brendan J. Godley[5], Daniel P. Costa[1], and Michael S. Coyne[6]

[1] University of California Santa Cruz, Santa Cruz, California, USA
[2] Wildlife Conservation Society, Parc National de Mayumba, Mayumba, Gabon
[3] Wildlife Conservation Society, Global Conservation Program, New York, New York, USA
[4] Agence Nationale des Parcs Nationaux, Libreville, Gabon
[5] University of Exeter – Cornwall Campus, Penyrn, Cornwall, UK
[6] SEATURTLE.org, Durham, North Carolina, USA

Movements of the Atlantic olive ridley (*Lepidochelys olivacea*) population have never been studied, despite strong political will to protect this species in Gabon and other West African nations. Mayumba National Park (MNP) in Gabon is a 900 km2 marine reserve along the Gabon-Republic of Congo border designed to protect nesting populations

of olive ridley and leatherback sea turtles (*Dermochelys coriacea*). Despite the reserve, however, olive ridley bycatch remains high and has prompted a proposed expansion of MNP and the development of a transboundary protected area between Gabon and the Republic of Congo. To understand internesting movements of olive ridleys as they relate to current and proposed protective measures, satellite transmitters were deployed on 18 nesting olive ridley sea turtles in 2007 (n=5) and 2008 (n=13). Our objectives were to characterize their internesting behavior and habitat in relation to the current park boundaries and the proposed transboundary park between Gabon and Republic of Congo, and to predict movements of turtles originating from other nesting beaches. A state-space model was used to process tracks and classify internesting behavior, and home range analyses were used to determine internesting habitat. Geographic information systems (GIS) were used to quantify overlap between internesting habitat and park boundaries, and we determined confidence intervals surrounding home range calculations. We applied a generalized additive mixed model to characterize environmental covariates that influence animal distribution during the internesting period, and predict distribution from additional nesting sites south of the study area. The state-space model revealed that turtles remained in the internesting behavioral mode for an average of 20.5 days from the point of tag attachment, with an average internesting interval of 17 days. Most turtles renested within 10 km of the original nest. Turtles remained largely within a 30 km radius from the original nesting site before departing for distant foraging grounds. Only 44.6 percent of high-density areas were found within Mayumba National Park's current boundaries but the proposed transboundary park would incorporate 97.6 percent of high-density areas. Though tagged individuals originated in Gabon, turtles were found in Congolese waters during greater than half of the internesting period (53.7 percent), highlighting the need for international cooperation. The internesting habitat model revealed that all variables were significant (depth, distance to coast, distance to nesting site, sea surface temperature and chlorophyll a). Predictive habitat modeling suggests that turtle density is similarly distributed in offshore regions of southern Congo, highlighting the need for additional protective measures in this area. This small-scale telemetry study provides a comprehensive understanding of olive ridley movements in an area where there is strong political will but limited information and resources. This study not only provides practical information to guide sea turtle management in Western Africa, but also serves as a model for how developing countries like Gabon can incorporate results of small-scale tracking projects into substantive management insights.

2006-2009 NESTING ACTIVITY IN ARRECIFES SECTOR, TAYRONA NATIONAL PARK, COLOMBIAN CARIBBEAN: ACTUAL SITUATION RELATED TO THE PAST

Maria C. Monterrosa, Alejandro Pavia, and Margarita M. Palomino

Fundacion Colombia Marina, Colombia

Since the 1960´s, Tayrona National Park (Northern Colombian Coast) was reported to be a nesting area for the four sea turtles species in the Caribbean coast of Colombia: *Dermochelys coriacea*, *Caretta caretta*, *Eretmochelys imbricata* and *Chelonia mydas* (Nicéforo, 1958). In the past, authors such as Medem (1962) and Kaufmann (1971; 1973) referred to the region as a major nesting area for *Caretta caretta*. The actual situation of this resource is unclear and due to this lack of information, Colombia Marina began the nesting assessments in 2007. Arrecifes´ nesting beaches were monitored in the night between 20:00 and 5:00 hours (March-August) from 2007 to 2009 seasons. These efforts were coupled with those of the Park authorities, who patrolled the nesting beaches in the morning since 2006. The tagging of nesting females, nests' protection and evaluation of threats were done following the methodology proposed by Balazs (1999) and Bolten (1999). Data collected systematically by Park officials and the Foundation´s team, showed a trend in the reproductive activity of sea turtles. Tracks and nests have been declining in the three index beaches at the Arrecifes sector, as shown in Figure 1 and Figure 2. During the night patrols, eight nesting females which arrived to this sector and four not nesting were tagged and measured (Table 1) to begin with the tag and recapture program for the Protected Area, which was long time overdue. The trend presented should be carefully considered due to the short time frame of the assessments (2006-2009) but data from past years doesn't have standardized methodologies or duration, making difficult the comparison. Although the data only represent one sector of the Park, a similar trend is seen for the entire area and nearby beaches, according to fishermen and Park staff. The situation is not a surprise due that since the 1960's, it was reported large numbers of nesting females killed and nearly 100% of nests (up to 70000 of *C. caretta* eggs per season) poached and sold in the markets of major cities (Medem, 1962). Fishermen and neighboring communities, affirmed that the female slaughtering has diminished gradually by almost 90% since the mid 1990´s, and egg poaching has lowered since 2000, with sporadic take of eggs and females (Monterrosa & Pavia, 2009). This means that before 2000 not hatchlings were born in the area and just few females survived their nesting attempts. In our opinion, the nesting occurrences observed in the area represents the few females which survived the over-exploitation that existed until 2000, as well as the little number of hatchlings that born 30 years ago, that now are reproductive females. We want to thank the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and the 31st International Sea Turtle Symposium for the travel grant awarded to Carolina Monterrosa. Colombia Marina Foundation wants to thank in particular the financial support of Rufford Small Grants Foundation, who has been supporting us from the start of this research in 2007.

INNOVATIVE USE OF TECHNOLOGY TO ENSURE ACCURATE DATA COLLECTION BY COMMUNITY-BASED MONITORING PROGRAMMES AT REMOTE SITES

Jeanne A. Mortimer

D'Arros Research Centre, Victoria, Mahe, Seychelles; Department of Biology, University of Florida, Gainesville, FL, USA

Basic monitoring of nesting activity at a turtle beach can provide the benefits to conservation and research that include: a) track count data to evaluate size of the nesting population; b) tagging data to provide insights into turtle behaviour and ecology; and c) protection from poachers. The latter (protection) is arguably the most valuable benefit at many sites. And protection is typically most effective in those programmes that involve members of the local community. At remote sites, however, interested members of the local community may lack formal scientific training or advanced literacy skills. This can undermine the scientific benefits of the programme—especially where trained scientific supervisory personnel cannot be based full-time. Although, to a great extent, one needs to trust that field personnel will collect data to the standards that they have been trained, modern technology can greatly enhance confidence in the calibre of the data being collected. One of the most fundamental challenges is to ensure that field personnel actually carry out nesting beach patrols as scheduled. Another is to ensure that turtle tags are actually applied, and that they are read accurately. This poster presents case studies of how GPS devices and digital photography have been used to tackle these problems in the remote islands of the Republic of Seychelles.

USE OF MOLECULAR-BASED PEDIGREES TO ASSESS THE NUMBER OF MALES CONTRIBUTING TO POPULATIONS OF LOGGERHEAD AND LEATHERBACK TURTLES IN SOUTH AFRICA*

Kerry Naish[1], Jenny Tucek[2], Melissa Baird[1], and Ronel Nel[2]

[1] School of Aquatic and Fishery Sciences, University of Washington, Seattle, USA
[2] Department of Zoology, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa

There are several aspects of turtle biology that make accurate assessment of population status difficult. Many of these assessments are based on the enumeration of reproductively active females and emergent hatchlings. However, knowing the number of males contributing to a population is important, because males can mate with many females, and a decline can go undetected for a very long time. An undetected decrease in males can negatively impact the demographic stability as well as the genetic “health” of a population. In South Africa, two species of nesting turtles, loggerheads and leatherbacks, receive equal protections, but the former is increasing while the latter is declining. Several theories have been advanced for this difference; one explanation may be that the sex ratios may differ between the two species. Here, we describe the results of genetic kinship approaches in loggerhead turtles, based on microsatellite panels, in which we compare the genotypes of breeding females and emergent hatchlings to estimate the number of males contributing to the population. We also provide details on the fitness and breeding biology of adult female turtles, and provide estimates of the effective population size within the species. We also present preliminary analysis of loggerhead breeding biology, based on genetic data, in anticipation of further studies.

SEA TURTLE CONSERVATION IN HONG KONG SAR*

Ka-yan Ng, Simon K.F. Chan, and Ka-shing Cheung

Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government, Hong Kong

Among the 7 sea turtle species in the world, 5 species are recorded in Hong Kong. They are green turtle (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), olive ridley (*Lepidochelys olivacea*), loggerhead (*Caretta caretta*) and hawksbill (*Eretmochelys imbricata*). Green turtle is the most commonly observed and the only species that nests in Hong Kong. The regular nesting site situates at a sandy beach of 0.5 ha called Sham Wan of an island named Lamma Island at the southeastern part of Hong Kong. In Hong Kong, nesting season of green turtle lasts from June to October. From 1998 until present, 3-7 clutches of eggs were delivered by female green turtle in a nesting season every 1 to 5 years. Each clutch of about 100 eggs was laid at an interval of 12 to 14 days in a nesting season. The nesting beach Sham Wan is designated as a "Restricted Area" under local law, the (Cap. 170), which forbids entry during the green turtle nesting season to protect nesting turtles and their eggs from June to October. During nesting season, nature wardens of Agriculture, Fisheries and Conservation Department (AFCD) of the HKSAR government regularly conduct day-time as well as night-time patrol on the beach at Sham Wan of Lamma Island. In addition to local law protection and enforcement, a number of conservation measures have been undertaken to safeguard the well-being of sea turtles in Hong Kong. Before the onset of nesting season each year, management works are carried out in Sham Wan the nesting site. These include removal of weeds which hinder turtles coming ashore to nest, regular monitoring of the site conditions and collection of refuse on the beach, etc. To identify the migratory routes of the nesting green turtles, AFCD has commenced satellite tracking programme on green turtles since 2002. 3 post-nesting satellite trackings have been conducted so far. According to the satellite tracking record, the same female green turtle migrated to its foraging ground in Vietnam in 1-month's time after nesting at Sham Wan in both 2003 and 2008. On occasion turtle eggs are threatened by external environmental factors in the natural nesting beach, namely inundation due to heavy rainfall, artificial incubation of the eggs in laboratory conditions would be put in place to enhance the hatching success. Since 1998, over 600 hatchlings artificially incubationed have been released from Sham Wan for their return to the sea. We recognize the success for conserving sea turtles greatly hinges on public reports on sea turtle sightings or strandings. Public engagement in sea turtle conservation works has been promoted and reinforced through educational occasions from public seminars, leaflet dissemination to hands-on experience in volunteer work, such as clean-up of nesting beach prior to onset of nesting season.

ENVIRONMENTAL FACTORS AFFECTING GAS EXCHANGE IN SEA TURTLE NESTS*

Michael P. O'Connor[1], Shaya Honarvar[1], Paul R. Sotherland[2], and James R. Spotila[1]

[1] Drexel University
[2] Kalamazoo College

Sea turtle nest development is one of the life stages where conservation efforts for sea turtles have been shown to be potentially effective. The sandy environment of developing sea turtle eggs creates a significant resistance to both diffusive and convective exchanges of respiratory gases. Empirical data suggest that the resulting relative hypoxia and hypercarbia affect egg metabolism, development times, and hatching success. Unfortunately, the magnitudes of the induced resistances are not clear and quantitative dependences on nest depth and density are unknown. We modeled the effects of several environmental factors on concentrations and fluxes of O2 and CO2 by numerically solving the Stokes equations for creeping flow in a porous substrate. Model results argue that: 1) Convection caused by metabolism with a low RQ can slightly increase O2 and CO2 concentrations. 2) Tidally driven excursions of the water table can ventilate the nests, reducing hypoxia and hypercapnia. 3) Crowding of nests in arribada nesting species could limit O2 concentrations and nesting success, but is unlikely to be important in most nests of other sea turtles. 4) The deeper nests constructed by larger sea turtle species provide larger resistances to gas exchange, exposing nests to more significant hypoxia and hypercapnia. 5) Time constants for approach to equilibrium can be long enough to prevent thermal (and to a lesser extent, gaseous) equilibrium in developing nests with metabolic rates that increase with weekly half times. Previously considered intra-nest factors (clutch mass, metabolic rate) also appear important. Such models are computationally intensive, but can be used to predict under which circumstances gaseous exchanges might limit metabolism and development.

CONSIDERING NEST DENSITY DURING OLIVE RIDLEY ARRIBADAS AT LA ESCOBILLA, MEXICO*

Melissa S. Ocana[1], Selina S. Heppell[1], and Martha Harfush Melendez[2]

[1] Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331
[2] Centro Mexicano de la Tortuga, CONANP, Mazunte, Oaxaca, Mexico

This project informs conservation efforts for the olive ridley sea turtle (*Lepidochelys olivacea*) by exploring mass-nesting (arribada) dynamics. During arribadas, tens of thousands of turtles come ashore to lay eggs over a few days. As home to one of the largest arribada populations, La Escobilla, Mexico, is an ideal location for research exploring currently underspecified but essential indicators of population health, such as nest density. Nest destruction is the most obvious potential impact of high density nesting, as later turtles often dig up previous nests. The goal of this study was to test the hypothesis that nest destruction is positively related to nest density by quantifying these two variables under natural nesting conditions. Previous studies have considered these variables in conjunction at solitary beaches, but empirical estimates at arribada beaches are challenging given the many potential density-dependent factors that influence arribada nests. With a team of biologists, student volunteers and local community members, nesting behavior of 1293 turtles was observed in 26 9m^2 study plots during two consecutive arribadas. Cumulative nest densities over two arribadas ranged from 1 to 8 nests/m^2. Mean destruction levels per plot per night ranged from 0-28.57%. A significant positive relationship between nest density and destruction was observed. Standardized methodology and definition of nest density and intra-specific destruction levels will allow for comparison among arribada sites. This project also serves as an update on nesting at La Escobilla, an important arribada site.

SYNCHRONY ON EMBRYONIC DEVELOPMENT OF MARINE TURTLES: INDIVIDUAL VARIABILITY AND ENVIRONMENTAL EFFECTS

Héctor Pérez-García[1], Rosa García Cerdá[2], Belén Fernández-Gil[1], Adolfo Marco[1], Mara Abu-Raya[3], and Luis F. López-Jurado[2]

[1] Estación Biológica de Doñana, CSIC, Seville, Spain
[2] Department of Biology, Universidad de Las Palmas de Gran Canaria, Spain
[3] Department of Marine Biology, University of Cape Verde, Cape Verde

For sea turtles, to hatch and emerge from the nest communally is essential to decrease hatchling mortality. Thus, it is very important within a nest the simultaneous fertilization and the synchronized embryonic development of all eggs. On loggerhead nesting beaches of Cape Verde we have studied the individual variability on developmental synchrony of embryos and the influence on this process of some biological, environmental and management factors. We have compared this trait within and between 34 nests naturally incubated on the beach and 34 nests relocated to a beach hatchery during the 2009 and 2010 nesting seasons. As an honest non-invasive indicator of embryonic development we have used the size of the white embryonic disc that it is externally visible and grow on the eggshell during the first 10 days of development. We studied the white spot at the first 48 hours of incubation and for 36 of these nests from both locations we also studied the white spot at the first 6 days (144 hours) of incubation. The rest of the nests where not studied at this second time to assess the possible effect of the experimental manipulation at day 6 on embryo viability. Because of the 2009 season results showed a delayed embryonic development within the first hours after egg laying, in 2010 season, we have done an additional study to improve our knowledge about the causes that explain such delay. We relocated 10 fresh-laid nests to a location very close to natural nests laid simultaneously to the relocated nest, to control for the environmental variability on the influence of nest relocation on embryonic development. The white spot was measured for both relocated and natural nests 2 days after egg laying. We detected a significant variability on the mean embryonic development stage at days 2 and 6 of incubation among nests of up to 5 days of difference. Relocation to a

hatchery significantly delayed embryonic development in the first hours after egg laying. This delay was compensated at day 6 of incubation on most of nests in 2009 but remained at day 6 in most of nests of 2010. We could say that this delay on embryonic development was not due to hatchery or microhabitat conditions, because in the 10 pairs of nests located and incubated together the relocated nest had also a delay of embryonic development. We found a negative correlation among size of white spot and female size. Perhaps large females have a shorter egg retention period before laying and nest when eggs are at an earlier embryonic stage than smaller females do. Finally, we detected a strong synchrony within each nest that only was altered on the deepest eggs of clutches that exceptionally had more than 95 eggs. Relocation on the beach or to a hatchery had no influence on the synchrony of embryonic development within a nest. Thermal, physiological and behavioral reasons are proposed to explain these patterns.

INTERNESTING BEHAVIOUR OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN RETHYMNO, GREECE*

Aliki Panagopoulou[1,2], Samir H. Patel[1], Dimitris Margaritoulis[2], Frank V. Paladino[3], Stephen J. Morreale[4], and James R. Spotila[1]

[1] Drexel University, Department of Biology, Philadelphia, PA, USA
[2] ARCHELON, the Sea Turtle Protection Society of Greece, Solomou 57, GR-104 32, Athens, Greece
[3] Indiana-Purdue University, Department of Biology, Fort Wayne IN, 46805, USA
[4] Cornell University, Ithaca, NY, USA

Rethymno is situated on the northern coast of Crete and with an average of 324 nests per season, hosts the third largest nesting aggregation of loggerhead sea turtles in Greece and one of the largest in the Mediterranean. The turtle nesting activity in Rethymno is well documented, through the efforts of ARCHELON the Sea Turtle Protection Society who has been working in the area since 1990: nests are recorded and protected, a public awareness campaign is implemented and management measures to ensure the long-term viability of the habitat are promoted. Nevertheless, little is known of the turtles' behavior at sea, including migrations to and from the foraging/overwintering areas, post nesting migrations or inter-nesting behavior. This can play a crucial role in the survival of this population as mortality at sea due to interactions with small scale fisheries and boat collisions can render all terrestrial conservation efforts invalid leading the population to a steeper decline. The purpose of this study is to determine the behavioral patterns of the loggerheads nesting in Rethymno so as to increase our understanding on their use of the near-shore marine habitat during the inter-nesting interval. During the 2010 nesting season which lasts from early June to late July, we attached radio transmitters (Telonics, MOD-050) and time-depth recorders (LOTEK LAT 1100 series) on 8 nesting females after they had finished laying their clutch. The equipment was attached after performing an ultrasound confirming the presence of follicles in their ovaries, suggesting that they would return after approximately 15 days to lay another clutch. Through daily observations for signals emitted by the radio transmitters in specific "hearing" locations it was determined whether females prefer to remain in proximity of the nesting area, while the time-depth recorders yielded their data upon retrieval of the equipment when the turtles were again observed on the beach. We were able to get regular signals from 5 of these turtles, suggesting that female loggerheads of Rethymno remain in proximity of the nesting area. Further, our observations indicate a preference for a specific marine area close to the shore which warrants further research. Three of the time-depth recorders were retrieved and the data downloaded from the loggers are currently analysed to determine behavioral patterns engaged by the Rethymno turtles during the inter-nesting behavior that may include resting on the surface, resting on the seabed or in the middle of the water column. Funding for this project came from The Betz Chair of Environmental Science at Drexel. The authors wish to thank ARCHELON and the Rethymno project team for their support in implementing this study. Special thanks are due to Nathan Robinson, Julianne Koval and Jonah Morreale for their valuable assistance in conducting our fieldwork and Gabi Blanco for her advice. A.P. wishes to thank the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service for financial support that made it possible to attend the Symposium.

SEASONAL VARIATION IN EGG SIZE IN THE LOGGERHEAD SEA TURTLE: RESOURCE PARTITIONING IN THE NESTING FEMALE

Ketan Patel[1], Kris Williams[2], Mike Frick[2], and David C. Rostal[1]

[1] Georgia Southern University, Statesboro, GA
[2] Caretta Research Project, Savannah, GA

Understanding maternal contributions and strategies in reproduction can reflect how resources are allocated in response to resource availability and physiological constraints by the mother. Sea turtles have the highest egg yields of any oviparous non-avian reptiles, laying between 50 and 130 eggs of masses between 27 and 80g depending on the species (Miller 1997) and clutches are 1 to 10 % of a female's total body mass (Shine 1992). Loggerhead sea turtles have high seasonal fecundity and display little variation in egg size, and instead maximize clutch size. Studies were conducted on Blackbeard and Wassaw Island National Wildlife Refuges during the 2008 and 2009 Loggerhead sea turtle nesting season. In order to assess the direct maternal effects, comparisons of wet mass and dry mass of eggs collected. Comparison of eggs laid in the early, middle, and late season will be performed as well. Both comparisons will give a more accurate estimate of how much actual nutrient investment is present in the eggs and the presence of any difference in investment between the periods.

CURRENT AND FUTURE SEX-RATIOS FOR LEATHERBACKS FROM THE ATLANTIC COAST OF COLOMBIA AND PANAMA UNDER SEVERAL GLOBAL WARMING SCENARIOS

Juan A. Patiño-Martínez[1], Adolfo Marco[2], Liliana Quiñones[2], and Catalina Monzón-Argüello[3]

[1] Society of Sciences Aranzadi, Donosti, Spain
[2] Estación Biológica de Doñana, CSIC, Seville, Spain
[3] Instituto Canario de Ciencias Marinas, Telde, Gran Canaria, Spain

Incubation temperature influences embryonic survival and hatchling sex-ratio and phenotype. Global warming is skewing hatchling sex-ratio toward females and climate predictions for next decades can cause a significant decrease of hatching success and the absence of male production in some areas. These impacts can contribute to increase the extinction risk of some endangered sea turtle populations. Thus, the continuous monitoring of incubation temperatures on natural and relocated nests should be implemented in all relevant sea turtle nesting areas. In the present study we present current hatchling sex-ratios on several nesting beaches for leatherbacks on the Caribbean coast of northwestern Colombia and eastern Panama. We have also evaluated several sources of variation on sex production within the nest, within a given beach, among beaches and among seasons. The focus has also been directed to asses and control sex production in relocated nests. Finally, using current sand temperatures we have estimated future hatchling sex-ratios under several scenarios of global warming. Hatchling sex-ratio varied among the study nesting seasons but in all of them was skewed toward females. The male – female percentage was on average 1.4 – 98.6 in 2005, 16.9 – 83.1 in 2006 and 5.9 – 94.1 in 2007. The mean percentage of females hatched during the 3 seasons was 91.9 % (SD = 7.9). Within a nest, there is variation on temperature depending on the position of the eggs and the distance to the surface. For example, in the center of the nest eggs had 0.7 ºC more tan eggs located at the bottom of the nest. This thermal difference can significantly affect sex determination. The location of nests on the beach or the color of the sand also influenced incubation temperature (mean differences of 0.3ºC and 0.4ºC respectively). Models that relate sand and air temperature together with predictions on air temperature for the next decades (IPCC) suggest that very slight increases on air temperature with produce the total hatchling feminization on the nesting population of the continental Caribbean. This populational impact may occur in the next decade. The speed of the climate changes, the high sensibility of leatherbacks to this changes that are impairing sex-ratio production and the slow maturation of the species may limit the reaction or adaptation of populations to this impact. Hatcheries may offer a temporal solution to the lack of male production. Relocated nests reburied in exposed locations of hatcheries had higher temperatures than natural nests. However, several regimes of artificial shade over the nests in the hatchery significantly increased male production and hatching success.

MAD DASH FOR OCEAN BETTER UNDER MOONLIGHT

Kellie Pendoley[1] and Milani Chaloupka[2]

[1] Pendoley Environmental P/L
[2] Ecological Modelling Services P/L

We used a generalized additive mixed modelling approach to assess factors affecting seaward orientation of flatback turtle hatchlings escaping from underground nests on 5 major nesting beaches on Barrow Island. Barrow Island comprises some of the most important marine turtle nesting beaches in the east Indian Ocean region, and especially so for the endemic flatback. Hatchling emergence dispersion during the previous night was measured as (1) the angular range of dispersion from the nest (emergence fan spread or disorientation) and (2) as the degree of deflection of the emergence fan from the most direct seaward bearing (fan offset or misorientation). Flatback hatchling disorientation was a significant nonlinear function of lunation cycle day with reduced dispersion during brighter lunar illumination such as around full moon (ca. lunar cycle days 14-16). Flatback hatchling disorientation was also a function of beach-specific effects with significantly lower disorientation on an artificial light-limited beach and higher on an artificial light-exposed beach compared to the other 3 beaches exposed to limited if any artificial night lighting. Flatback hatchling misorientation (fan offset) tended to be greater on the beach exposed to artificial night lighting but was not a function of lunar illumination. Flatback hatchling misorientation was also greater on those beaches exposed to apparent beach predation risk whereas there was no predation effect for flatback hatchling disorientation.

SELENIUM SAVES THE DAY: FIRST EXPLANATION FOR DECREASED HATCH AND EMERGENCE SUCCESS IN LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*)- LESSONS LEARNED FROM TWO POPULATIONS*

Justin Perrault[1], Jeanette Wyneken[1], and Debra L. Miller[2]

[1] Florida Atlantic University, 777 Glades Road, Building 1, Boca Raton, FL, USA, 33431
[2] Veterinary Diagnostic and Investigational Laboratory, University of Georgia, 43 Brighton Road, Tifton, GA, USA, 31793

Leatherback turtles (*Dermochelys coriacea*) are pelagic migrants that specialize on gelatinous zooplankton prey. They often experience higher reproductive failure than other sea turtle species. We examined the role of mercury and selenium in hatch and emergence success. Mercury enters the ocean through industrial sources and natural geologic processes. It lacks biological function, can compromise health, and impedes normal development. Selenium is a trace element that acts to detoxify mercury in the liver. Mercury and selenium enter the body through food and water intake and, in reptilian species, these elements are transferred from females to their offspring via the yolk. We measured blood mercury and selenium concentrations in nesting leatherback sea turtles from Florida and St. Croix and also documented mercury and selenium concentrations in their hatchlings (blood, liver, yolk sac). These values were compared, by nest, to mercury and selenium concentrations measured in the blood of nesting females to determine if the values correlated. Additionally, the concentrations of total mercury and selenium in nesting females and hatchlings were compared to hatch and emergence success. We found that nesting female blood selenium concentrations positively correlated with blood selenium concentrations of their hatchlings. We also found that as hatchling liver mercury concentrations increased, liver selenium increased concurrently, a trend common in marine vertebrates at higher trophic levels. This supports the interpretation that selenium is a protective mechanism against mercury in hatchlings. We observed a significant positive correlation between both hatch and emergence success and liver selenium and the ratio of hatchling liver selenium to mercury. Assuming that selenium concentrations are similar in hatchlings within a nest, this may indicate that selenium plays an important role in successful hatching and emergence. In both Florida and St. Croix, mercury concentrations in the blood of nesting females tended to decrease and blood selenium concentrations tended to decrease in St. Croix leatherbacks as the nesting season progressed, which suggests nesting females may be offloading both mercury and selenium into their eggs. We also measured mercury and selenium in the shelled albumin globs, commonly laid by this species. These too may contribute to elimination of toxicants or excess concentrations of nutrients, as selenium can be toxic when bodily concentrations are elevated. To our knowledge, no studies have documented mercury and/or selenium concentrations in leatherback prey items. Jellyfish that consume zooplankton likely sequester mercury and selenium from these planktonic sources and pass it on to the next level in the food chain. Our initial study of mercury and selenium levels in their prey found that their concentrations were often higher than those found in the blood of nesting females. Our study is the first to document mercury and selenium concentrations in hatchling sea turtles and to demonstrate that mercury and selenium likely play roles in hatch and emergence success in sea turtles.

REPRODUCTIVE SYNCHRONY IN A RECOVERING BOTTLENECKED SEA TURTLE POPULATION*

Virginie Plot[1,2], Benoit de Thoisy[3,4], Stéphane Blanc[1,2], Laurent Kelle[5], Anne Lavergne[6], Hélène Roger-Bérubet[1,2], Yann Tremblay[7], Sabrina Fossette[1,2,8], and Jean-Yves Georges[1,2]

[1] Université de Strasbourg, IPHC, 23 rue Becquerel 67087 Strasbourg, France
[2] CNRS, UMR7178, 67037 Strasbourg, France
[3] Kwata Association, 16 avenue Louis Pasteur, 97335 Cayenne, French Guiana
[4] Institut Pasteur de la Guyane, 97306 Cayenne, French Guiana
[5] WWF France, 5 Lot. Katoury, 97300 Cayenne, French Guiana
[6] Pasteur de la Guyane, 97306 Cayenne, French Guiana
[7] Centre de Recherche Halieutique, IRD, Avenue Jean Monnet BP 171, 34203 Sète, France
[8] Present address: Institute of Environmental Sustainability, School of the Environment & Society, Swansea University, Swansea SA2 8PP, UK

Although the assessment of species extinction risk is well established, the assessment of potential for recovery is far more challenging, because complementary approaches are required to detect reliable signals of positive trends. Several populations, including marine turtles, are nevertheless considered to have recently recovered, but these assertions may remain uncertain because of too fragmentary approaches implemented to monitor these trends. In this work we combined genetics, demography and behavioural data at three different scales of time for assessing historical and recent population changes and evidence of present reproductive synchrony in a relict, yet apparent recovering, population of olive ridley sea turtle, *Lepidochelys olivacea*, commonly considered as the most extraordinary example of reproductive synchrony in any reptiles. Using recent Bayesian coalescent-based models of microsatellite nuclear DNA variability, we show that effective population size of olive ridley sea turtle nesting in French Guiana dramatically declined by 99% over the last 20 centuries, further supported by the quasi absence of genetic diversity in the present nesting population. Yet, recent nesting population monitoring on the major nesting sites in French Guiana suggests a possible recovery of the population over the last decade. Additionally, satellite tracking of gravid females show evidence of present reproductive synchrony where individuals gather together off the nesting sites before emerging en masse in significant peaks. We propose that in olive ridley sea turtles, reproductive synchrony in critically-sized populations may be related to some relict behaviour and may contribute to the expected recovery of the population. The gregarine behaviour of reproductive individuals close to the shore facing human-induced perturbations however raises the need for timely conservation efforts in this region of growing importance for this still poorly known species. We are grateful to the International Sea Turtle Society, the Western Pacific Regional Fishery Management Council, the U.S. Fish and Wildlife Service, the U.S. National Marine Fisheries Service and the International Sea Turtle Symposium for their support and for providing us a travel grant.

NUTRIENT TRANSFER FROM LEATHERBACK SEA TURTLE (*DERMOCHELYS CORIACEA*) NESTING ACTIVITIES AT SANDY POINT NATIONAL WILDLIFE REFUGE

Clayton Pollock[1], Paul Jobsis[1], and Claudia Lumbard[2]

[1] University of the Virgin Islands
[2] US Fish and Wildlife Service

Sea turtle nesting represents a potential transfer of nutrients from the marine to the terrestrial environment. This transfer can affect the distribution and growth of plants inhabiting sea turtle nesting beaches and subsequently affect the hatch success of nesting beaches. In this pilot study imperiled leatherback sea turtle clutches were relocated to tilled plots located within the sprawling seaward vegetation community dominated by *Ipomea* sp. and to traditional relocation sites utilized by resource managers at Sandy Point National Wildlife Refuge. Soil parameters within relocated and in situ nests were measured at deposition, excavation and post-excavation (D, E, P-E; P-E occurred approximately 30 days following excavation) to determine changes in soil composition important to plant growth including estimated nitrogen release (ENR), available phosphorous, percent organics and soil pH. ENR values were 53.6±2.2, 58.4±5.9, 63.4±3.8 (D,E,P-E, lbs/acre, n=27); phosphorous values were 1.1±0.3, 21.5±40.2, 5.6±5.6 (D,E,P-E, ppm, n=24); percent organics values were 0.53±0.09, 0.74±0.27, 0.97±0.19 (D,E,P-E, percentage, n=27), soil pH values were 9.39±0.08, 9.02±0.41, 9.08±0.30 (D,E,P-E, n=27). Repeated measures ANOVA analysis was used to determine significant changes all reported in soil parameters. Nest type, in situ, traditional relocation, tilled plot relocation, did not appear to affect the nutrient deposition. However the decomposition was not complete even at post-excavation therefore these values are certainly an under estimation of the nutrients delivered to the beach by the turtles. This investigation is relevant to resource managers attempting to understand the effects of nutrient transport associated with sea turtle nesting that may enhance plant growth. For sea turtle nesting beaches encroaching vegetation can compound negative factors such as dynamic erosion patterns and sea-level rise. The placement of relocated nests and the ability to exert more control over the relocation process may become increasingly more important as global climate change will likely alter the environmental parameters of nesting beaches.

REPRODUCTIVE SUCCESS OF THE NESTING POPULATION OF GREEN TURTLES, *CHELONIA MYDAS*, IN THE AVES ISLAND WILDLIFE REFUGE FOR SEASON JULY-NOVEMBER OF 2010

David A. Prieto[1], Jim L. Hernández[1], Luz A. Sánchez[2], and Jesús G. Ortega[3]

[1] Laboratorio de Investigaciones Piscícolas Dr. Lino Hernández, Facultad Experimental de Ciencias, Universidad del Zulia, Estado Zulia, Venezuela
[2] Oficina Nacional de Diversidad Biológica, Ministerio del Poder Popular para el Ambiente
[3] Comandancia General de la Armada Bolivariana, Servicio de Hidrografía y Navegación, Caracas, Venezuela

Wildlife Refuge Aves Island is the main nesting site for green turtles (*Chelonia mydas*) in Venezuela and the second most important nesting colony in the Caribbean. The objective of this research was to assess the reproductive success of the nesting population of *C. mydas* during the season from July to November 2010. External marking was performed placing Inconel # 681 metal plates, inscribed with an alphanumeric code to identify nesting females, by allowing the capture-recapture method, the determination of periods of renesting and remigration. We measured the curved carapace length (CCL) and curved carapace width (CCW) following the procedure described by Bolten (2000). For the determination of reproductive success we calculated nesting success, nesting frequency, period of incubation, hatching

success, emergence success and recruitment success by formulas of Miller 2000. The spatial distribution of nests was determined by GPS GarminTM 72 and ArcView GIS 3.3. The average values for the CCL and CCW were 112.2 cm and 101.9 cm respectively. There were 1106 females: 670 tracks on the season, 436 remigrantes with 7 brand replacements. We counted 1511 nests, with a nesting success of 74.47% and an observed nesting frequency of 1.6 times. The nests were distributed in 37.57% South Zone, 20.38% Central Zone and 42.09% North Zone of the island. Posted Interval Observed was 19.5 days, remigration range of between 2 and 4 years. Mean brood size was 124 eggs with an period of incubation of 58 days. Hatching success was 54.38%, the successful emergence of 74.29% and the success of 50.61% recruiting. A total of 4160 calves observed managed to reach the sea.

EMBRYONIC DEATH IS LINKED TO MATERNAL IDENTITY IN THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*)*

Anthony Rafferty[1], Pilar Santidrián Tomillo[2], James Spotila[2], Frank Paladino[3], and Richard Reina[1]

[1] Monash Univerity, Melbourne, Victoria, Australia
[2] Drexel University, Philadelphia, USA
[3] Indiana-Purdue University, Indiana, USA

Leatherback turtles have an average global hatching success rate of ~50%, lower than other marine turtle species. Embryonic death has been linked to environmental factors such as precipitation and temperature, although, there is still a lot of variability that remains to be explained. We examined how nesting season, the time of nesting each season, the relative position of each clutch laid by each female each season, maternal identity and associated factors such as reproductive experience of the female (new nester versus remigrant) and period of egg retention between clutches (internesting interval) affected hatching success and stage of embryonic death in failed eggs of leatherback turtles nesting at Playa Grande, Costa Rica. Data were collected during five nesting seasons from 2004/05 to 2008/09. Mean hatching success was 50.4%. Nesting season significantly influenced hatching success in addition to early stage embryonic death. Neither clutch position nor nesting time during the season had a significant effect on hatching success or the stage of embryonic death. Some leatherback females consistently produced nests with higher hatching success rates than others. Remigrant females arrived earlier to nest, produced more clutches and had higher rates of hatching success than new nesters. Reproductive experience did not affect stage of death or the duration of the internesting interval. The length of internesting interval had a significant effect on the proportion of eggs that failed in each clutch and the developmental stage they died at. Intrinsic factors such as maternal identity are playing a role in affecting embryonic death in the leatherback turtle. Financial support was provided for this project by the Betz Endowment of Drexel University, the Earthwatch Institute and The Leatherback Trust. We are also grateful to the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service, and the International Sea Turtle Symposium for grant support to attend this symposium.

NESTING ACTIVITY OF THE OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) AT EL VALLE, CHOCOAN PACIFIC COAST, COLOMBIA

Cristian Ramírez-Gallego and Karla Barrientos-Muñoz

Colombian Sea Turtle, Medellín, Colombia

During the 2008 (from August to December) nesting season, we documented several aspects of the colony of *Lepidochelys olivacea* from El Valle beach on the Colombian Pacific coast. El Valle beach is an important nesting site for *Lepidochelys olivacea* in South America. All nest laid in the beach, which are not transferred to a protective enclosure, are depredated by humans, as are a substantial number of the nesting females. We translocated 164 nests obtained from the 172 registered nests. The mean curvilinear carapace length of the females was 64.9 cm (SD= 2.4) and the mean number of eggs per nest was 87 (SD=19.1). During this season there was an obvious peak of nesting the estimated hatching success rate based upon 25 of the 164 transferred nest was 77.6% and 65 days of incubation. Finally, management strategies should continue to be evaluated to permit an in situ hatching of the nest, through a

control of human predation, and an attempt to conduct studies of the reproductive ecology of this colony should be made.

EVALUATION OF THE ACTIVITY OF NESTING OF MARINE TURTLES IN NATIONAL NATURAL PARK TAYRONA, SECTORS ARRECIFES AND CAÑAVERAL, SANTA MARTA-COLOMBIA (SEASONS 2005 TO 2008)

Guiomar Aminta Jáuregui Romero, Soraya Catalina Ospina Sánchez, and Alvaro Andrés Moreno Munar

Programa de Conservación de Tortugas Marinas, Universidad Jorge Tadeo Lozano, ProCTM-UJTL, Santa Marta, Magdalena, Colombia

When evaluating the historical data of the Program of Conservation of Marine Turtles of the University Jorge Tadeo Lozano (ProCTM-UJTL) during these years, we managed to demonstrate the presence of *Dermochelys coriacea*, *Caretta caretta*, and *Eretmochelys imbricata* like predominant species in the area, emphasizing the absence of *Chelonia mydas*. In spite of the drastic diminution of these quelonios in the studied sectors, the analysis of the information registered of you tread-caracoleos and nests, showed a general tendency of biennial increases in the nesting activity, although not data simultaneous of all the beaches we had conform that them. Throughout the 4 years a total of 135 reproductive events was registered, for 2005 (43) 16 in Arrecifes, and 27 in the sector of Cañaveral; in 2006 (28) 24 and 4 respectively; in the 2007 (48) only for the main beach of Cañaveral of this sector; and in 2008 (16) 2 in Arrecifes and 14 in Cañaveral. As far as the interception of nests females in the 2005 any unit could not be sighted whereas in the 2006 one was moderate *D. coriacea* with morphometrics of Curve Carapace Length (CCL) 1.34 m and Curved Carapace Width (CCW) 0.87 m; in 2007 6 specimens of *C. caretta* in Cañaveral with an average of CCL 0.98 m and CCW 0.87 m and for the 2008, a unit of *E. imbricata* with CCL of 0.95 m and CCW of 0.81 m. With respect to the egg biometry obtained in the 2007 data of weight average of 39.10 g for *C. caretta* whereas for the 2008, the measured eggs of some broods reached averages of 42.2 g of weight and 4.1 cm of diameter for *C. caretta* (n= 10) and of 40.0 g and 3.7 cm for *E. imbricata* (n=10), being within the reported general ranks. The morphometrics of hatchlings also took newly emerged, obtaining for the 2005 values of Straight Carapace Length (SCL) of 6.54 cm and Width Carapace Length (WCL) of 3.94 cm in *D. coriacea* (n=5) and in *C. caretta* (n=10) an average of 4.32 cm SCL and 3.20 cm. In the 2006 the *D. coriacea* (n=12) reached SCL of 6.7 cm and WCL of 4.35 cm; for *C. caretta* (n=10) the average of SCL was 4.38 cm and WCL of 3.41 cm and *E. imbricata* (n=27) with SCL 4.14 with and WCL 3.17cm. In 2007, *C. caretta* (n=72) showed of SCL 4.32 and WCL of 3.20 cm, very similar to those of the 2008 for the same species (n= 10) with SCL 4.3 cm, WCL 3.5 cm and weight 11.0 g; for *E. imbricata* (n=20) SCL 4.1 cm, WCL 3.0 cm and weight of 20.6 g. Finally the percentage of hatchlings obtained in (2005) 49.8% of 538 eggs; (2006) 14.23% of 885 eggs; (2007) 39.5% of 372; (2008) *C. caretta* 40.5% of 106, *E. imbricata* 63.8% of 104, makes suppose the necessity to implement handling measures to ensure the reproductive success of the species that arrive there.

TEMPERATURE EFFECTS IN HATCHLING SEX DETERMINATION AND "SLIDING LANDMARKS" METHOD VALIDATION FOR THE SEX ESTIMATION BY MEANING IN MORPHOMETRIC IN THE SEA TURTLE *DERMOCHELYS CORIACEA*

Laura Natalia Romero[1] and Nicole Valenzuela[2]

[1] Laboratorio de Biología Molecular Marina, Universidad de los Andes, Bogota, Colombia
[2] Department of Ecology, Evolution, and Organismal Biology, Iowa State University

The sea turtle *Dermochelys coriacea* exhibits temperature–dependent sex determination (TSD). At the pivotal temperature (29.4°C) a 1:1 sex ratio is produced, while higher temperatures bias sex ratios toward females, and lower temperature toward males. Nevertheless, the relationship between fluctuating temperatures and sex in nature remains poorly understood. Additionally, identification of hatchling's sex is difficult because juveniles are not obviously externally dimorphic, and current techniques to estimate sex are often logistically unfeasible for field studies or not recommended for endangered species. In this study, we developed an alternative to indentify the sex of hatchling turtles using a "sliding landmark"-based geometric morphometric method. Sex ratio data was then used to test two models for the prediction of sex determination under fluctuating temperature, namely, constant temperature equivalent (CTE) and cumulative temperature units (CTUs). We tested for the effect on sex ratios of three conservation strategies to manage nests (nests incubated in situ, relocated in a beach and relocated into a hatchery) at the Querepare beach, Peninsula of Paria, Sucre State - Venezuela The morphometric analysis revealed that the hatchling turtles of *D. coriacea* have a noticeable sexual dimorphism in the external morphology of the carapace, and the morphometric approach proved to be a suitable tool to estimate the sex of hatchlings with high accuracy, thus providing researchers with a noninvasive and inexpensive alternative. Population-specific studies are needed to determine the discriminant function for sex assessment at particular localities. The analyses of the sex determination showed that the CTE model is superior to the CTU model at explaining sex determination in natural nests of *D. coriacea*, with the average CTEs describing 52% the variation of the observed sex ratios. The comparison among nest management strategies revealed a significant difference among treatments, marked by a bias towards females in the nests located in the hatchery in comparison to nests incubated in situ and relocated in a beach. Further research exploring the potential effects of other physicochemical variables on sex determination will complement the findings on this study. Finally, because relocation of nests to hatcheries have a strong biasing effect on hatchling sex ratio, this management activity should be restricted to instances where protection of nests in situ or relocation to a beach are not feasible, and implemented with caution by choosing a location most similar in its characteristics to the original location of the nests.

ANOMALIES IN DORSAL AND COSTAL SCUTES IN LOGGERHEAD HATCHLINGS FROM MANIPULATED NESTS

S. Jiménez Bordón, M. Medina Suárez, A. Liria Loza, and L.F. López-Jurado

Universidad de Las Palmas de Gran Canaria, Gran Canaria, Spain

The five dorsal and five pair of costal carapace scutes characterize the loggerhead turtle. The number of marginal scutes is variable (12 to 13), but the dorsal and costal scutes are taxonomic characters. In the last years some authors was seen different numbers of dorsal and costal scutes than five, and some suggest that the cause of this anomalies is the manipulation of the nest to moving them to hatcheries. Since 2006 a reintroduction project has been carried out in the Canary Islands (Spain), moving nests from the Capeverdian loggerhead population to the Canarian beaches. Each year are transported 9 or 10 nests to suitable beaches in Fuerteventura Island (Canary Islands, Spain). The eggs are taken from the females in the oviposition moment and the nests are traslocated directly. The time of transport of the nests is about 15 to 20 hours, and the eggs are reincubated immediately in Canarian beaches. This study describes this type of variation in the carapace scutes of 1130 loggerhead hatchlings from 19 different nests, whose eggs have been manipulated to travel long distances (from Cape Verde to Canary Island) in 2009 and 2010.

LOGGERHEADS (*CARETTA CARETTA*) ON THE RISE? NESTING IN THE ARCHIE CARR NWR, FLORIDA, USA IN 2010

Cheryl L. Sanchez, Dean A. Bagley, and Llewellyn M. Ehrhart

University of Central Florida, Orlando, Florida, USA

The Archie Carr National Wildlife Refuge (ACNWR) in south Brevard County, FL, USA is one of the most important loggerhead nesting beaches in the western hemisphere and accounts for approximately 25% of all loggerhead nesting in Florida. The University of Central Florida (UCF) Marine Turtle Research Group began studying marine turtles in this area in 1982, leading to the development of the ACNWR in 1989. The southern Brevard portion of the Refuge comprises 21-kilometers of beach and is surveyed every season from 1 March to 31 October for marine turtle nesting activity. Since the establishment of the ACNWR, survey protocol has followed Florida's standardized Index Nesting

Beach Survey program (INBS). Throughout the 1980s, loggerhead nesting averaged 9,270 nests per season. In the 1990s, more than 10,000 nests were laid each season, reaching a high of 17,729 loggerhead nests in 1998. From 1999-2009, mean nest production decreased to fewer than 10,000 nests per season, an average decrease of 39.3% relative to 1998. The 2010 season's total of 12,233 nests is the highest number of nests recorded since 2001. In fact, it represents a 41% increase relative to 2009. During the 2010 season, 150 nests were marked in order to measure and examine reproductive success, and more than 250 loggerheads were newly PIT tagged. Data for reproductive success are still being analyzed and will be presented. The average clutch size was 110 eggs, and the oldest recaptures were from 1996. Viewing this year's results in the context of our long-term data set (1982-2010) reveals that the past three years' nest numbers resemble those of 1988, 1989, and 1990. That level of nesting activity foreshadowed the doubling of loggerhead nesting seen during the decade of the 1990s. These results provide cautious optimism for the upcoming seasons.

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

Sarahi Sandoval[1], Victor M. Gómez-Muñoz[1], and Juan M. Rodriguez-Baron[2]

[1] Centro Interdisciplinario de Ciencias Marinas-Instituto Politécnico Nacional, La Paz, Baja California Sur, México
[2] Universidad Autonoma de Baja California Sur, P.C. 23080, km. 5.5 Carretera al Sur, La Paz, B.C.S. Mexico; Red Colombiana Para la Conservacion de Tortugas Marinas

It is well known that the temperature of sea turtle nests during the middle third of the incubation period is critical for sex determination. For *Lepidochelys olivacea*, temperatures below 28ºC produce males, above 32ºC females. Sex ratios of olive ridley hatchlings were estimated from average temperature nests in the middle period of incubation by using a Girondot curve fitted for this species with controlled temperature experiments and published data. Data were recorded in turtle camps from the states of Baja California Sur, Sinaloa, Colima and Guerrero; Mexico, during the 2009 and 2010 seasons. Programmable digital thermal sensors with a resolution of 0.02°C were used to record data every 30 minutes in 46 nests during the whole incubation period, near surface (10 cm depth), and at 30 cm depth (where the center of clutches are usually located). Nest temperature data was used during three periods of the nesting season 2009, early (July and August), middle (September and October) and late (November and December). Significant hatchling male production was determined only in the late season of the three northern areas: Baja California Sur, Sinaloa and Colima (98, 99.9, and 85%, respectively) and a very low 7% male production in Guerrero. Both in early and middle nesting seasons, when nest productivity is highest, female production was 100% predominant.

SEX RATIO ESTIMATIONS OF LOGGERHEAD SEA TURTLE HATCHLINGS BY NEST TEMPERATURES ON DALYAN BEACH, IN SOUTHWEST TURKEY

Fikret Sari and Yakup Kaska

Pamukkale University, Faculty of Arts and Sciences, Department of Biology, Denizli-Turkey

Temperature is an important factor for sea turtles, since they possess temperature-dependent sex differentiation owing to the absence of their sex chromosomes. The aim of this study was to estimate hatchling sex ratios in the loggerhead turtle (*Caretta caretta*) and show the changes in sand temperatures according to distance to the sea on Dalyan beach during 2010 breeding season. To estimate sex ratios, electronic temperature recorders were placed in 24 nests but two of these nests were predated by foxes. Over the season, mean nest temperatures during the incubation periods ranged from 27.2 to 31.3 °C while the mean temperature in the middle third of the incubation period ranged from 27.9 to 31.8 °C and incubation period ranged from 46 to 66 days. The mean temperature during the middle third of the incubation period is a good indicator of the sex ratio of the clutch. Using the mean temperature during this period, it was calculated that 60.9% of the hatchlings were females. The nests at the beginning of the season produced more males. The sand temperature analyses showed that sand temperature varied with the distance from the sea. Furthermore, there was a positive correlation between the temperature and the distance from the sea. This sex ratio result contrasts with the highly female-skewed sex ratios in loggerhead turtles elsewhere; Dalyan has a relatively high proportion of male hatchlings. Dalyan beach is an important nesting ground for endangered loggerhead sea turtles because survival of sea turtle populations depends on the production of offspring of both sexes. The results were analyzed both seasonal and temporal distribution of the nests on the beach. The nests laid in May produced quite remarkable male proportion and discussed under the regular conservation efforts run by University students usually started at the beginning of June each year.

NESTING BEHAVIOR OF HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) ON AN URBAN BEACH AND ITS IMPLICATIONS IN CONSERVATION

Cinthia Saska, Camila Poli, and Rita Mascarenhas

Universidade Federal da Paraíba, João Pessoa, Paraíba, Brazil and Associação Guajiru - Projeto Tartarugas Urbanas, Cabedelo, Paraíba, Brazil

The nesting activities in two spawning areas for the hawksbill turtle were compared, in which one was totally urbanized, the beach of Intermares of the north coast of the state of Paraiba (07º03'S, 34º50'W) and the other on non-urban beaches of the south coast of the state of Rio Grande do Norte (6°11'S, 35°05'W). The behavior was based on 49 nesting of 35 females and observed by a single person at a distance of 2-4 m from the animal, utilizing the method all occurrence sampling and noting the time of each phase and total time. On the urban beach, we measured luminosity at two heights (ground and 1.70 m), at five points in the nest(North, South, East-sea, West-fringe and Central), and in both areas, we measured the noise of the environment. On the urban beach, five of 27 females showed an altered behavior. On the non-urban beaches, we observed nine nesting of eight different females, and none showed behavioral alterations. The hawksbill turtles showed the following mean times (in minutes) for each phase of nesting: emerge (urban: 8.9 ± 4.2, N = 22; non-urban: 4.2 ± 1.6, N = 5), body pit (urban: 6.9 ± 4.7, N = 28; non-urban: 9.4 ± 9.2, N = 5), dig (urban: 20.8 ± 4.6, N = 29; non-urban: 22.4 ± 7.8, N = 5), oviposition (urban: 18.2 ± 4.7, N = 38; non-urban: 22.1 ± 5.5, N = 8), cover (urban: 13.1 ± 3.8, N = 38; non-urban: 11.6 ± 3.1, N = 8), camouflage (urban: 11.5 ± 5.9, N = 38; non-urban: 13.5 ± 7.0, N = 8), return (urban: 2.8 ± 1.3, N = 25; non-urban: 4.3 ± 2.1, N = 9), and total time (urban: 84.9 ± 13.9, N = 20; non-urban: 83.2 ± 3.6, N = 5). Comparing the two areas, on the urban beach, the turtles were slower during emerge (Mann-Whitney test: U = 10.5, P = 0.0055) and faster during oviposition and return (t test: t = -2.0933, P = 0.042; Mann-Whitney test: U = 61.0, P = 0.0444, respectively). There was a negative correlation with significant difference only between luminosity at the point North (ground) and the phase body pit (rs = -0.3760, P = 0.0443). Luminosity at points West, North and Central was significantly different for the behaviors considered expected and altered (Westground - Mann-Whitney test: U = 16.00; P = 0.0032; West1.7m - Mann-Whitney test: U = 15.00; P = 0.0028; Northground - Mann-Whitney test: U = 29.50; p = 0.0159; North1.7m - Mann-Whitney test: U = 38.50; P = 0.0402; Centralground - Mann-Whitney test: U = 11.00; P = 0.0018; Central1.7m - U = 18.00; P = 0.0045). In both areas, the environmental noise was the same and there was no correlation between total time and noise. In this study was observed that urbanization alters the nesting behavior and may accelerate some phases of the nesting of the hawksbill turtle, where this is an important problem in conservation projects of sea turtles.

RELATING NESTING FEMALE BODY SIZE TO CLUTCH SIZE, NESTING FREQUENCY, AND HATCHING SUCCESS IN LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, AT JEKYLL ISLAND, GEORGIA, USA

Joseph Scarola

Georgia Sea Turtle Center, Jekyll Island, Georgia, USA

Data for Loggerhead Sea Turtles nesting on Jekyll Island, Georgia (USA) was reviewed from 2007-2009. Straight carapace length (notch to notch) of 82 turtles was taken for three consecutive seasons (2007-2009) and body size was correlated to three different variables; clutch size, nesting frequency and hatching success. From those 82 nesting

females, 219 nests were analyzed and the mean clutch size was found to be 108 eggs (±26) for all nesting loggerheads, while the nesting frequency of each loggerhead sea turtle was 3 times per season (±2). Hatching success of each nest was determined to be on average 65 % (±34 %). There was a strong positive correlation between nesting female body size and clutch size ($r = 0.5109$, $P < 0.01$), indicating that females of larger size may lay more eggs than females of a smaller size. However, there were only weak positive correlations between body size and both nesting frequency and hatching success ($r = 0.31$and $r = 0.17$ respectively; $P < 0.01$), which may indicate no correlation at all.

ENVIRONMENTAL EFFECTS ON LOGGERHEAD NEST INCUBATION TEMPERATURES AND HATCHING SUCCESS IN SOUTHWEST FLORIDA: IMPLICATIONS FOR CLIMATE CHANGE

Jill Schmid[1], David Addison[2], and Victoria Vazquez[1]

[1] Rookery Bay National Estuarine Research Reserve, Naples, Florida, USA
[2] The Conservancy of Southwest Florida, Naples, Florida, USA

During 2001, 2002, and 2004 – 2010, a total of 524 HOBO® temperature data loggers were deployed in loggerhead nests in situ to monitor incubation temperatures on Keewaydin Island, Collier County, Florida. The study was initiated to examine the effect of exotic vegetation removal on incubation temperatures. These efforts have continued in order to examine long term temperature trends and the role environmental factors play in determining hatchling sex ratios. A HOBO® rain gauge was deployed on Keewaydin Island to record rainfall events and air temperature for the duration of the 2010 sea turtle nesting season to further examine their influence on incubation temperatures and hatching success. The loggerhead nesting season in Florida coincides with the hurricane season so the intensity and timing of rainfall and tidal conditions associated with these events can significantly impact incubation temperatures. Results of the study have shown significant annual and seasonal variability in incubation temperatures that appeared to be correlated to La Nina and El Nino climatological patterns. Nests on Keewaydin Island produced predominately mixed ratio clutches during El Nino years and male biased clutches during La Nina years based on both incubation temperature predictions and histological evaluations. Climate change is predicted to alter the frequency and intensify storm activity potentially impacting hatchling sex ratios. These long term data can be used to model past and present scenarios and provide insight to the extent climate change may impact sea turtle populations.

YEARLY NESTING PATTERNS AND SITE FIDELITY IN SOUTHERN BAJA CALIFORNIA SUR OLIVE RIDLEY SEA TURTLES

Nicole R. Schuetz[1], Nancy E. Mathews[1], Timothy R. Van Deelen[2], Jorge Gonzalez Villalba[3], and Graciela Tiburcio[3]

[1] Nelson Institute for Environmental Studies, University of Wisconsin-Madison, Madison, WI, USA
[2] Forest and Wildlife Ecology, University of Wisconsin-Madison, Madison, WI, USA
[3] Programa para Protección, Conservación e Investigación de Tortugas Marinas: Campamento Tortuguero Don Manuel Orantes, San Jose del Cabo, Baja California Sur, Mexico

Listed as vulnerable by the IUCN, olive ridley sea turtle (*Lepidochelys olivacea*) populations have been declining for decades, primarily due to coastal development, by-catch and poaching. As human-use of coastal areas increases, turtle populations are increasingly adversely affected primarily due to the destruction of nesting habitat. Though sea turtles are believed to be highly philopatric to their hatching locations, little data exists on fidelity and return rates. This study was conducted on the southern tip of the Baja Peninsula, from 2001 to 2010 to assess breeding characteristics of female olive ridley sea turtles and their beach fidelity. The objectives of this study were to assess the nest characteristics and size of females to determine the degree of beach fidelity exhibited by olive ridley sea turtles and morphological variation. Capture, mark and recapture data were collected during nightly beach patrols and beach fidelity was assessed by calculating return rates. Quasi-AIC was used in program MARK to estimate the apparent survival and the encounter

probability, to calculate return rates. Results suggest that carapace size, clutch size, and reproductive frequency of females using beaches on the southern tip of the Baja Peninsula, Mexico, closely matches those parameters in populations reported elsewhere. We estimated a 4.15 percent return rate, suggesting that female olive ridleys exhibit a certain degree of beach fidelity. This study provides the first detailed report on the beach fidelity, nesting characteristics and carapace size of olive ridley sea turtles near San Jose del Cabo, Mexico.

INCUBATION TEMPERATURES OF LOGGERHEAD TURTLE (*CARETTA CARETTA*) NESTS DEPOSITED ON NORTHWEST FLORIDA BEACHES

Brail S. Stephens [1], Margaret M. Lamont[1], Raymond R. Carthy[2], and Lorna Patrick[3]

[1] Florida Cooperative Fish and Wildlife Research Unit, Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida, USA
[2] U.S. Geological Survey, Florida Cooperative Fish and Wildlife Research Unit, Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida, USA
[3] U.S. Fish and Wildlife Service, Panama City Fish & Wildlife Service, Panama City, Florida, USA

Sex ratio directly relates to reproductive rate and adaptive capability of a population and is essential for determining size, status, and dynamics of the population. Sex determination of sea turtles is dependent upon the temperature at which the eggs are incubated therefore understanding characteristics of nesting beaches that regulate beach temperatures is critical to our knowledge of sex ratio. The objectives of this study were to: (1) determine sand temperatures and loggerhead nest incubation temperatures, (2) determine the relationship between sand temperatures and incubation temperatures, and (3) examine variations in incubation rates, sand temperatures, and incubation temperatures at four nesting beaches in Northwest Florida. From 1998 – 2003 temperature data loggers were placed in the sand at four nesting beaches in Northwest Florida: Perdido Key, Walton County, St. Joseph Peninsula and St. George Island. At each site, loggers were placed in three transects at defined depths near the base of the dune and at mid-beach. In addition, in 1998 and 1999, loggers were placed inside loggerhead turtle nests throughout incubation. Temperatures were recorded hourly from May 15 through October 15. Daily averages were calculated for each transect and within each nest, and all data were standardized to the same time frame. A Student T-test was used to assess differences among means for beach temperatures, incubation temperatures, and incubation rates. Preliminary results indicated that sand temperatures increased from west to east, with warmer sand temperatures east of the Cape San Blas spit (27.7° C) and cooler sand temperatures west of the Cape San Blas spit (28.8°C; $p < 0.05$). Perdido Key, Walton County, and St. Joseph Peninsula were all statistically cooler than St. George Island. Temperatures near the dune and at mid-beach were nearly identical at all sites. Incubation rates were shorter from west to east ($p < 0.05$), with rates for Perdido Key (63 days), Walton County (62 days), and St. Joseph Peninsula (60 days) statistically longer than rates on St. George Island (57 days). From 1998 through 2003, overall mean sand temperatures decreased (28.7° C to 27.7°C), although not all comparisons were statistically significant. Temperature data from inside nests are forthcoming. The Cape San Blas spit appears to be the dividing point with sand temperatures warmer and incubation rates longer east of the spit than west of the spit. Beach orientation may be a possible explanation for these differences. Beaches west of the spit face SW whereas those east of the spit face south or SE, which may allow for greater sun absorption. More likely however is the effect of albedo. Sand east of the Cape San Blas spit may be darker due to sediments and debris from the Apalachicola River and thereby may absorb more solar energy making sand temperatures warmer. As expected, shorter incubation rates east of the Cape San Blas spit resulted from warmer sand. The overall decrease in sand temperatures observed from 1998 through 2003 may be linked to global climate patterns with the highest global temperatures on record observed in 1998.

SIGNIFICANT IMPACTS OF RAINFALL ON INCUBATION DURATION AND HATCHLING SEX IN LEATHERBACKS MAKE INCUBATION DURATION A POOR INDICATOR OF HATCHLING SEX

April Stevens and P. Chow-Fraser

McMaster University, Hamilton, ON Canada

The effects of rainfall on in situ sea turtle nests have largely been understudied. Existent literature details the effects of large rainfall events causing drowning; however, incubation durations and hatchling sex ratios resulting from exposure to consistent rainfall have mostly gone unstudied. The aim of this research was to determine the effects of rainfall on incubation duration as it related to potential sex ratios of Leatherback sea turtle nests on Playa Norte, Costa Rica. Daily ambient air temperature and rainfall were monitored throughout the nesting seasons. In-nest temperatures were monitored by placing HOBO® tidbit data loggers in the middle of each clutch (n=15). As expected, a significant positive correlation (p= 0.0395) for rainfall on incubation duration was found. However, incubation durations (mean= 64 days) proved to be incorrectly predicting sex ratios arising from those nests, as determined by in-nest temperatures during the critical sex determination period. This research is significant in light of species conservation and the potential climate change impacts of increasing global temperatures and weather pattern changes. As it is important to be able to reliably estimate potential sex ratios, this work will help modelers predict sex ratio production more accurately and possibly help protect those habitats necessary for male hatchling production during increasing global temperatures.

A PRELIMINARY ANALYSIS OF LEATHERBACK PIT TAGGING DATA FROM THE BIRD'S HEAD PENINSULA, PAPUA BARAT, INDONESIA

Ricardo F. Tapilatu[1], Deasy Lontoh[2], Peter H. Dutton[3], Manjula Tiwari[3], Scott R. Benson[3], Creusa Hitipeuw[4], and Thane Wibbels[5]

[1] Marine Laboratory, The State University of Papua (UNIPA), Manokwari (98314), Papua Barat Province, Indonesia
[2] Moss Landing Marine Laboratories, Moss Landing, CA 95039, USA
[3] Protected Resources Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration
[4] WWF Indonesia, Kantor Taman A9, UnitA-1, Kawasan Mega Kuningan Jakarta 12950, Indonesia
[5] Department of Biology, University of Alabama at Birmingham (UAB), AL 35294-1170

Jamursba-Medi and Wermon beaches on Bird's Head Peninsula in Papua Barat, Indonesia, are believed to support the largest remaining nesting aggregation of endangered leatherbacks in the Pacific. The Jamursba-Medi beach complex is separated from Wermon by about 30 km. Nesting activity peaks in July at Jamursba-Medi, whereas at Wermon nesting activity is bimodal with peaks in December and June. Beginning in 2003, we began periodically tagging females with Passive Integrated Transponder (PIT) tags. Tag-recapture effort was opportunistic through 2008, but a systematic protocol was initiated during the 2009-2010 nesting season. Between 2003 and 2010, 977 distinct females were tagged. Remigration intervals were documented for some females, and a few females nested on both Jamursba-Medi and Wermon during the same season. Committed long-term population monitoring and protection are prerequisites for determining the conservation status and initiating the recovery of the Pacific leatherback. We thank U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service, Western Pacific Regional Fishery Management Council and International Sea Turtle Society for their generous supports to fund our participation in the Symposium.

TEMPERATURE-DEPENDENT SEX DETERMINATION AND TURTLE CONSERVATION PROGRAMS: WHICH TEMPERATURES ARE BEST?

Corie Therrien and Thane Wibbels

University of Alabama at Birmingham, AL, USA

A variety of turtle conservation programs artificially incubate eggs. These programs often have to choose specific temperatures for incubating the eggs. For example, if a 1:1 sex ratio were desired, do you incubate all the eggs at a pivotal temperature or do you incubate half at male-producing and half at female-producing temperature? The differential fitness hypothesis suggests that the fitness of hatchlings may vary with specific incubation temperatures. The current study addressed the potential physiological mechanism by which temperature-dependent sex determination might affect fitness. The effects of specific incubation temperatures on the morphology and endocrinology of the gonads and reproductive tracts were examined in the red-eared slider turtle (*Trachemys scripta*). Gonads and reproductive tracts were compared between late-stage embryos incubated at temperatures that produced either 1) all females, 2) mostly females, 3) mostly males, or 4) all males. The gross morphology and histology of the reproductive tracts of these four groups were compared and the testosterone and estradiol-17B content were measured. The results indicate significant variation between the gonads of females incubated at different temperatures and moderate differences in the males. The results show morphological and physiological variation in the gonads of from turtles incubated at different temperatures. These findings provide a potential mechanistic basis for the differential fitness hypothesis. Further, the results provide insight on optimal incubation temperatures for turtle conservation programs that artificially incubate eggs.

WHERE HAVE THE NEOPHYTES GONE?

Dominic Tilley and Kathryn Levasseur

The Jumby Bay Hawksbill, Long Island, Antigua, W.I.

In order to conserve long-lived species such as sea turtles, it is essential to understand their different life stages. Estimating the age at which turtles reach sexual maturity is fraught with difficulty but primordial to assess the overall health of a population. For the past 24 years, the Jumby Bay Hawksbill Project (JBHP) has been monitoring hawksbill turtles (*Eretmochelys imbricata*), nesting on Long Island (Jumby Bay), Antigua. Using saturation tagging from the onset, it was established that 98% of the population has a remigration interval of 2 to 4 years, thus from 1991 onwards a clear separation between neophytes and remigrants was done. This allows us to observe the fluctuations of neophyte input in the population and attempt to determine the causes of such events. The average neophyte input has more than tripled since 1991, driving recruitment and now representing up to 43% of annual nesting cohorts. Over the last 8 years of monitoring, the neophyte input averages 22.2 individuals (SD= 4.9); however, 2004 and 2010 only see 15 individuals. Excluding these seasons, the neophytes average 24.3 individuals (SD= 3.1). So, where have the neophytes gone? Added to these drops, sharp increases in nesting occurred in 1998 and 2002 setting levels for the following seasons. Based on our assumptions, and, using empirical and historical evidence, we attempt to explain the population fluctuation over the last quarter of a century and estimate the age at which hawksbill turtles reach sexual maturity on Long Island, Antigua. We discuss the implications in terms of population structure and the ecological consequences this presents as well as the limitations of this research. My attendance to this symposium has been made possible through the generous grants from the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service, and support from the Jumby Bay Hawksbill Project and the International Sea Turtle Symposium.

SEASONALITY OF OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) EMBRYOS WITH REGARD TO INCUBATION TEMPERATURE AND RAINFALL AT NANCITE BEACH, COSTA RICA*

Roldán A. Valverde[1], Luis G. Fonseca[2], and Romeo M. Spínola[2]

[1] Southeastern Louisiana University, Hammond, Louisiana, USA
[2] Instituto Internacional en Conservación y Manejo de Vida Silvestre, Universidad Nacional, Costa Rica

We studied embryo development, hatching and emergence rates of olive ridley embryos as a function of incubation temperature and rainfall at Nancite beach, Costa Rica during the months of August 2009 and January 2010. Experimental nests from rainy season (August – November) were exposed to a mean rainfall of 286 mm (min: 194.10 mm, max: 340.00 mm), whereas dry season (December and January) nests were exposed only to a mean rainfall of 6.58 mm (min: 0.40 mm, max: 8.20 mm). Incubation temperature of experimental rainy season nests was 1.21°C (CI95 %: 0.50, 1.92) lower in the average than dry season nests. We found that experimental nests from the rainy season exhibited a hatching rate of 17.75 (CI95 %: 8.11, 27.40) higher than dry season nests. Rainy season experimental nests yielded 491 hatchlings, whereas those from the dry season only yielded 32. We suggest that the high incubation temperatures observed in dry season nests are responsible for the low hatching rate. We recommend the continued monitoring of incubation temperatures & rainfall over the years in order to generate empirical information that allows us to determine the causes of the low hatching rates exhibited by arribada beaches in the region.

GENETIC VERSUS ENVIRONMENTAL CAUSES OF EXTREME MALFORMATIONS OF FLATBACK EMBRYOS

Roger Vanderlely and Michael L. Guinea

Charles Darwin University, Darwin, NT, Australia

Extremely deformed embryos were found amongst the clutches laid by three individual Flatback Sea Turtles, *Natator depressus*, at West Alligator Head, Northern Territory, Australia. The three beaches at West Alligator Head support a population of fewer than 80 nesting flatback sea turtles. Over the nesting seasons of 1993 and 1994, nine nests were transferred to a hatchery set up on the beach to protect them from predation by monitor lizards (*Varanus panoptes*). Other nests were left undisturbed to assess natural hatching success. All nests were moved during laying to minimise movement induced mortality. Nests protected in the hatchery were examined 24 hours after hatching as were those that survived in situ. All of the nesting turtles were tagged. Moved and in situ nests were identified to their respective female. Female CA108 had a high percentage of deformed hatchlings in 1993 and 1994 and from preliminary studies in 1992. Deformities occurred in clutches left in situ and in those that were relocated to the hatchery. Two other females had high rates of deformities in hatchery protected nests. Unfortunately their in situ nests did not survive predation by monitors. Deformities in embryos from hatched nests included: dicephalic, amelanistic and hypomelanistic and cycloptic embryos, macrocephalic, incomplete jaw formation, and incomplete closure of the plastron with unbounded organs with and without malformation of the carapace. This small population of nesting Flatback Sea Turtles displayed a high frequency (2.5%) of gross malformations of unhatched embryos. The evidence suggests these abnormalities are genetic, or possibly teratogenic, rather than being caused by relocation to a hatchery. This population may be a relict faced with eventual extinction given the high proportion of malformed embryos, the high levels of nest predation during the survey, the high philopatry of the nesting population, and the nesting season coinciding with the cooler months of the year. Additionally the beaches flank the northern shores of Australia with no means for the population to gradually shift southwards in response to a predicted global warming scenario.

INTER-NESTING MOVEMENTS OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) NESTING AT NEEDHAM'S POINT, BARBADOS*

Julian A. Walcott[1], Scott A. Eckert[2], and Julia A. Horrocks[1]

[1] Department of Biological and Chemical Sciences, University of the West Indies, Cave Hill Campus, Cave Hill, St. Michael, Barbados, BB 11000
[2] WIDECAST, 1348 Rustic View Drive, Ballwin, Missouri, 63011, USA

The management and conservation of the Critically Endangered hawksbill turtle requires an understanding of many different aspects of its ecology. Inter-nesting movements, i.e. at-sea movements of females between nesting activities within a breeding season, is an important yet little studied component of sea turtle biology. Selected females nesting on the national index beach in Barbados (Needham's Point) during the 2008 - 2010 breeding seasons were outfitted with GPS dataloggers (utilising Sirtrack FastlocTM software) after successful nesting events. Study animals were tracked for the duration of either one or two inter-nesting intervals (15 or 30 days respectively) before data were downloaded during subsequent nesting events and analysed using GIS software (ArcGIS 9.2). After nesting, females swam away from the nesting beach to inter-nesting resident areas, defined as the area of concentrated movements where the majority of the inter-nesting interval was spent. Resident areas ranged from 0.7 - 21.2 km from the nesting beach, and were usually reached within 24-hours of nesting. Once reached, females exhibited relatively localized movements within these habitats for the following 8 - 13 days. Following these periods, females began their return to the nesting beach. Movements between the nesting beach and inter-nesting habitats were typically parallel to the coast and never exceeded 2.5 km from the coastline. Females tracked for more than one inter-nesting interval exhibited both temporal and spatial variation in their movements, yet the inter-nesting resident areas utilized by each female were generally very similar.

DETERMINE THE SEX RATIO OF GREEN TURTLE HATCHLINGS IN TAIWAN; HISTOLOGICAL EXAMINATION

Cheng Wan-Hwa[1], Chang Yu-Yin[2], Lee Ken-Pei[2], King Rowena[1], and I-Jiunn Cheng

[1] Institute of Marine Biology, National Taiwan Ocean University, Keelung, Taiwan, 202-24, ROC
[2] Department of Life Science, National Taiwan Ocean University, Keelung, Taiwan, 202-24, ROC

Sex ratio is one of the key life history traits for sea turtle population. It is important because the sea turtle is temperature-dependent sexual differentiation (TSD) during embryogenesis. Males typically produce at lower temperatures and female produce at higher temperatures. Biased sex ratio may results in the extinction of the population, especially for the endangered species like sea turtles. Thus, the fitness of the population depends critically on the incubation temperature, especially during the middle third of incubation, when the sex organs are formed. Currently, most studies found that the sex ratios of sea turtle hatchlings are female-dominated. In Taiwan, the nesting ecology studies of green turtle on two main nesting sites; Wan-an Island of Penghu Archipelago and Lanyu Island of Taitung County have been carried out more than 13 years. In spite the fact that sex ratios on both islands were estimated based on the incubation temperature, the sex of hatchlings has not been determined directly. By using the histology examination (H & E method), we determined the sex ratio of dead hatchlings from these two islands during the nesting season of 2010. We only use the dead fetus because of the endangered status of green turtle and low nesting females (barely exceeds 20 nesters per season) in Taiwan. A total of 60 dead hatchlings were determined; 19 from 6 nests on Wan-an Island and 41 from 3 nests on Lanyu Island. Results showed that the sex ratio was 88±21 % female from Wan-an Island, and 62±46 % from Lanyu Island. These data were close to the sex ratios estimated from the temperature loggers on both islands, and also suggest the female-dominated hatchlings from Taiwan. However, due to the fact that the proportion of dead hatchling varies from nest to nest, more nests and sand temperature during the incubation period are needed to obtain a better picture of the hatchling sex ratio from nesting sites in Taiwan.

THE EAST END MARINE TURTLE PROJECT, ST. CROIX, U.S. VIRGIN ISLANDS (1994-2010)

Ryan C. Welsh and Amy L. Mackay

East End Marine Turtle Project, Lusby, Maryland, USA

In 1992, three adjacent pocket beaches (East End Bay, Issac's Bay and Jack's Bay known collectively as the East End Beaches) on the eastern end of St. Croix, US Virgin Islands were identified as important nesting habitat for green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles. Since 1994, a combination of daytime and nighttime monitoring activities has provided valuable information on these nesting populations. The number of nesting greens has increased steadily since 2001 while overall hawksbill numbers have decreased. Each season, nest success in both species is most significantly threatened by predation by the introduced Asian mongoose (Herpestes javanicus), poaching, and coastal erosion. Continued monitoring and new research are warranted while expanded conservation activities are needed to mitigate the threats to these populations.

MAZIWE ISLAND: CO-MANAGEMENT INITIATIVE LEADS TO FIRST HATCHING SUCCESS IN OVER THREE DECADES

Lindsey West, Catharine Joynson-Hicks, John Mbugani, and Omari Abdallah

Sea Sense, PO BOX 105044, Dar es Salaam, Tanzania

Maziwe Island Marine Reserve in Pangani District, northern Tanzania has long been known as an important sea turtle nesting site. In the mid-1970’s, it was widely considered to be one of the most important breeding grounds for sea turtles in East Africa as a whole (Frazier 1976) and was a key site for nesting populations of olive ridley turtles. In the 1980’s, vegetation on Maziwe Island was removed and the island subsequently submerged due to erosion. It now exists as a shifting tidal sand bank on top of Maziwe reef and has therefore been considered an unsuitable nesting site. No further records of olive ridley nests have since been made in Tanzania. However, local fishers and dive operators have repeatedly observed sea turtle tracks when the island is exposed at low tide, suggesting that sea turtles continue to nest on the sand bar even though the nests are inundated during both spring and neap tides. As a result of these reports, an action plan was agreed between Tanzania Marine Parks and Reserves Unit, a marine conservation NGO, a local dive operator and a community fisher association. Patrol groups were recruited and trained in the identification of sea turtle nests and nest translocation protocols. Daily patrols of the island commenced in April 2009 and all nests were carefully translocated to a pre-determined site on the mainland. For the 18 month period between April 2009 and September 2010, 58 nests were recorded and translocated to the mainland. During the incubation period, the nests were monitored and protected from predators and poachers by the dive operator staff. 36 nests hatched successfully with 3,326 hatchlings reaching the sea. Average hatchling success rate was 73%. All were laid by green turtles. 22 nests failed to hatch and each was carefully excavated after 70 days following initial translocation. Most of the failed nests contained rotten eggs suggesting that the nests were inundated by the high tide before they were translocated. Upon excavation, five nests contained a significant proportion of fully developed hatchlings that had failed to hatch. Excessive temperature within the nest may have been a causal factor. The Maziwe Island sea turtle conservation programme has created a lot of local interest and has provided a valuable opportunity to engage a variety of stakeholders in sea turtle conservation. Members of the local fishing community, District officials and tourism operators have participated in a sea turtle workshop and are actively participating in the sea turtle conservation programme. Community events focusing on sea turtle conservation have been held and Pangani District is now being promoted as a key site for sea turtle ecotourism. A programme of mangrove re-planting is currently underway to try and stabilise Maziwe Island, prevent further erosion and re-establish the island as a key nesting site for sea turtles in Tanzania and the wider coastal zone of East Africa.

EXPANDING NESTING RANGES: THE SOUTHERNMOST RECORDS OF *CHELONIA MYDAS* AND *LEPIDOCHELYS OLIVACEA* NESTING ACTIVITY IN THE EASTERN PACIFIC

Jasper H. Wester[1], Shaleyla Kelez[2], and Ximena Velez-Zuazo[3]

[1] Leiden University, Leiden, The Netherlands
[2] ecOceanica, Peru & Duke University Marine Lab, Durham, NC, USA
[3] ecOceanica, Peru & University of Puerto Rico, Rio Piedras, PR

Sea turtles are fairly common in Peru and use its marine environments as feeding grounds and migratory corridors to other feeding and breeding areas. The coasts of Peru have never been considered regular nesting areas and only a few nests have been reported in the 1970's. However, recent observations of olive ridley sea turtle (*Lepidochelys olivacea*) nests indicate that there are more reproductive events than previously estimated. Here we report the first observation of a green sea turtle (*Chelonia mydas*) nesting female in Peru and the documentation of a new olive ridley nest. These two reports occurred in the region of Piura and represent the southernmost nesting records in the Eastern Pacific for the two species. Between December 2009 and April 2010 field work was conducted in the town of Lobitos (4°26.92'S, 81°16.54'W), Piura and its surrounding areas. The research included an anthropological study of the local communities and conservations views regarding biodiversity and sea turtle conservation. It also included collecting data about wild sea turtle observations. The morning of the 5th of February, during a weeklong stay in a fishermen camp in Tres Cruces beach (4°24.22'S, 81°15.41'W, north of Lobitos), a green turtle was observed nesting north to the camp in the solitary beach. The green turtle was laying eggs when encountered and 2 hours later went back to the sea. On February 26th, an olive ridley nest was reported in Playa Negritos (4°42.25'S, 81°18.62'W) after fishermen observed the emergence of about 80 hatchlings. These reports confirm the occurrence of green turtle nesting in Peru and extend their nesting range to Tres Cruces from their previously southern range limit in the Beach of Salango (1°36'S) Ecuador. In the case of olive ridley, the nest reported here extends its nesting range 57 miles south from the previous southernmost report in a beach north of El Nuro (4°12.95'S), Piura. Interviews with local fishermen and other residents in and around Lobitos indicate that nesting was common in the past and that there has been a sharp decline of nesting activities. The field work also indicates that products such as meat, oil, blood, eggs and shells are being used by locals. Besides local consumption, a great threat to nesting habitat is the invasion of coastal areas, land trafficking and increasing coastal development. However, we believe that some of the threats could be significantly reduced if the importance of protecting turtle nesting sites is recognized. What is more, during our research in the area, some fishermen showed interest in helping conserve sea turtles and many people mentioned they want to see more turtles in the water. In this regard, ecOceanica, is committed to continue monitoring nesting activities in the north of Peru to identify and promote the protection of the most important beaches for sea turtles and thus contribute to the conservation of these species in the Eastern Pacific.

INCREASING HATCH SUCCESS AND DETERMINING CAUSES OF LATE-TERM MORTALITY IN DOOMED LEATHERBACK SEA TURTLE (*DERMOCHELYS CORIACEA*) NESTS

Emily G. Weston[1] and Jeanne A. Garner[2]

[1] Florida Atlantic University, Boca Raton, Florida, USA
[2] West Indies Marine Animal Research and Conservation Service, Frederiksted, St. Croix, USVI

Intensive nest protection and management of leatherback sea turtles nesting at Sandy Point, St Croix USVI over the past 30 years has contributed to a significant population increase. Continuous nightly monitoring throughout the nesting season has dramatically decreased both human poaching and animal predation of nests. Additionally, 40-60% of nests per season laid in the erosional part of the beach are routinely relocated to a more stable part of the beach to avoid washout. However, despite the increase in adult recruitment and nest numbers, hatch success and hatchling production has been declining on Sandy Point since 2001, particularly in relocated nests. Much of the increased mortality on Sandy Point occurs in the late-term stages, between days 45-60 of incubation. Therefore, we hypothesized that adverse environmental nest conditions, as opposed to maternal factors, were causing late-term death. A late-term artificial incubation experiment was implemented in 2006 and 2007 to investigate whether conditions in nest boxes could mitigate the late-term mortality seen in relocated nests. In addition, environmental parameters including temperature, CO2, and O2 were studied in both nest boxes and beach nests to determine their relationship to egg survival. Between days 48 and 52 of incubation, when eggs were less susceptible movement-induced mortality, relocated nest clutches (n=43) were excavated and live eggs were incubated in Styrofoam˙ boxes until hatching. Any dead eggs were staged and then discarded. In the experimental nest boxes, full-term hatch success and hatchling production was significantly increased when compared to relocated nests left incubating on the beach. Hatch success was not significantly related to nest temperature. However, measurements of respiratory gas concentrations in the nest boxes and on the beach suggest that decreased CO2 and increased O2 concentrations in nest boxes positively correlate with late-term survival of eggs. Adverse conditions on the beach such as altered nest morphology due to relocation, high nest density, compromised gas exchange, or increased microbial load may impact leatherback embryo survival. Because the nest box experimental protocol can increase the number of hatchlings per nest, it may be a valuable conservation tool for minimizing late-term death and boosting hatchling output of this critically endangered species.

A COMPARISON OF THE THERMAL INFLUENCE OF HATCHING AND EMERGENCE SUCCESS IN TWO MAJOR FLATBACK (*NATATOR DEPRESSUS*) ROOKERIES IN NORTH WESTERN AUSTRALIA

Jessica L. Williams

Murdoch University, Perth, Western Australia

Flatback turtles, *Natator depressus* are the least studied of all seven species of sea turtles and are the only species restricted to Australian continental waters. The north west of Western Australia (WA) contains one of four recognised breeding units and is a region of major industrial development. There is limited published baseline ecological data for the species at these sites. The aim of this study was to quantify standard measures of incubation success and evaluate environmental influences on *N. depressus* breeding at two locations; Barrow Island and Mundabullangana Station in the Pilbara region of north west WA. A total of 102 Nests were marked in December 2009 and monitored until February 2010 to collect incubation success data and nest temperatures were monitored using data loggers inserted in the nest at time of oviposition. Variations in local weather experienced at each rookery were highly influential in determining the incubation successes despite only 300km and less than 0.5 degrees of latitudinal separation. Rates of nest disturbance (predation, nesting females and tidal inundation) were significantly greater at Barrow Island although reasons for this difference remain unclear. Mean clutch size was not significantly different between the Mundabullangana and Barrow Island rookeries and is consistent with results reported from other *N. depressus* rookeries. Mean nest depth was 20% greater at Mundabullangana, than those from Barrow Island. The mean incubation period is significantly longer at Barrow Island (49.3 days) than Mundabullangana (47.3 days) however both are shorter than any reported in the literature for *N. depressus* and may be a response to consistently high ambient temperatures. Hatching (70.3%) and emergence success (62.1%) rates from Mundabullangana are the lowest recorded for the species and are significantly lower than Barrow Island. In contrast hatching (92.0%) and emergence success (87.7%) from Barrow are the highest rates recorded for any Western Australian Flatback population. Temperatures in undisturbed nests were significantly greater at Mundabullangana (34.0°C) than at Barrow Island (31.0°C) and peaked at 36.7°C, considered extreme for sea turtles. Estimates of metabolic heat were significantly greater at Barrow Island (1.4°C) compared to Mundabullangana (0.9°C). It is possible that as a consequence of high nest temperatures, both Barrow Island and Mundabullangana rookeries are currently biased towards female hatchling output. If temperatures increase as a result of global climate change it is possible that incubation temperatures exceeding lethal temperatures will significantly increase embryo mortality rates at both rookeries. Alternatively if lethal temperatures are not encountered feminisation of both the Barrow Island and Mundabullangana rookeries may occur in the future. Given the low incubation success rates of Mundabullangana and the high ambient and nest temperatures, it is possible that this rookery is marginal habitat for the species. Further monitoring of both populations is necessary to confidently quantify inter-seasonal and inter-rookery variation. Understanding the nesting ecology at both Barrow Island and Mundabullangana will be essential if the potential impacts of development and global climate change are to be detected and managed at two significant *N. depressus* rookeries.

LONG-TERM STUDY OF LOGGERHEAD SEA TURTLE HATCHLING SEX RATIOS ON TWO GEORGIA BARRIER ISLANDS (2000-2010)

Kristina L. Williams[1], Michael G. Frick[2], Anne Marie LeBlanc[3], Kristina Drake[3], Jacob Tuttle[3], Jessica Sparrow[3], and David Rostal[3]

[1] Caretta Research Project, Savannah, GA
[2] Friends of the National Zoo, Washington DC
[3] Georgia Southern University, Statesboro, GA

Hatchling sex ratios have been reported for loggerhead sea turtle beaches worldwide. Most studies have estimated sex ratios by recording nest temperatures throughout incubation for one or two seasons and have extrapolated those results to previous years. Alternatively, researchers have analyzed nest incubation durations, as speed of development increases with warmer temperatures (thus producing female hatchlings). However, there are many factors influencing nest temperatures both within and among seasons, including time of season, placement of nest on the beach and yearly environmental conditions. We estimated the sex ratios of 450 nests on Wassaw and Blackbeard Islands, Georgia from 2000-2010 using the pivotal temperature of 28.9°C reported by LeBlanc (2004). Most years produced a female biased sex ratio. No years were completely male biased. Mean incubation temperatures and mean critical period temperatures varied by both time of season and year, re-enforcing the importance of considering such fluctuations when making projections for management and conservation efforts.

NUTRIENT TRANSPORT BY GREEN TURTLES

Hannah B. Vander Zanden, Karen A. Bjorndal, and Alan B. Bolten

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

Spatially separated ecosystems and habitats are often linked by movement of nutrient subsidies. Such externally-derived nutrient input may be transferred by physical vectors (i.e., wind and water) or by biotic vectors. In this study, we examine the role of green turtles as biotic vectors of nutrient transport, moving between marine and terrestrial ecosystems and depositing eggs on nesting beaches. We compare low and high nest density sites at Tortuguero, Costa Rica, the largest green turtle rookery in the western hemisphere. Four plant species were analyzed for $\delta^{15}N$, C, N, P, and soil samples were analyzed for $\delta^{15}N$ and N. Vegetation at high nest density sites had higher $\delta^{15}N$ signatures and N content, suggesting a marine-derived source. Sand samples show a similar trend in $\delta^{15}N$, though may not integrate nutrient input as well as the vegetation. Sea turtles have been shown to deposit tremendous amounts of nutrients and energy on nesting beaches, and we demonstrate that beach vegetation assimilates these marine-derived nutrients.

AGE AT FIRST NESTING OF GREEN TURTLES IN THE MEXICAN CARIBBEAN*

Julio C. Zurita[1], Roberto Herrera[2], Alejandro Arenas[3], Ana C. Negrete[4], Leonel Gómez[3], Benito Prezas[5], and Christopher R. Sasso[6]

[1] Comité de Protección de Tortugas Marinas en Quintana Roo (CPTMQROO), Hermosillo 26, C.P. 06760, México, D.F.
[2] El Colegio de La Frontera Sur (ECOSUR), C.P. 77900 Chetumal, Quintana Roo, México
[3] Flora Fauna y Cultura de México A.C., C.P. 77500 Cancún, Quintana Roo
[4] Parque Xcaret, km 282 Carretera Chetumal-Pto.Juárez Playa del Carmen, C.P. 77710 Quintana Roo, México
[5] Universidad de Quintana Rôo (UQROO), Boulevard Bahia s/n, C.P. 77019, Chetumal, Quintana Roo
[6] National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, FL 33149

In order to determine age of first nesting for green turtles in Quintana Roo, Mexico, green and loggerhead turtles were marked with living tags. A total of 93,116 green turtles were marked between 1990 and 2006 with 1,277 of the turtles being head started for 12 months. 93,607 loggerhead turtles were marked with living tags from 1991 to 2008 with 5 being head started. Beginning in 1996, nesting beaches were patrolled nightly from May until October as part of an ongoing tagging study. The beach coverage allows for >90% of nesting turtles to be observed. All encountered turtles are checked for flipper and living tags. To date, there have been 26 recaptures of juvenile and 30 recaptures of nesting adult green turtles with no recapture of any loggerhead. The first recapture of an adult female green turtle occurred in 2004 after being marked and head started in 1991. The first non-head started turtle was recaptured in 2006 after being marked in 1990. For green turtles recaptured as nesting adults, 0.55% were head started (n=4) and 0.086% were not head started turtles (n=26). Based on the recapture of green turtles marked with living tags, nesting begins between 12 and 20 years of age with an average of 16 years. Our results indicate that the best management technique is to release hatchlings on the beach instead of keeping them in captivity.

Conservation Through Social, Economic, Cultural, and Legal Pathways

SEA TURTLE CONSERVATION FAR FROM THE OCEAN AND FAR FROM THE BEACH: RESULTS OF THE CAMPAIGN "I DO NOT EAT SEA TURTLE EGGS" TWO YEARS OF EXPERIENCE IN THE PACIFIC COAST NICARAGUA

Gena del Carmen Abarca and Josè Urteaga Augier

Fauna & Flora International

Nicaragua is known for hosting critical nesting habitat for four sea turtles. One of the main threats to these species has been the consumption of turtle eggs. This tradition, still deeply rooted, is prohibited by law (Law No. 641 and Ministerial Resolution No. 043-2005). Illegal trade of sea turtle eggs is complex and involves a wide range of stakeholders. This activity takes place along a trade chain that starts in the nesting beach where the nests are poached and ends in the cities when someone is willing to pay to eat these eggs in bars or markets. In the last decade in Nicaragua, little communication efforts were made to reduce demand for turtle eggs in the cities. Most environmental education efforts have focused on communities near nesting beaches. Between 2007 and 2009 Fauna & Flora International, working with a network of partners, launched the campaign "I do not eat turtle eggs." This effort has been a pioneer of its kind to Nicaragua, documenting positive results and lessons learned for the continuation of such efforts. The campaign was structured in four main phases; (1) a participatory designing process including the development of

logo and slogan; (2) the production of merchandising materials such as posters, stickers, T shirts; public displays as signs on buses; radio spots and video; (3) dissemination of materials through a network of partners and 63 promoters (4) collection and evaluation of information on illegal trade status and the impact of the campaign. For diagnosis and evaluation purposes 1993 surveys targeting potential traders (e.g. fish markets and cantinas) and potential consumers were performed. In Year 1, 754 surveys were performed to potential traders in 8 Markets of 4 cities. In year 2, 1.239 surveys were performed in 21 markets of 7 different cities, including potential traders and consumers (people visiting markets, cantinas etc). Of all potential traders surveyed 6% in both years were observed selling turtle eggs, in addition 18% in year 1 and 17.8% in year 2 answered that they sold turtle eggs occasionally. 56% of surveyed responded to know about the campaign at the end of year 1 increasing to 63% at the end of year 2. At the end of year two, 83 % of surveyed answered to understand that sea turtle eggs consumption is illegal. In year 2, 48% of the surveyed answered to have eaten turtle eggs at least once in their life and 29% on the last year. Surveys indicated that while the level of knowledge on sea turtle conservation status and legal regulations were increased after two years of campaign, no significant changes on the illegal trading activity was observed. Some change in attitude could be starting on the younger segment of the population. Attitude change in a society could take additional years or decades of work, in which implementation a strategy that corvine awareness, enforcement and livelihoods initiative should be sustained through the time.

STUDENT EDUCATION PROGRAM SUPPORTS CONSERVATION OF SEA TURTLES ON THE CARIBBEAN COAST OF COSTA RICA

Eylen Zuñiga Acuña[1] and Katharine Hart[2]

[1] Ecology Project International, San Jose, Costa Rica
[2] Endangered Wildlife Trust, San Jose, Costa Rica

Ecology Project International (EPI) is a nonprofit organization whose mission is to improve and inspire scientific education and conservation efforts through field-based student-scientist partnerships. EPI runs programs in the USA, Ecuador, Mexico and Costa Rica. Our programs involve education, conservation and cultural exchange in order to create a positive impact and motivate students to take an active role in conservation. Since 2000, more than 4400 students from high schools in the Caribbean region of Costa Rica and the US have been involved in the Sea Turtle Ecology Program based in Pacuare Nature Reserve (PNR). PNR is a private reserve owned by the Endangered Wildlife Trust (EWT); it has four miles of beach and 1050 hectares of rainforest, and is one of the most important nesting sites for leatherbacks (*Dermochelys coriacea*) on the Caribbean coast of Costa Rica. The aim of EPI's Sea Turtle Ecology Program, is to educate students about biological aspects of sea turtles, coastal ecosystems and national and international conservation efforts. Students assist EWT researchers in the collection of biometric data from nesting females, and form an essential part of the turtle conservation project in PNR. In many of the communities from which the students originate, the consumption of sea turtles and their eggs remains a deep-rooted cultural practice. Although many are familiar with sea turtles, very few have had an opportunity to observe a female nesting. Consequently, the experience obtained with EPI is critical in shaping the habits of the younger generation, developing a sense of belonging of their natural resources and reducing the tendency to poach in the future. In 2010, 1269 leatherback activities (including 899 nests) were recorded in PNR, with a maximum of 32 tracks observed in one night during the peak of the season. Without the collaboration of EPI student groups, it would be impossible for EWT researchers to achieve the 70% encounter rate with nesting leatherbacks reported from March through July, 2010. Furthermore, there has been a dramatic reduction of poaching from more than 95% in 1989 to less than 1% this year due to increased presence of groups on the beach. EPI groups comprise approximately 75% of the groups received by PNR each season, and provide valuable financial support for the conservation efforts of EWT. The partnership between EPI and EWT provides an opportunity to immerse young people in a real conservation project. Through EPI, EWT is able to educate students from communities surrounding the reserve, subsequently assisting the battle against poaching. Furthermore, it increases the encounter rate of turtles on the beach and eases the pressure on reserve staff during the peak of the season. The acceptance of groups at PNR provides EPI with a forum to initiate hands-on environmental education. This successful partnership can be viewed as a model for effective conservation and environmental education, facilitating dissemination of information into communities and the interaction of international scientists and local students.

STATUS AND CONSERVATION OF MARINE TURTLES IN LAGOS, NIGERIA

Akintunde Ajulo, Boluwaji Solarin, M. Yarhere, O. A. Adeogun, Dunsin Bolaji, Oyeronke Adegbile, and Oluwatoyin Orimogunje

Nigerian Institute for Oceanography and Marine Research, Lagos, Nigeria

From the seven species of sea turtle representing two families, Cheloniidae and Dermochelyidae, five of them are known to exist in the Nigerian waters namely, Green turtle (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Loggerhead (*Caretta caretta*), Olive Ridley (*Lepidochelys olivacea*) and Leatherback (*Dermochelys coriacea*). Little is known about the distribution and population status of globally endangered sea turtles in the Nigerian waters. This knowledge hinders comprehensive management and conservation efforts that may represent a key foraging area for sea turtles. Data collection and awareness creation of sea turtle in Lagos State, Nigeria for this particular survey started in 2008. Findings show that accidental capture was responsible for sea turtle catch in the Nigerian waters through gill net, purse seine and long-line fishing (fisheries bycatch). Effort to reduce accidental catch includes education-awareness of fishermen, stimulating regional/international cooperation and efforts to strengthen implementation of national laws protecting sea turtles is ongoing.

THE SEA TURTLE PROTECTION ACT: THE FUTURE OF U.S. SEA TURTLE MANAGEMENT

David L. Allison, Elizabeth Griffin Wilson, and Beth Lowell

Oceana, Washington, DC, USA

Sea turtle populations worldwide have plummeted over the last century largely due to human activities like fishing with unselective methods, direct harvesting, and habitat destruction. All six sea turtle species found in United States waters have been listed as threatened or endangered under Endangered Species Act (ESA) for nearly 30 years. Species are afforded protections by the ESA because they are in danger of going extinct. Despite decades of protection, some populations of sea turtles in U.S. waters continue to decline. Major deficiencies in U.S. sea turtle management include the lack of current population estimates for sea turtles, lack of cumulative analysis of the harm humans are causing sea turtle populations and the lack of a scientific determination of the number of sea turtles that can be injured or removed from a population without reducing its ability to recover. While management of marine mammals in the U.S. is not perfect, incidental take limits in commercial fisheries are based on estimates of a marine mammal population size. The U.S. government conducts regular population reviews and updates the allowable take levels with the goal of reducing takes over time while staying under established limits. Sea turtles in U.S. waters could benefit significantly from a similar system that forces resource managers to consider cumulative impacts of human activities on sea turtle populations. Marine mammals have the benefit of specific take restrictions regardless of their ESA status as they are mandated in the Marine Mammal Protection Act. It’s time for sea turtles to have a law specifically tailored to their protection and restoration needs, threats and their life histories. We can accomplish that with a law that is guided by science and is enforceable regardless of ESA status. It’s time for a Sea Turtle Protection Act.

SURPASSING THE WILDEST OF EXPECTATIONS: A NEWLY DISCOVERED HAWKSBILL (*ERETMOCHELYS IMBRICATA*) NESTING ROOKERY IN THE ESTERO PADRE RAMOS NATURAL RESERVE, NICARAGUA, PROVIDES NEW HOPE FOR RECOVERY OF THE SPECIES IN THE EASTERN PACIFIC*

Eduardo Altamirano[1], Perla Torres[1], Luis Manzanares[2], Eddy Maradiaga[3], Jeffrey A. Seminoff[4], José Urteaga[1], Ingrid L. Yañez[5], and Alexander R. Gaos[6]

[1] Fauna & Flora International, Reparto San Juan, Del Portón Trasero (Oeste) de la UCA 1/2 c. sur Casa Nº578, Managua, Nicaragua
[2] ARVINATUR, Cooperativa Asociemos la Vida por la Naturaleza, Comunidad de Venecia, Municipio El Viejo, Departamento de Chinandega, Nicaragua
[3] COJIZOPA, Cooperativa Multisectorial de Jiquilillo, Los Zorros y Padre Ramos, Comunidad de Padre Ramos, Municipio del Viejo, Departamento de Chinandega, Nicaragua
[4] National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center, La Jolla, California, USA
[5] Eastern Pacific Hawksbill Initiative, San Diego, California, USA
[6] San Diego State University, San Diego, California, USA and Eastern Pacific Hawksbill Initiative, San Diego, California, USA

The hawksbill turtle (*Eretmochelys imbricata*) is a Critically Endangered species and is considered particularly threatened in the Eastern Pacific Ocean (EP), where it faces potential extirpation. While several remnant hawksbill nesting sites have been identified in the EP over the past two years, the majority of these rookeries are small (i.e. *Chelonia mydas*), 7.01% loggerheads (*Caretta caretta*), 6.14% (*Eretmochelys imbricata*) and 1.75% Ridleys (*Lepidochelys olivacea*). We recommend continuing the application of these new techniques, as well as adding new protocols or methods to complete an effective conservation work.

SEA TURTLE CONSERVATION STRATEGIES IN THE GULF OF VENEZUELA: INVESTIGATION-ACTION MULTICULTURAL EFFORTS*

Hector Barrios-Garrido[1], Jordano Palmar[2], Ninive Espinoza[2], Luis Montiel[2], Martin Oquendo[2], Lisandro Moran[3], and Natalie Wildermann[1]

[1] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV), Laboratorio de Ecologia General, FEC-La Universidad del Zulia
[2] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV)
[3] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV), Laboratorio de Sistematica de Invertebrados Acuaticos, FEC-La Universidad del Zulia

The multicultural conservation technique: “Investigation-Action” promotes the participation in the development of endangered species researches of community members worldwide, not only as observers, but as protagonists of the scientific activities, sharing ideas with the investigators about their daily experiences and observations. In this manner, they become an essential piece in obtaining information and making decisions about the conservation projects. Based on this, the participation of Wayúu indigenous settlers has been fundamental in the Gulf of Venezuela for several years in order to obtain the current positive results that were not tangible at the beginning of the project, such as the high survivorship of sea turtles interacting with artisanal fisheries. The Gulf of Venezuela is an ecosystem where five sea turtle species from the Caribbean and the Atlantic Ocean converge. It has been estimated as one of the major green turtle harvesting areas in the southern Caribbean (203 sea turtles/year), due mainly to the depressed economical situation of the zone and for being in occasions the only animal protein source (red meat) for the inhabitants. Because of this, the inclusion of community leaders, indigenous clan leaders, school teachers, community council presidents and

fishermen councils in our work has allowed the insert the conservation message into the Wayuunaiki dialect. This has permitted that the expositions and chats in fishing ports, the participation of social service university students, and the collection of scientific data from sea turtles interacting with artisanal fisheries is now considered as an integrated part of the communities, and not an activity isolated from the community. We have reached a raise of the annual rescued sea turtle greater than 150%, thanks to the initiative of the communities. In 2010, we have given a total of 125 sea turtles a second and even third (live recaptures) life opportunity, preventing them from being used as food resource. More than 70 students have directly participated in the fishing ports with the communities, and have shared throughout environmental education essential ideas about the conservation in the beaches of the Gulf of Venezuela. It is necessary to increment the effort in order to cover new fishing ports in our study area that still sacrifice dozens of sea turtles each month, and in this manner directly transmit the conservation message towards the sea turtles and the ecosystems used by these animals.

PROMOTING ECOTOURISM AND SEA TURTLE CONSERVATION IN EL SALVADOR

Joshua N. Baugh

DePauw University, Greencastle, Indiana, USA

The Republic of El Salvador, C.A has long been characterized by conflict. In the past, the conflicts were part of a civil war. A current conflict is occurring on the sea turtle nesting beaches between local egg collectors and a coalition of sea turtle conservation initiatives lead by international organizations. El Salvador has many premier beaches for nesting sea turtles, including the critically endangered eastern hawksbill and leatherback, but local people have survived for many decades on the harvesting of these eggs. Until 2009, virtually 100% of all sea turtle eggs were collected and sold in bars and restaurants, pushing sea turtles along the coast of El Salvador to the verge of extinction. In the last two years, following a nation wide ban on the sale and consumption of sea turtle eggs, nominal progress has been made to conserve the populations. How can we resolve this conflict? During summer 2010, I visited the beaches of El Salvador where the sea turtle hatcheries are located. I lived and aided the work of hatchery managers, as well as collaborated with the on going conservation initiatives occurring throughout the country. Reflecting on my personal time working on the conservation battlefront I see the potential for ecotourism to resolve these conflicts. Hatcheries and emerging hostels such as “La Tortuga Feliz” in Playa San Diego can provide the foundation for creating an ecotourism industry around which the local community and conservation can flourish. Under this system local people will be recruited to assist with tourism and conservation education of visitors. This will spread sea turtle conservation ideas and practices not only among visitors (i.e., tourists) but also within the local community. In addition, providing locals with economic alternatives will drastically reduce their need to harvest sea turtle eggs. This type of programming is already supported by such organizations as see.turtles.org but currently does not exist in El Salvador. Let us put this model into action in El Salvador and benefit both sea turtle conservation and increase possibilities for a sustainable local economy.

CAMPAIGN OF VISUAL COMMUNICATION FOR THE CONSERVATION OF SEA TURTLES IN THE GULF OF VENEZUELA

Laura Carruyo-Rincón[1], N. Espinoza Rodriguez[2], and Héctor Barrios-Garrido[3]

[1] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV)/Universidad del Zulia, Facultad de Arquitectura y Diseño, Programa de Diseño Gráfico
[2] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV)
[3] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV), Laboratorio de Ecologia General. FEC-La Universidad del Zulia

Through the analysis of diverse multicultural and communication codes and the identification of the main aspects to consider into for the conservation of sea turtles in coastal areas at the Gulf of Venezuela, we present the following study of communications approach in order to identify key factors for the development of visual communications campaign to promote the Conservation of Sea Turtles. Responding to the methodology of the creative process three

phases were established for the development of the graphical strategies; the analytical phase: where it was collected, ordered and evaluated the information the previous investigation; the creative phase, we considered the implications multicultural formulated the message and formalizing the basic idea, and the execution phase, where the visual message was adjusted to different formats and media and one gave the process of correction, test and materialization of the same. The creative process gave origin to a series of graphical strategies audiovisual production, intervention by public spaces, editorial material and merchandising, agreement to the requirements of the population, and using different channels of communication to achieve greater projection of the message in the locality, bearing in mind that the interpretation of the same one is interpersonal and is fastened experiences and previous messages. This way was obtained as a result the development of different tools of education, awareness and information that will engage and encourage the different regional communities, with an unique message: the Conservation of Sea Turtles in the Gulf of Venezuela.

CREATIVE STRATEGIES FOR ORGANIZATIONAL PROJECTION OF THE "GRUPO DE TRABAJO EN TORTUGAS MARINAS DEL GOLFO DE VENEZUELA"

Laura Carruyo-Rincón[1] and Héctor Barrios-Garrido[2]

[1] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV)/Universidad del Zulia, Facultad de Arquitectura y Diseño, Programa de Diseño Gráfico
[2] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV), Laboratorio de Ecologia General. FEC-La Universidad del Zulia

Analyzing the different scenes and multicultural factors which develops the "Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela" (GTTM-GV), we present the following study of integrated communications for the creation of creative strategies for the promotion and organizational projection of the same. If it is true that the goal of GTTM-GV is not to sell a product of consumption as such, for being a non-government organization without ends of profit, sells to the public its ideologist, objectives and values as an institution, which must be transmitted so appropriate and creative ways to penetrate and establish in the public, thus achieving greater awareness and the inclusion of the population in conservation of Sea turtles of the Gulf of Venezuela. Basing on a design methodology projectual, and applying tools of marketing and communication was made analysis a target audience and situational description of the organization, and designing a marketing strategy and developing an organizational communication message, adapted to different communities that converge in coast of the Gulf of Venezuela. This way originated a creative process of analysis, production and execution, resulting in a series of creative strategies, as the creation of a public image, the development of a campaign of visual communication for the conservation of marine turtles, the construction of an interactive brochure as tool of support for the search of financings on the part of companies of the public and private sector, the design of a accessible web providing tools and information on the sea turtles and their conservation; the production of material merchandising encouraging the automanagement of the organization, achieving this way the projection integral to the GTTM-GV and the active participation of the sector citizen and business in the various activities and projects of research, education and outreach that develop within the same.

NESTING OF THE PACIFIC HAWKSBILL TURTLE IN THE OSA REGION, SOUTHEASTERN PACIFIC COAST OF COSTA RICA

Didiher Chacon[1], David Rojas[2], Adi Barash[2], and Claudio Quesada[3]

[1] WIDECAST Latin American Program Coordinator
[2] WIDECAST Osa Program
[3] WIDECAST Costa Rica Caribbean Projects

This research was developed during the second semester of 2010 in the Osa region (9º 09.2289 N, 083º 45.1420 W to 8º 22.3996 N, 083º 08.0714 W), southeastern Pacific coast of Costa Rica in order to evaluate the status of the Pacific Hawksbill nesting and conservation of this species, in general. A survey apply to local coastal communities was

developed to guide researchers to nesting hot spots and to raise information about uses and threats of the species. At the same time, a team of researchers ran beach nesting observation and monitoring from Uvita location to Punta Banco, including coastline inside of Dulce Gulf, after confirm the nesting, the nest was marked and weekly visits where developed until hatch date when exhumation was developed. From each nest success rate were estimated and tissue sample were collected. When females were found biometrics were collected and recorded, also tissue samples for DNA studies were collected. The results show that the nesting in Osa region is around 50 nests in Isla Violín, Río Claro, Danta, San Jocesito, Corcovado, Llorona, Pejeperro, Sombrero, Platanares and Punta Banco, in average we reported 5 nests/beach (1-15 nests) with a maximum in Corcovado-Llorona section. An average of 120 eggs/nest and 91.1% success rate in n=29 for in situ nests. The incidental fishing by nets and hand lines, trade of carapace to produce cock fighting spurs and damage to critical habitats were the main threats for the Osa Hawksbills.

STRENGTHENING REGIONAL COOPERATION: THE INTER-AMERICAN CONVENTION FOR THE PROTECTION AND CONSERVATION OF SEA TURTLES (IAC)

Verónica Cáceres Chamorro

Inter -American Convention for the Protection and Conservation of Sea Turtles, Arlington, Virginia, USA

Without a doubt sea turtle distribution covers a wide range of countries due to their complex life cycle and migratory patterns. These particular characteristics complicate their management and expose them to many pressures over broad geographical areas, therefore, the conservation of these animals require multilateral agreements and international cooperation that cover the species wide range of distribution in order to effectively protect them. The Inter-American Convention for protection and conservation sea turtles (IAC) entered in to force in 2001 due to the need for regional cooperation to protect and conserve sea turtles in the Americas. As the IAC approaches its 10th Anniversary, it currently has 14 contracting parties and is still growing, which clearly shows a great interest and need by the countries to implement harmonized sea turtle protection and conservation measures, including the legal framework under which they are protected, at a regional level. It is clear that in order to have a greater impact on the recovery these species, the efforts made by each country must be complemented by joint efforts of all the countries in the region that share this resource whether it be on nesting beaches, feeding grounds or migratory routes. The IAC is the only legally binding treaty for sea turtle conservation and protection in the Western Hemisphere. The objective of the Convention is to promote the protection, conservation and recovery of the populations of sea turtles and those habitats on which they depend on the basis of the best available scientific information and taking into consideration the environmental, socio economic and cultural characteristics of the parties. The IAC promotes cooperation among its party countries and non-party countries through a series of agreements, resolutions and memorandums of understanding. IAC parties are obligated to submit annual reports highlighting their activities in favor of sea turtle protection and conservation, especially regarding the leatherback and hawksbill turtles, their efforts to mitigate fisheries interactions with sea turtles and adaptation to climate change. These tasks, however, are not without their challenges and it is important to continually motivate countries in the region to continue to work together with all sectors, at both local and international levels, to obtain the goals of the Convention.

PROPOSALS FOR EFFECTIVE PROTECTION OF THE MARINE TURTLE IN MEXICO: CASE OF STUDY JALISCO

Alicia Loeza Corichi, Carlos Félix Barrera Sánchez, Francisco Javier Jacobo Pérez, Eloy Flores Millán, and Javier Ezau Pérez Rodríguez

Universidad de Guadalajara, Zapopan, Jalisco, México

In this work we present an analysis about the protection of the sea turtle in base of the federal juridic frame in Mexico across the discussion of operative and technical interpretation of such frame which has been implemented and interpreted by most of governmental instances for their protection and conservation. Other problems that are related with the strategies about protection and conservation of these species are also analyzed. Finally, the conclusions and

proposals appear that from the point of view of the authors, must be applied in beaches of nesting and egg-laying of these species to obtain an effective protection of the resource. One concludes that is necessary to elaborate the plan of corresponding handling for the decreed natural areas protected especially for the conservation of the marine turtle, where technical elements that sustain the legal frame to reach a handling and effective protection of these areas are gotten up that in addition it includes to the local communities. We want to thank for Grant Travel who facilitates the presence of the first author in this symposium.

NETWORKING THE GLOBAL SEA TURTLE COMMUNITY: THE SEA TURTLE NEST MONITORING SYSTEM*

Michael Coyne[1], DuBose Griffin[2], Matthew Godfrey[3], Mark Dodd[4], Charlotte Hope[2], Kelly Sloan[2], Jennifer Cormany[2], Arturo Herrera[2], Gretchen Coll[2], and Wendy M. Cluse[3]

[1] SEATURTLE.ORG
[2] South Carolina Department of Natural Resources
[3] North Carolina Wildlife Resources Commission
[4] Georgia Department of Natural Resources

Monitoring is taking place at sea turtle nesting beaches around the world. The nesting data collected at these monitoring sites are typically gathered by local (individual beach) organizations and aggregated at the state or national level under the direction of a state or national coordinator. In most cases the exact data collected and the method of storage (database format and software) varies from state to state and in some cases between individual organizations within a state. This makes it difficult to compare data across broad geographic scales, something that is critical to the proper monitoring and assessment of threatened and endangered sea turtle species that ignore state and national boundaries. In addition, top-level resource managers often do not receive data until weeks or months after the data are collected, making it difficult to respond to immediate threats or potential data collection problems. Seaturtle.org has created the Sea Turtle Nest Monitoring System (STNMS) as a data management network to help organizations distributed around the world to collect and store data in a standardized format for real-time comparison and monitoring of all participating nesting beaches. The STNMS is an online reporting system that allows detailed nesting data to be submitted by the original observer (or local data manager) directly into a centralized database. Anyone with internet access and a relatively modern web browser can participate in the network. Participants receive instant feedback (and gratification), resource managers have immediate access to data, and summary data are presented to the public in near real-time. All data are automatically backed up and available for download at any time using a wide variety of export and reporting options. Integrated error checking limits data entry errors. The STNMS was designed in cooperation with sea turtle programs in South Carolina, North Carolina and Georgia, and has been in use for the past two years. During this time cooperators in the three states have reported 16,535 emergence events and 8,606 loss events from 83 nesting beaches. Of these, 44.8% (7,405) of all emergence events were reported within a day, 59.7% (9,865) within two days, 67.5% (11,166) within three days, and 82.8% (13,692) within a week. Summary data presented on the STNMS website provide real-time feed back to all participants and the public and have resulted in more than 750,000 visits to date. Near instantaneous feedback helps contributors and the public see how their local beach and contribution fits in to the larger sea turtle picture and helps managers more efficiently manage their sea turtle and human resources.

SATELLITE TAGGING: AN EFFECTIVE TOOL FOR OUTREACH AMONG STAKEHOLDERS, SOUTH INDIA

Supraja Dharini

TREE Foundation, #63 First Avenue, Vettuvankeni, Chennai, Tamilnadu, India, PIN: 600041

This poster expounds the networking and methods involved in the process of Satellite Tagging for the first time in South India. Conservation goals directed at protecting sea turtles and their marine habitats involving communities living along the coast, general public, recruiting students into the program, media involvement and networking with the various government official will also be explained. The project area covers 85 km along the Kancheepuram coast and 20 km along the Nellore Coast. The fishing communities of 30 villages along Kancheepuram have been involved during the past 8 years and 14 villages of Nellore coast for the past 2 years respectively. The olive ridley (*Lepidochelys olivacea*) nest on the beaches, juvenile hawksbill turtles (*Eretmochelys imbricata*) and green turtles (*Chelonia mydas*), forage in the ocean of the project area. There is an urgent need to protect the ridley nesting sites along the coast and the adult olive ridley turtles en-route to the mass nesting beaches of Orissa. TREE Foundation was founded in 2002 with the aim of protecting marine turtle populations, understanding the interrelatedness between coastal communities and the marine resources upon which the former survive. The poster will focus on initiatives that combine conserving species and habitat with empowering all the stakeholders and networking with various government departments/agencies. The media ‘s role in the outreach made th satellite tagging program an effective tool in spreading the much needed awareness on sea turtles and their plight and why the marine habitat has to be conserved. Therefore satellite tagging can be used as a scientific and effective method of outreach among all audiences.

ENGAGING COMMUNITY TO RECOVER DECLINING MARINE TURTLE POPULATIONS ALONG THE SOUTH INDIAN COAST - THE CHALLENGES

Supraja Dharini

TREE Foundation, #63 First Avenue, Vettuvankeni, Chennai, Tamilnadu, India, PIN: 600041

This paper expounds the, struggles, challenges and success of achieving conservation goals directed at protecting sea turtles and their marine habitats involving communities living along the coast. The project area covers 85 km along the Kancheepuram coast and 20 k.m. along the Nellore Coast. The fishing communities of 30 villages along Kancheepuram have been involved during the past 8 years and 14 villages of Nellore coast for the past 2 years respectively. The olive ridley (*Lepidochelys olivacea*) nest on the beaches, juvenile hawksbill turtles (*Eretmochelys imbricata*) and green turtles (*Chelonia mydas*), forage in the ocean of the project area. There is an urgent need to protect the ridley nesting sites along the coast and the adult olive ridley turtles en-route to the mass nesting beaches of Orissa. TREE Foundation was founded in 2002 with the aim of protecting marine turtle populations, understanding the interrelatedness between coastal communities and the marine resources upon which the former survive. The presentation will focus on initiatives that combine conserving species and habitat with empowering local people training and involvement of local young fishermen as members of Sea Turtle Protection Force (STPF) in monitoring of nesting turtles, relocating eggs into hatcheries, incorporating the human element from a variety of perspectives including: education programs, capacity building, economic development, poverty alleviation, human and animal health programs and networking with various government departments/agencies.

TURTLE FRIENDLY BEACHES: EDUCATION AND FINANCIAL INCENTIVES TO REDUCE LIGHT POLLUTION

Andrew P. Diller[1], Mark A. Nicholas[2], Christina M. Verlinde[3], and Brooke Saari[4]

[1] Florida Sea Grant, University of Florida, Cantonment, Florida, USA
[2] National Park Service, Gulf Islands National Seashore, Gulf Breeze, Florida, USA
[3] Florida Sea Grant, University of Florida, Milton, Florida, USA
[4] Florida Sea Grant, University of Florida, Crestview, Florida, USA

The Northern Gulf of Mexico nesting population is one of five recovery units identified by the National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWS) as essential for the recovery of the Northwest Atlantic loggerhead sea turtle population. Northwest Florida accounts for 92% of the loggerhead sea turtle nests in the Northern Gulf of Mexico recovery unit. Unfortunately, light pollution on developed beaches in the Florida Panhandle threatens nesting females and hatchlings by leading them inland, away from the Gulf. Switching to sea turtle friendly lighting can result in significant energy savings when older fixtures and lamps are replaced with more efficient models. These savings, along with available grant funds are motivating property owners to retrofit outdoor lighting to sea turtle friendly fixtures and improve nesting habitat in the Florida Panhandle. As part of the Turtle Friendly Beach Program, Florida Sea Grant Extension agents in the Panhandle partner with personnel from the USFWS, Florida Fish and Wildlife Conservation Commission, National Park Service, and local sea turtle permit holders to host sea turtle friendly lighting workshops for both professionals and residents. Agents also assist with lighting surveys on beaches to identify properties that could cause disorientation. Finally, agents work with property owners to retrofit lights, including obtaining grant funds for cost-share assistance. Results of the program include training thirty-two professionals in sea turtle friendly lighting methods. More than two-hundred people have attended property owner lighting workshops in the Panhandle. Agents have obtained more than $65,000 in grant funds to assist property owners with retrofit projects. Additional funds for habitat restoration after the BP oil spill are also becoming available. The largest condominium complex on Pensacola Beach installed 2230 sea turtle friendly lamps in the garages of all five towers. Additional homeowner associations, restaurants, businesses, schools, and others are receiving assistance to reduce lighting for future sea turtle nesting seasons. Finally, over 3000 students who live inland have been encouraged to examine their home's exterior lighting for ways to save energy and help wildlife, as urban glow can still be an issue for sea turtles and other wildlife even when beaches are dark.

INCIDENTAL EXTINCTION: HOW THE ENDANGERED SPECIES ACT'S INCIDENTAL TAKE PERMITS FAIL TO ACCOUNT FOR POPULATION LOSS*

Patrick M. Duggan[1] and Michelle B. Nowlin[2]

[1] Duke University Law School, Durham, NC; Duke University Nicholas School of the Environment Durham, NC; U.S. Department of Justice - Environmental Crimes Section, Washington, DC
[2] Duke University Environmental Law & Policy Clinic, Durham, NC

The Endangered Species Act issues an explicit prohibition against the taking of any endangered or threatened species. The statute's purpose is to halt and reverse a species' decline into extinction, regardless of economic cost. So powerful is this purpose that "take" is broadly defined to include any type of harm, even harm that would not result in the death of a single individual. Despite this explicit mandate, the statute also allows for the "incidental" taking of an otherwise protected species, as long as that take is unintentional, or "incidental" to the rightful exercise of a lawful purpose. In the context of sea turtle protection, such lawful purposes include commercial fisheries, military exercises, dredging for navigation, oil and gas exploration, and many others. The National Marine Fisheries Service has issued a surprising number of these incidental take permits to various commercial interests authorizing the take, both lethal and non-lethal, of endangered sea turtles. Arguably, the incidental exemption is necessary to continued public support of this controversial statute. Moreover, if implemented properly, the takes would be truly incidental and would not threaten the continued viability of protected species. However, a review of the process by which NMFS and other federal agencies issue incidental take permits for migratory species such as loggerhead sea turtles shows that the loophole threatens to swallow the statute. NMFS has authorized the incidental take of over 165,000 loggerheads per year, despite widespread concern that the population is in decline. A review of ITPs issued for loggerheads in U.S. waters reveals that no consideration was given to the cumulative impact of these takes or of their impact on future population trends. Instead, the calculations are based on the current, static population data without reference to the ongoing decline, not even decline due to previous take that was authorized and will continue for the life of the ITP. Thus the methodology used to calculate "acceptable take" is mathematically flawed, based on an activity's current take levels rather than an assessment of what degree of population loss the species could withstand before its existence was jeopardized. This study examines the flaws in the regulatory structure that contribute to the ITP program failures and illustrates the potential impact on struggling loggerhead populations. The study then articulates straightforward regulatory and methodological changes that are needed to ensure that incidental takes do not jeopardize the continued existence of the loggerhead and other endangered species.

COMMUNITY PARTNERSHIP IN UNDERSTANDING POPULATION CHANGES IN "TORTUGA GOLFINA" (*LEPIDOCHELYS OLIVACEA*) ON THE SOUTH COAST OF HONDURAS*

Stephen G. Dunbar[1], Lidia Salinas[2], and Samaria Castellanos[3]

[1] 1Department of Earth & Biological Sciences, Loma Linda University, Loma Linda, California, USA
[2] Protective Turtle Ecology Center for Training, Outreach, and Research (ProTECTOR), Loma Linda, California, USA
[3] Protective Turtle Ecology Center for Training, Outreach, and Research (ProTECTOR), Tegucigalpa, Honduras

The Olive ridley (*Lepidochelys olivacea*) sea turtle, referred to along the south coast of Honduras as "tortuga golfina," is a species of special concern because of the economic value placed on commercial egg harvesting and declining population numbers seen over the last 50 years. While the importance of the species to local community economies has been recognized since the 1970s, local residents report a continuing decline in the numbers of turtles nesting at Punta Ratón, over the past five decades. Still, no efforts have previously been made to estimate population numbers of this species in the Golf of Fonseca (GOF), resulting in inadequate plans to properly manage egg harvesting or monitor the turtle numbers in the area. We began flipper tagging nesting *L. olivacea* in 2007 as a strategy to estimate population numbers through capture-mark-recapture methods. Although still in the early stages of the study and temporally limited to the 25-day "veda" period in September each year, these methods have resulted in understanding aspects of population dynamics of turtles in Punta Ratón. To date, we have tagged over 257 turtles, and have a return incidence of approximately 53%. The ProTECTOR tagging and conservation program has had direct involvement from the local community and continues to gain greater acceptance among community members. This program is seen as a benefit to the community because it is increasing awareness of the impact of egg harvesting on *L. olivacea* through research and environmental education, it increases motivation for the conservation of sea turtles by promoting proper management under scientific parameters, and it is introducing opportunities for alternative income sources. These initiatives arise from the community through their interaction with the study in promoting conservation, generating economic alternatives, and reducing consumptive pressure on the species. In turn, data from this research have encouraged the central government to provide more accurate national and international reports regarding turtle conservation activities, improving decision-making for the management of the species in Honduras.

SHARING BEST PRACTICES THROUGH A MARINE PROTECTED AREAS NETWORK AS A PATHWAY TO SEA TURTLE CONSERVATION*

Karen Eckert[1], Emma Doyle[2], and Sharon Gulick[3]

[1] Wider Caribbean Sea Turtle Conservation Network (WIDECAST), Ballwin, Missouri, USA
[2] Caribbean Marine Protected Areas Management Network and Forum (CaMPAM), Houston, Texas, USA
[3] formerly Organisation of Eastern Caribbean States Protected Areas and Associated Sustainable Livelihoods (OPAAL) Project, Union Island, St. Vincent and the Grenadines

Marine protected areas (MPAs) can make a significant contribution to sea turtle conservation, be it by helping ensure protection of foraging areas, by protecting nesting beaches and rookeries, or by providing opportunities for the public to see and learn about sea turtles. In some cases, the designation of an MPA derives directly from the need to protect sea turtles and their critical habitat, with direct links forged between sea turtle protection and sustainable livelihoods for local communities. In other cases, sea turtles are considered to be important indicator species of ecological health and are included in biophysical monitoring in MPAs, yet staff may lack direction in applying best practices. By virtue of the highly migratory nature of sea turtles, a network of effective MPAs stands to make a more meaningful contribution to regional sea turtle conservation than a single MPA alone. It is thus relevant to evaluate the state of play in sea turtle conservation at the level of an MPA network, and it is likewise crucial to encourage the application of best practices related to sea turtles across the members of an MPA network. The Wider Caribbean region provides a perfect test case

for such an approach. The outcome of a new joint assessment by the region's very active sea turtle network (Wider Caribbean Sea Turtle Conservation Network, WIDECAST) and by the region's existing MPA network (Caribbean Marine Protected Areas Management Network and Forum, CaMPAM), this paper presents (for the first time) current best practices in sea turtle monitoring, conservation and associated sustainable livelihoods among MPAs in the Wider Caribbean. A matrix of best practices covering 10 countries and including the region's 6 species of sea turtles highlights a number of model MPAs, identifies best practices for replication, and provides learning points and new directions for the region's MPA managers as they address gaps in sea turtle conservation and research in their MPAs in the face of current and future threats. The matrix can also be used to help leverage resources, both technical expertise and funding, to support the replication of best practices for sea turtle conservation in order to bring important MPAs for sea turtles up to speed on best practices. As initiatives such as the Caribbean Challenge strive to increase the number and effectiveness of MPAs in the region, these learning points are both instructive as well as timely. With WIDECAST providing the link to technical guidance on best practices, the OECS Protected Areas and Associated Sustainable Livelihoods (OPAAL) Project providing demonstration site experience on sustainable livelihoods, and CaMPAM serving as a forum for sharing of experiences and helping build bridges to necessary resources, this Caribbean approach can illustrate to sea turtle conservationists in other parts of the world the links necessary for a collaborative pathway to successful conservation outcomes.

DESIGNATING AND PROTECTING LEATHERBACK SEA TURTLE CRITICAL HABITAT OFF THE U.S. WEST COAST*

Ben Enticknap[1], Todd Steiner[2], Miyoko Sakashita[3], Brendan Cummings[4], and Geoff Shester[5]

[1] Oceana, Portland, Oregon, USA
[2] Turtle Island Restoration Network, Forest Knolls, California, USA
[3] Center for Biological Diversity, San Francisco, California, USA
[4] Center for Biological Diversity, Joshua Tree, California, USA
[5] Oceana, Monterey, California, USA

Pacific leatherback sea turtle populations have declined by 95% since the 1980s. The conservation and recovery of the Pacific leatherback sea turtle requires a comprehensive approach from nesting beaches, across migratory pathways, to foraging hotspots. Bringing together science, the law and broad public support, Oceana, the Center for Biological Diversity (CBD) and Turtle Island Restoration Network (TIRN), petitioned the United States government on October 2, 2007 to designate critical habitat for leatherback sea turtles in marine waters off the U.S. West Coast. Results from satellite tracking and other observations have demonstrated that the Northeast Pacific Ocean waters of the California Current ecosystem contain critical migratory routes and foraging grounds for these endangered sea turtles. Leatherback sea turtles make trans-Pacific migrations from nesting beaches in the western Pacific (e.g. Indonesia, Papua New Guinea, and the Solomon Islands) to productive foraging grounds in these coastal marine waters. After the U.S. government missed key legal deadlines, Oceana, CBD and TIRN filed a lawsuit seeking date certain findings on our petition. Following settlement of the case, the National Marine Fisheries Service (NMFS) released a proposed rule in January 2010 to designate 70,600 square miles (182,854 square kilometers) of marine habitat as "critical" to the leatherback sea turtle. In the proposed rule, NMFS included a comprehensive analysis of leatherback tagging, fishery interactions, and observations, and found that most of the U.S. West Coast Exclusive Economic Zone is important for the primary constituent elements of forage and safe migration. Many of the proposed areas, however, were excluded based on economic findings. The proposed critical habitat designation included primary foraging areas, but excluded other important areas such as secondary foraging grounds and areas necessary for safe migratory passage to and from foraging hotspots. In the proposed rule, NMFS did not consider commercial fishing or shipping as potential adverse modifications to leatherback sea turtle critical habitat. Citizen initiatives are critical to advance comprehensive protections, including bringing forward the science to identify critical habitat for endangered sea turtles and holding governments accountable. Here we discuss critical habitat designation as a conservation tool for protecting migratory routes and feeding hotspots for Pacific leatherback sea turtles. We also present the legal pathways and science necessary for amending leatherback sea turtle critical habitat under the U.S. Endangered Species Act, likely implications of the final designation, and the importance of building broad public support for such conservation efforts. A final decision by the U.S. government to designate leatherback sea turtle critical habitat is expected in early 2011.

INCREASING OF THE MONITORING SITES AND CAPTURE EFFORTS OF SEA TURTLES IN NORTHWEST MEXICO, MORE THAN A DECADE OF GRUPO TORTUGUERO DE LAS CALIFORNIAS

Aaron Esliman[1], Beatriz Dias[1,2], and Jesús Lucero[1]

[1] Grupo Tortuguero de las Californias A.C.
[2] Unversidad Autonoma de Baja California Sur

The Grupo Tortuguero works with local communities to recover migratory sea turtle species and reduce declines of diversity, complexity and connectivity of ocean basins. To reach the conservation goals, Grupo Tortuguero has as objectives 1) build a strong conservation network, 2) develop our understanding of human-caused threats to turtle's survival and develop new management solutions to mitigate those threats, and 3) communicate our message widely, promoting conservation of sea turtles throughout the region. Our program integrates nesting beaches and in-water monitoring surveys in order to reduce poaching, incidental capture, and to follow population trends. The Grupo Tortuguero network is composed by community members, government agencies, researches and students, and during the past ten years this NGO is capacitating individuals from the communities by fostering sustainable behavior and providing them with necessary tools to become active sea turtle protectors. Currently, 30 communities located along the Baja California peninsula and Gulf of California represent GTC throughout Northwest Mexico, about 15 are dedicated to monitoring in water and the others 15 dedicated to nesting beaches care. The majority of in-water sites are important foraging grounds for east pacific green turtle, hawksbill and loggerhead. In a recent study we reported new nesting activities of olive ridley in Bahia de La Paz, Loreto Bay, Agua Verde and Bahia de Los Angeles, Sonora and north of Sinaloa. In 2010 our network had the incorporation of two new monitoring sites for black turtles by responsibility of local fishermen, one in Estero La Soledad (Magdalena Bay, Baja California Sur) and other in Sonora state for working in Isla San Pedro Martir and Kino Bay. Another methodology applied by GTC is massive surveys with collaboration of a research crew to assess health conditions of sea turtles. In all monitoring sites the efforts applied on surveys are an important component to involve the community in conservation activities, creating an environmental thinking path, which allows a better management of the natural resources.

SEA TURTLE NESTING AND CONSERVATION ACTIVITIES IN THE CONTINENTAL REGION OF EQUATORIAL GUINEA: 2009-2010 AND 2010-2011 SEASONS

Alejandro Fallabrino[1], D. Carolina Bohorquez[2], Angela Formia[3], Ernesto Nguema[4], Venancio Elonga[5], Aimee Sanders[6], Juan Nsogo[4], Lorenzo Brindis[4], Fidel Esono Mba[4], Jesus Mba Mba[4], and Helena Landauer[1]

[1] Karumbé, Rivera 3245, 11600, Montevideo, Uruguay
[2] Mandala, Bogotá, Colombia
[3] WCS, Wildlife Conservation Society, BP 7847, Libreville, Gabon
[4] Instituto Nacional de Desarrollo Forestal y Manejo del Sistema de Areas Protegidas (INDEFOR), Bata, Guinea Ecuatorial
[5] TOMAGE, Base Tika, Guinea Ecuatorial
[6] Gabon Sea Turtle Partnership, BP 7847, Libreville Gabon

Project TOMAGE (Sea Turtles of Equatorial Guinea) works on the mainland of Equatorial Guinea at three index beaches, Tika (Rio Campo Natural Reserve), Punta Llende (Natural Reserve), and Nendyi (Scientific Reserve). Our main activities include nesting beach monitoring, monitoring of captures at sea, threat reduction and environmental outreach. We present here results of nest monitoring of *Lepidochelys olivacea* and *Dermochelys coriacea* in the 2009/2010 and 2010/2011 seasons. The most important conservation issues in the region are incidental capture in fish nets, direct capture using special turtle nets, capture of nesting females, and nest poaching. Captured animals are

slaughtered in their entirety for consumption or sale at a price of approximately USD 5-7 per Kg. In addition, we found crafts made from olive ridley carapaces for sale at several shops in the main city of Bata. As part of the capacity-building activities with local communities, we trained local technicians in sea turtle data-collection and handling. In January 2010 we inaugurated the Community Library and Ecomuseum of Tika, with the official ceremony attended by more than 100 members of the local community, government officials and NGO partners. Throughout the project, we conducted awareness-raising activities in coastal communities and more extensive environmental education in the Tika school and community. TOMAGE's presence in Tika and adjacent areas has already achieved a change in attitudes and positive impacts for sea turtle conservation. Several fishermen have stopped targeting sea turtles, and consumption of eggs has decreased. In addition, several turtle fishermen expressed an interest in joining TOMAGE as an alternative to directed capture, suggesting a swap of fish nets for turtle nets.

CLIMATE CHANGE AND SEASONAL CONSERVATION PROGRAMMES PUSH SEA TURTLE POPULATIONS TOWARDS EXTINCTION; RESULTS AND ANALYSIS FROM A 'LOW SEASON' IN MAJAHUAS CAMP IN 2003 AND CHALACATEPEC CAMP IN 2005, TOMATLÁN, JALISCO, MEXICO

Eloy Flores-Millán, Rodrigo Castellanos-Michel, Alicia Loeza Corichi, Carlos Félix Barrera Sánchez, Marcos Becerra-Degado, Javier Jacobo-Pérez, Sara Michel-Carabes, and Ildefonso Enciso-Padilla

División de Ciencias Biológicas y Ambientales, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara. Carretera Nogales km 15.5 CP 45110 Zapopan, Jalisco, México, e-mail: e-en-bio@hotmail.com

The Playón de Mismaloya Sanctuary, located between the municipalities of Tomatlán and Cabo Corrientes, Jalisco, Mexico, is one of the most important nesting sites for sea turtles. Within the sanctuary there are five different camps which perform conservation efforts by doing daily beach patrols, localizing and relocating nests to protected incubation areas during the months of July to December each year. This study concentrated on carrying out the above processes in Majahuas Camp in 2003 and Chalacatepec Camp in 2005, during what is considered as the 'low season', from January to June. In both cases the percentage hatchling rate per nest of olive ridley turtles (*Lepidochelys olivacea*), as well as the collection of surface sea temperature (SST) and air temperature (AT) data, was collected. The two temperature variables were obtained from the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) and National Oceanic and Atmospheric Administration (NOAA). In Majahuas, with a sample size of 75 (n=75), it was found that the correlation coefficient between temperatures (SST and AT) and the percentage hatchling rate was 0.4654 (r=0.4654). Differences were found in percentage hatchling rates related to the variation in SST and AT of each month (one way ANOVA, F2-74=9.9564). In Chalacatepec, with a group size of 7 (n=7), the correlation coefficient between temperature (SST and AT) and percentage hatchling rate was 0.5246 (r=0.5246). Differences were found in percentage hatchling rates related to the variation in SST and AT of each month (one way ANOVA, F2-6=0.7597). For each data group a regression equation was generated and feedback was used from 2003 to 2010 in Majahuas and 2005 to 2010 in Chalacatepec for SST and AT data. The results of replacing the temperature data with the estimated increase in temperatures from the Mexican National Institute of Ecology (INE) in the regression equation, demonstrated that for the first six months of the year 2020 (0.8 to 1.4ºC increase) and 2050 (1.5 to 2.5ºC increase), the change would benefit nesting populations, a situation meaning that conservation efforts should be extended to these months; but starting from 2080, according to the estimated rise in temperature (2 to 4ºC), a high mortality rate could be expected. This analysis demonstrates that the populations with the highest possibility of long term survival (those that nest in the first six months of the year, when the temperatures are lower) are being biased due to the lack of conservation efforts in their favour, due to the low nesting numbers during that time of the year, exposing them to more population threats such as predation.

DIFFERENCES IN KNOWLEDGE REGARDING SEA TURTLE PROTECTION IN AKUMAL, MEXICO BASED ON 234 RANDOM INTERCEPT INTERVIEWS

Nicole Gabriel[1], Monica Rosquillas[1], Allison Baxter[1], Armando Lorences Camargo[2], and Katherine Comer Santos[1]

[1] The Science Exchange, San Diego State University, San Diego, CA, USA
[2] Centro Ecológico Akumal, Akumal, Quintana Roo, México

Akumal, Quintana Roo, Mexico, is located south of Cancun on the Yucatan Peninsula in eastern Mexico. Since 1993 the Centro Ecológico Akumal (CEA) has been providing protection for and education about their resident loggerheads (*Caretta caretta*), greens (*Chelonia mydas*), and hawksbills (*Eretmochelys imbricata*). To help strengthen their educational program two interns in The Science Exchange program interviewed 234 tourists at Akumal Bay beach and locals in the town during the summers of 2009 and 2010. Using the random intercept method, thirty percent were Mexicans, 40% from the U.S., 22% European, and 8% from other countries. Thirty-three percent appeared to be in their 20s and 25% in their 30s. Questions included the following: What do you hope to see while snorkeling in Akumal Bay? Have you seen/touched a turtle in Akumal? Do you know if sea turtles are legally protected in Mexico? How can Mexican authorities better protect sea turtles? Seventy-five percent stated seeing sea turtles was a goal while in Akumal. At the time of the interview, 57% had already seen one. This indicates that people are having a satisfying eco-tourism experience. Sixty-three percent knew that turtles are protected in Mexico, 27% thought they were not, and the rest unknown. The educational program can be improved in this area. We tested differences in demographic responses with chi square tests and found that Mexicans had a significantly lower desire to see turtles in Akumal ($p=.004$) and also did not see turtles as often as other nationalities ($p=.001$). Possible reasons could be that Mexicans have more chances to see turtles than people from other countries. Eighty-one percent of Mexicans knew turtles are protected in Mexico while Americans (53%), Europeans (19%), and others (52%) were significantly less knowledgeable ($p=<.05$). Males and the 20-31 age group answered the protected question correctly more often than their counterparts ($p<.05$). Only 60% of teens knew turtles are protected, while 13% of teens said they had touched one. Although not significantly different from other age groups, teens could benefit from more education and are excellent investments. Interestingly, 62% of Europeans admitted to touching turtles (prohibited by law) versus other nationalities (around 1%) ($p=.000$). People over age 50 also touched turtles more often than other age groups ($p=.03$). Around half the suggestions included more education in schools, on the beaches, and through brochures or kiosks. Twenty-six percent suggested stricter laws, more enforcement, and patrolling. Better in-situ nest signage was a popular answer. There may be inconsistent results between 2009 and 2010 due to differences in the interviewers styles and Spanish ability and also some bias in answers because of the conversational style of the interviews and the CEA affiliation of the interviewers. Multiple choice questions and exit poll interviews may help future interviewers. However, we feel these results clearly prove the importance of the protection of the resident sea turtles to the economy of Akumal. The results can also help CEA target certain demographics in future educational campaigns, specifically Europeans, Americans, females, teens, and people over 50.

FACTORS INFLUENCING ATTITUDES TOWARD MARINE TURTLE CONSERVATION AND CONSERVATION PROFESSIONALS: THE DIMENSIONS OF HUMAN-WILDLIFE INTERACTIONS IN PEARL LAGOON, NICARAGUA*

Kathryn A. Garland and Raymond R. Carthy

[1] Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida, USA

Human-wildlife conflicts caused by interactions between economic goals and wildlife biodiversity place pressure on threatened species and are therefore, critical aspects of conservation. Local people whose livelihoods depend on natural resource extraction or consumptive use of wildlife often disagree initially with conservation programs designed to

preserve resources. People's attitudes are central to developing effective conservation plans and culturally acceptable natural resource management programs. Researchers have found positive evidence that local cooperation and participation are key aspects in successful conservation programs. The largest foraging population of green turtles (*Chelonia mydas*) in the Atlantic Basin, and second largest in the world, exists off the Caribbean coast of Nicaragua. These waters are also home to one of the longest-running legal green turtle fisheries. Green turtles have become a focus of conservation initiatives in the last century; however programs in Caribbean Nicaragua have been in place less than 20 years. Wildlife Conservation Society has been present and actively investigating the green turtle fishery (and monitoring harvest numbers) on Nicaragua's Caribbean coast since 1993. The mission of Wildlife Conservation Society (WCS), founded in 1895, is to preserve wildlife and wild places globally. The implementation of WCS marine turtle conservation effort in Caribbean Nicaragua was a collaborative effort with the Ministry of the Environment and Natural Resources (MARENA – Ministerio del Ambiente y Recursos Naturales). Studies have shown that perspectives on conserving natural resources and conservation attitudes may be affected by education, ethnicity, wealth and other socioeconomic and demographic attributes. Perceived benefits from conservation also influence the attitudes of locals toward conservation of protected areas, as do sociodemographic variables, personal relationships with conservation organization staff and perceived costs from and changes of conservation. Based on these findings, conservation planners could potentially minimize conflict with and garner higher levels of support from local people by accounting for various social issues during initiative development. This case study focuses on communities of mixed Miskito and Creole ethnicity based in the 5200km² Pearl Lagoon Basin (RAAS). We conducted semi-structured interviews and attitudinal surveys in the fishing village of Pearl Lagoon (approximately 2540 inhabitants) over a ten-month period, in 2006 and 2008. This paper explores attitudes of rural residents in the Caribbean community of Pearl Lagoon (R.A.A.S.), Nicaragua, toward (1) conservation organizations (Wildlife Conservation Society, in particular) and (2) sea turtle conservation. Generally, we were interested in the factors that influence attitudes toward these two concepts, specifically demographic characteristics and knowledge of local sea turtle conservation and regulations. Understanding local attitudes and opinions are vital to the success of conservation programs, in particular in areas experiencing rapid population growth and rural development like Caribbean Nicaragua. An understanding of attitudes can also clarify understanding of potential influences on behavior and conservation initiative effectiveness. This is particularly relevant in the context of diminishing resources, where poor local inhabitants face greater losses from harvest restrictions and conservation measures. Studies on local perceptions of the green turtle and of conservation organizations are necessary for program design that will be accepted in the local culture.

NEST PROTECTION AND COMMUNITY ENGAGEMENT AT PRIORITY NESTING AREAS IN SOUTHWESTERN NICARAGUA*

Liza Gonzalez[1], Salvador Sanchez[1], and Sarah Otterstrom[2]

[1] Paso Pacifico, Km 15 Carretera Ticuantepe, Ticuantepe, Nicaragua
[2] Paso Pacifico, PO Box 1244, Ventura, CA 93002-1244

Nicaragua presents some of the Eastern Pacific's most important sea turtle nesting areas. For over three years, Paso Pacifico has led a sea turtle conservation program in partnership with communities located adjacent to the La Flor Wildlife Refuge in Southwestern, Nicaragua. These programs empower communities to protect over eight solitary nesting beaches and reduce the illegal trade of sea turtle eggs across the Rivas, Nicaragua province. One program trains and maintains a team of professionalized community rangers, while another relies on performance-based incentive payments to reward those poachers who voluntarily protect nests. Additionally, Paso Pacifico promotes sustainable tourism and youth education as a way to reinforce the social and economic benefits that accompany turtle protection. We review the major components of these programs and their future direction towards further involving artisanal fisheries and extending protection to additional nesting beaches. Additionally, we provide results from three years of sea turtle monitoring including findings that are novel to sea turtle conservation in the Eastern Pacific. These include the presence of Hawksbill nesting activity and the location of foraging habitat at nearby coral reefs. Results also demonstrate the presence of significant green sea turtle nesting colonies. Finally, we will share the costs for maintaining a performance-based incentive payment program and also Paso Pacifico's efforts to make the program financially sustainable using ecosystem service markets.

FIELD VOLUNTEERS FROM UNDER-REPRESENTED GROUPS IN SEA TURTLE CONSERVATION: A COGNITIVE APPRENTICESHIP MODEL AS AN APPROACH TO INCREASING SELF-EFFICACY AND AWARENESS

Shannon C. Graham[1] and Erica M. Wilkins[2]

[1] University of Hawai`i at Hilo, Hilo, HI, USA
[2] Gallaudet University, Washington, DC, USA

Recent studies suggest lack of mentoring, experience of discrimination, and assumptions of barriers hinder under-represented individuals from continuing their interested in science beyond post-secondary education. In the past decade, there have been a growing number of initiatives for retention of this specific population. Past efforts have included research opportunities, partnerships with scientists, and innovative approaches in college (Sadler, Burgin, & McKinney, 2010). Under-represented individuals are typically defined as people from various ethnic and racial backgrounds; however, people with disabilities share similar experiences. There are a limited number of deaf scientists and science teachers due lack of emphasis in content training and pedagogy, lack of confidence, and insufficient experience in science education (Mangrubang, 2005). Communication barriers and stigmatization are believed to contribute to the low numbers. While ADA law ascertains reasonable accommodations, field-based programs that are not accountable to the law cannot afford the cost. The rationale of this study is to identify factors that hamper access to internship, volunteer, and career opportunities for deaf science majors. The study is framed according to two theories: Social Cognitive Career Theory (SCCT) and Cognitive Apprenticeship Model (CAM). Career choice is believed to be dependent on assumptions and types of relevant experiences (Lent, Brown, & Hackett, 2000). Gaining these experiences is thought to be effective through guided experience and observation of experts solving problems in an authentic environment (Lave & Wenger, 1991). The study is guided by the following research questions: 1. What are some barriers that deaf science majors face in their field and how do these barriers affect volunteer or career opportunities? 2. What were experiences of deaf science majors as field volunteers on an all-signing sea turtle research team? 3. How did this experience influence their knowledge about sea turtle research and conservation issues, as well as future opportunities in science fields? Throughout five months of nesting season, a sea turtle research team consisting of a project leader and six field volunteers were formed. Most members were deaf; all were fluent in American Sign Language (ASL). Fieldwork included monitoring of nesting beaches and assistance with transmitter attachment procedures. The purpose of these field activities was to elucidate the feeding behavior of hawksbill turtles. From a naturalistic inquiry approach, the researcher interviewed team members based on their experiences. Upon completion of transcription of interviews and field notes, Atlas.ti, textual analysis software, will be utilized to organize and display identified emerging themes. Data are currently in the analysis phase; however, preliminary results confirm communication and stigmatization as barriers to entering science fields. Further, the awareness of sea turtle issues and conservation are disseminated in K-16 deaf education programs. Results of this study will provide insight for managers, researchers, and educators pertaining to stigmatization and barriers of scientists from under-represented groups. Through education and advocacy, science fields will become a viable career choice for many more deaf people.

USING CULTURAL IDEOLOGIES AND HEALTH CONCERNS TO CAMPAIGN FOR SEA TURTLE CONSERVATION IN HAINAN ISLAND, CHINA

Jennifer E. Gross[1], Frederick C. Yeh[1], Shi Haitao[2], Laura Gross[1], and Alexander Walther[1]

[1] Sea Turtles 911, Hainan, China
[2] Hainan Normal University, Haikou, Hainan, China

Hainan Island, located off the south eastern coast of China, is a place where folklore and ancient traditions surrounding the sea permeate modern society. People are adorned with hawksbill jewelry, an amulet believed to grant a long healthy life. Shops proudly display items crafted from tortoise shell, degrading what was once an integral part of the islands ecology to a mere wardrobe accessory. Sea turtle meat has been a delicacy in China for nearly 2,000 years and despite their endangered status, China's consumption of sea turtle meat is one of the highest in the world. Hainan Island is a

place where ancient traditions cannot be sustained by modern society. In an effort to decrease the market demand for sea turtle meat and items crafted from sea turtles, we are launching a multilayer campaign, adapting cultural ideology to make turtle products taboo and promoting the health risk associated with the consumption of sea turtle meat. Bacteria, parasites, organocholorines, and heavy metals have been found as contaminates in sea turtles. Reports of food poisoning and even death linked to eating sea turtle meat are increasing around the world. Local students from Hainan Normal University will be promoting the campaign through public talks, education programs, posters, and press releases. Giving many local students the opportunity to get involved in marine conservation for the first time in China! The campaign is composed of three levels, all building upon one another as it advances. The first level involves a grass roots movement through word of mouth by Chinese students and volunteers; the second level expands the demographics by using publications and printed materials to reach a greater audience; finally, to spread awareness further we will actively collaborate with local and regional governments in advocacy and legislation measures. Since much of the drive in the market for sea turtles products and meat is from visitors to Hainan Island. A large portion of the campaign will be aimed towards tourists and will be done in conjunction with the Hainan Provincial Tourism Administration and The Ritz-Carlton, Sanya. We will be promoting not only the hazard in consuming sea turtle meat but also educating the public about ecological role and importance of sea turtle conservation. Effectiveness of the campaign will be determined by monitoring market demand for sea turtle products through a series of observations at restaurants and curio markets. Additionally, general questionnaires will be distributed to the public to determine awareness of health hazards and effectiveness of the campaign.

SAVING TURTLES ONE KID AT A TIME IN CAPE VERDE: THE SCHOOL IN NATURE PROJECT

Joana Hancock[1], Emiliano Santos[2], Alexandre Monteiro[2], and Julio Rocha[1]

[1] Turtle Foundation
[2] Clube Ambiental da Boavista

The consumption of sea turtle meat, although prohibited by law in Cape Verde, is still widely practiced in the archipelago, especially in Boavista island, where up to 90% of all the loggerhead nesting in the country occurs. Turtle Foundation, in Partnership with Boavista Environmental Club, with funding from the GEF Program, initiated in 2010 the environmental education project “School in Nature”. In this project, the classroom is exchanged for a beach-front setting, and about 150 kids aged between 11-16 years old receive lectures on sea turtle biology and conservation, talk about trash and participate in beach clean-up. They also learn about the importance of biodiversity, and discuss other issues such as the importance of the family, children rights and much more. At night, they actively participate in night patrols and join the research teams. Although kids are exposed to turtles in various awareness events around the island, this project allows them for the first time, to be part of the research team for two nights, helping to collect data on the turtles and have a hands-on experience with the animals at night time. The 2010 season concluded with some work presented by the kids in a Mini-Symposium at the end of the season. Each kid had to fill a questionnaire after their participation in the program, to assess changes in their opinions and perceptions about sea turtle conservation, and the islands conservation needs. The results presented here provide us an insight of what the kids perceive to be the conservation issues in the island, and the impact of educational education on their attitude towards consuming turtle meat.

TURTLE DANCE: NEGOTIATING SEA TURTLE CONSERVATION AND WESTERN PACIFIC ISLAND CULTURES

Jessy J. Hapdei[1] and Tammy M. Summers[2]

[1] Department of Lands and Natural Resources, Division of Fish and Wildlife, Caller Box 10007, Lower Base Road, Saipan, MP, 96950, CNMI, USA
[2] University of Hawaii at Manoa, East West Center and the Department of Natural Resources and Environmental Management, 1910 East-West Road, Honolulu, Hawaii 96822, USA

Although quantitative historical records are few, dramatic reductions in numbers of nesting and foraging green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) sea turtles have apparently occurred in Micronesia since World War II, largely because of increased access to remote nesting beaches by indigenous fishermen outfitted with modern equipment (i.e. spear guns, outboard motors, SCUBA; Johannes 1986, Pritchard 1995a,b). Severe overharvest in the Pacific has also been attributed to the loss of traditional restrictions that had limited the numbers of turtles taken by island residents, loss of the spiritual significance of sea turtles, and inadequate regulations and lack of enforcement. Green turtle meat is considered a delicacy and was traditionally caught to be shared at village celebrations (McCoy 1997), while hawksbill turtle is used for ornamental products (e.g., jewelry). Resource management using western scientific techniques has fallen short of adequately protecting and conserving both the green and hawksbill sea turtle species in the Western Pacific. As numbers continue to decline, I argue that a collaborative approach that combines indigenous and western knowledge systems may provide the solution that sea turtle managers and conservationists have been searching for. I utilize a life history account by a keeper of sea turtle indigenous knowledge from the Western Pacific to assist in answering the research questions of this study. My primary research question for this project was: How does the Yapese indigenous hand-capture of sea turtle method, the use of sea turtle for subsistence and trade, and traditional conservation measures of sea turtle hunting on the island of Ulithi, Yap contribute to the conservation and management of these species today? My subquestion was: What are the policy and practice implications of indigenous knowledge learned in Yap for other sea turtle programs in the Western Pacific, specifically in the Commonwealth of the Northern Mariana Islands (CNMI)? The purpose of this study was to develop new strategies for sea turtle conservation policies and management practices in Micronesia from traditional ecological knowledge of this same region. Based upon this goal, the objectives of the study were: 1) to describe an indigenous method for capturing sea turtles in near shore waters, 2) to provide a description of cultural traditions relevant to sea turtles, 3) to explain how these indigenous methods and cultural traditions have contributed to the conservation of sea turtles in the past, and 4) to discern the implications of these methods and traditions for sea turtle conservation and management in the future. In order to accomplish these objectives I interviewed Jessy Hapdei, an indigenous fishermen from the island of Ulithi, Yap who currently works for the CNMI Department of Lands and Natural Resources Division of Fish and Wildlife sea turtle program on the island of Saipan, CNMI. He was the clear choice as the focus for my interviews not only because of his background and training in Micronesian traditional ecological knowledge, but because he is currently utilizing this indigenous knowledge in coordination with a project located within the same region that also uses western knowledge systems.

CREATING THE FUTURE GENERATION OF SEA TURTLE CONSERVATIONISTS: THE JUNIOR RESEARCH ASSISTANT PROGRAM AT TORTUGUERO, COSTA RICA*

Emma Clare Harrison and Dagnia Nolasco

Sea Turtle Conservancy (Formerly Caribbean Conservation Corporation), Apartado Postal 246-2050, San Pedro, Costa Rica

Sea Turtle Conservancy (Formerly Caribbean Conservation Corporation), STC, has been conducting a sea turtle research and conservation program at Tortuguero, Costa Rica for over 50 years. Local community support has been fundamental in ensuring the success of the project, and since the beginning STC has sought to raise local awareness about sea turtles and conservation issues through education and active participation of community members in program

activities. In recent years a structured environmental education program has been developed for students at schools in the area, with the objective of teaching the younger generation the value of their local natural resources, the need to protect them, and the active role that each of them can play in conservation efforts. The experience of a group of Tortuguero students at a regional Student Sea Turtle Symposium, and their subsequent request to STC staff to become more involved in the research and monitoring activities, was the inspiration for the development of a new education program for high school students in 2008. The primary goal of the Junior Research Assistant Program (JRAP) is to give students the opportunity to learn first hand about the work of STC, and to gain practical field work experience. Ultimately it is hoped that JRAP participants will develop an interest in conservation biology, be inspired to continue into further education to gain a degree, and will want to become future members of the STC research team in Tortuguero. Students complete a comprehensive program of theoretical and practical activities, working closely with international researchers based at the STC biological field station in Tortuguero. They receive presentations about sea turtle biology, their principal threats and conservation initiatives, and also assist in all aspects of the monitoring protocol, including night patrols and track surveys. Other important aspects of the program are their involvement in environmental education activities at the school, and the completion of a research project. Students who complete all the required elements receive a certificate and a specially designed t-shirt at the end of the program. Since 2008, over 100 students have participated in JRAP activities, although only a small number have graduated from the course. JRAP students have presented their research findings at the annual Student Sea Turtle Symposium, and in 2010 a group was invited to visit another sea turtle conservation project on the Caribbean coast, to share their experiences with students from other high schools in the area. And the first former JRAP graduate worked as an STC Local Research Assistant in 2010. It is planned to further develop the JRAP, to include components that focus, for example, on the work of park rangers in Tortuguero National Park, or biologists studying other species in the area. The JRAP has been successful in developing closer links between STC and the community, particularly with the younger generation. Programs such as this provide an excellent opportunity to create a positive conservation ethic among young people to guarantee the success of sea turtle projects in the future.

BUILDING A NEST EGG FOR A SEA TURTLE PROJECT’S FUTURE THROUGH GRASSROOTS FUNDRAISING

Erica D. Heimberg

Turtle Island Restoration Network, Olema, California, USA

The Sea Turtle Restoration Project (STRP) of Turtle Island Restoration Network has developed a fundraising program that includes an array of income streams to provide diversified funding for its hands-on conservation, public education and policy advocacy programs. This replicable model has enabled STRP program managers to build a nest egg that will allow the organization to continue its efforts and protect sea turtles into the future. The fundraising program’s foundation is the engagement of individual members and donors in supporting protection efforts. These individuals not only provide long-term funding, but also act as engaged volunteers and advocates for sea turtle protection. STRP’s approach includes an individual membership, major donor program, planned giving program, benefit events, retail sales efforts as well other sources of funding including private foundations. By utilizing diverse fundraising efforts, STRP has been able to continue its work to address the growing need for environmental conservation and protections for sea turtles and other marine species during the severe economic downturn in recent years in the United States. The downturn has affected many traditional funding sources including foundation grants. STRP has focused on 1) developing a strong base of support from individual grassroots members through email, online action, and direct mail programs; 2) individual donor programs that involve personal interactions with donors and opportunities for them to be engaged in programs; 3) planned giving programs that offer simple ways for interested people to support the organization through their wills; and 4) fundraising events targeted to donors with informative presentations and retail sales. STRP’s grassroots fundraising programs provide a model for sea turtle program managers to begin to build a sustainable future for their own efforts. A simple fundraising plan helps program managers build short-term and long-term financial support. STRP uses basic planning techniques including the concept of a giving pyramid, circles of influence, and an annual fundraising plan. These tools provide ways that small, grassroots groups can carry out these efforts with minimal expense. STRP also communicates with established sea turtle and marine conservation organizations around the globe, gaining partnerships and inspiration from those groups. Ten key tips on fundraising for sea turtle conservation will be shared in the presentation.

THE LEGACY OF SINKEY BOONE

Sally R. Hopkins-Murphy[1], Todd Steiner[2], and Randall Arauz[3]

[1] South Carolina Dept. of Natural Resource (retired), Sheldon, South Carolina, USA
[2] Turtle Island Restoration Network, Forest Knolls, California, USA
[3] PRETOMA, San Jose, Costa Rica

Shrimp trawling is believed to be the current leading cause of sea turtle mortality in the US and around the world where it occurs. With the listing of sea turtles as threatened or endangered on the US Endangered Species Act, the need to significantly reduce turtle mortality from shrimp fishing became a legal necessity. The US government sought to find a "technological fix" that would allow shrimp trawling to continue while reducing turtle mortality. The result was a device known as a turtle excluder device or TED. The original government TED was generally rejected by shrimp fishers, who described as a big, clumsy, and boxy device that was dangerous and unworkable. Sinkey Boone, a Georgia shrimper and inventor, had previously invented a device that excluded jellyfish in order to improve shrimp efficiency and modified it to also exclude turtles. This new TED, called a "Georgia Jumper," which resembles a large bar-b-que grill, was more readily accepted by shrimp fishers, and became a model for most of the TEDs currently certified for use. Sinkey's life-long work was to promote the use of his device in the US and worldwide. Sea turtle conservation took a giant step forward with the invention and implementation of the Georgia Jumper TED and similar TED's. This is the legacy of Sinkey Boone.

FROM PROTECTED AREA TO SUSTAINABLE NON-CONSUMPTIVE USE OF SEA TURTLE— CASE STUDY OF GREEN TURTLES IN TAIWAN

I-Junn Cheng

Institute of Marine Biology, National Taiwan Ocean University, Keelung, Taiwan, 202-24, ROC

The nesting populations of green turtle in Taiwan were small, barely exceeds 20 nesters per year on each of the two main nesting islands. One of the nesting site; Wan-an Island of Penghu Archipelago has established as the nesting refuge site since 1995. The purpose of the refuge site is to protect the nesting females and the hatchlings. However, due to the fact that the nesting beaches run along the major villages on the island, the management is extremely challenged. In order to protect the green turtle and rights and interests of local residents simultaneously, the effectiveness of protected areas occurs only in the night, and impose mainly on the tourists, not the residents. In the meanwhile, we convinced the private industry and county government to hire the local residents as the beach patrols. Based on the knowledge of long-term scientific researches on the island, we initiated the public awareness campaigning by giving the free lectures on sea turtle ecology and conservation to the tourists every night during the nesting season 13 years ago. The Penghu National Scenic Administrative Bureau (PNSAB) also built a "Green Turtle Tourism and Conservation Exhibition Hall" in 2002 by the harbor to promote local tourism and sea turtle conservation. We also promoted the ecotourism summon with green turtles since 2000. We even encourage and help commercialize of this activities since 5 years ago. Currently, the ecotourism has become normal activities during the nesting season. The Exhibition Hall has also become one of two main tourist attractions on the island. Last year, PNSAB estimated that almost one-thirds of the tourists on Penghu Archipelago visited this hall. One of my student also estimated that the minimum net income of local communities from sea turtle-related tourism activities in 2009 exceeded 4 million NT dollars. With the growing tourism activities, PNSAB hosted a meeting in April 2009 with the county government, Penghu Marine Biological Research Center, and my laboratory to discuss the further cooperation among different bureaucrat systems. A MoU was signed after that meeting. Now, most of the problems we faced in the past were solved officially. It is possible that the local communities and even Penghu County residents can receive essential financial benefits from sea turtle related activities, most of them no longer hold a opposite or questionnaire attitude towards our conservative researches. In addition, the ecotourism activities also provide a chance to introduce the unique island ecological resources to the tourists. Local communities are also respecting our regulations and decrease their activities on the beach and nearby waters in the night. Thus, with the non-compulsory execution of the regulations, we reach the

mutual recognition on sea turtle protection with local residents. The tourism activities summoned with green turtles also bring financial benefits to local residents. These achievements provide a chance for us to advance the goal towards non-consumptive sustainable use of this natural resource. All this, however, depend critically on the long-term saturated ecological monitoring and researches on the protected area.

EFFORTS OF SEA TURTLE CONSERVATION AND RESEARCH IN BANGLADESH BY MARINELIFE ALLIANCE

Mohammad Z. Islam[1], Md. Foysal[2], and Somnath Chakrabarti[1]

[1] Marinelife Alliance, Cox's Bazar, Bangladesh
[2] Jogonnath University, Dhaka, Bangladesh

Sea turtle conservation started late in Bangladesh compared to other parts of the world. As we have more fragile habitat in terms of development and unregulated activities from both government and private sectors during 2 decades and due to dense coastal population, the situation far worse in current days as a result of the government's contradictory wrong developmental decisions. In fact, there will be no impact of the sea turtle activities unless it is integrated including field intervention, awareness and community based. With this vision the research and conservation organization Marinelife Alliance conducting field activities during the last several years along the rookeries of St. Martin island, Cox’s Bazar - Teknaf coast and Sonadia island. The major activities are monitoring of nesting and dead sea turtles, in situ & ex situ breeding program throughout the 140 kms of coastline, habitat mapping and scientific morph-metric data collection with the help of community, awareness with the community people, local children’s education through school program, bycatch awareness program with the offshore fishermen through training, and motivation. In scientific facts uncovering efforts are also our major thrust like satellite tracking, tagging, offshore survey etc. are major effort currently. So far we trained 2700 fishermen and engaged 355 fishermen heads of the offshore bycatch data collection and mitigation to contribute bycatch reduction, we educated more than 2545 school children in 62 deferent programs within 22 schools along the coast since 2004. So far since 2004 we released over 85 thousand hatchlings of olive ridley and 849 hatchlings of green turtle. Marinelife is trying to establish the sea turtle conservation and monitoring program sustainable and community based through alternate livelihood generation based on conservation efforts that community can keep those activity going for their won interest and for long time.

IMPROVING INTERNATIONAL ADOPTION OF CIRCLE HOOKS AND TEDS: LESSONS FROM ECUADOR*

Lekelia D. Jenkins[1], Patrick J. Christie[1], Wallace J. Nichols[2], Nikita Gaibor[3], Mark Mizrahi[1], and Michael Viña[4]

[1] University of Washington, Seattle, Washington, USA
[2] California Academy of Sciences, San Francisco, California USA
[3] University of Rhode Island, Kingston, Rhode Island, USA
[4] New Mexico State University, Las Cruces, New Mexico, USA

In has been 40 years since the last large-scale assessment of international transfer of marine technology (mostly exploitative technologies) by the United States. Section 609 of the Endangered Species Act of 1989 and Section 403 of the Magnuson-Stevens Fishery Conservation and Management Act of 2007 require the international use of turtle excluder devices (TEDs) and circle hooks, respectively, by foreign fishers who want to export fish to the United States under certain conditions. Clearly, the focus of international transfer of marine technology has shifted from exploitative to conservation technologies, but is the technology transfer model the United States uses effective and appropriate now? In the past two years, the U.S. government has embargoed shrimp imports from some countries, because their shrimp fishers have not met the U.S. standard for use of TEDs. Despite two decades of TED workshops and other extension activities by the United States abroad, rumors abound of poor or improper TED use by foreign fishing fleets. In contrast, the U.S. government has repeatedly certified the shrimp fisheries in other Latin American countries,

including Ecuador, which has made significant efforts to adopt both technologies, allowing their continued export of shrimp to the United States. In addition, international organizations like the Inter-American Tropical Tuna Commission and NGOs like WWF have partnered with the U.S. government and organizations in other nations to promote the use of circle hooks in longline fisheries throughout Latin America. This program's sustained effort, especially in Ecuador, has made progress, in spite of significant impediments to adoption (e.g. circle hook availability, cost, etc.) In our study we sought to understand why the United States' promotion efforts yielded better acceptance of TEDs and circle hooks in some countries than in others. In this presentation, we focus on the lessons learned from a socio-cultural study in Ecuador. We applied qualitative and quantitative methodologies in a triangulated approach. First, we conducted semi-structured in-person interviews with key informants from the United States and Ecuador selected with purposive and snowball sampling and analyzed the transcriptions with a grounded theory approach using computer assisted qualitative data analysis software. Second, we conducted a formal survey of fishers and analyzed the results with multivariate statistics. Third, we conducted a social network analysis using the software program UCINET. We interpreted these results within the context of theories on technology transfer, diffusion of innovations, and cross-cultural communications. Our preliminary findings suggest that programs burdened with many restrictions such as the U.S. promotion program for TEDs can yield a standard program with little flexibility to accommodate cultural and other differences in nations. However, partnerships with other organizations that do not have such restrictions, such as in the circle hook program, allows supplemental initiatives that can be tailored for the specific needs of each countries fisheries. A balance between accountability to rules generated by external governing bodies and freedom to create context-appropriate rules appears to speed technology adoption. In all cases, incentives are needed, and it is important to identify the most effective ones.

THE EFFECTIVENESS OF COMMUNITY TURTLE CONSERVATION GROUPS ALONG THE KENYAN COAST

Joan A. Kawaka[1], Rose B. Machaku[1], and Doughlas Maina[2]

[1] Wildlife Conservation Society, Marine Program Kenya, P. O. Box 99470-80107, Mombasa, Kenya
[2] Kenya Sea Turtle Conservation Committee, P. O. Box 58-80122, Mombasa, Kenya

Community conservation groups have become a very important part of marine conservation in the western Indian Ocean region. The posterity of marine resources depends partly on coastal communities. This case study depicts community conservation groups in sea turtle conservation, their effectiveness in sea turtle awareness initiatives along the Kenyan coast, and factors affecting these initiatives. The study explored socioeconomic conditions of these communities and their involvement in decision-making in the community in relation to the level of education, age, sex and religion. Turtle Conservation Group members (TCGs), officials and community leaders were interviewed on their perception of sea turtle conservation. More than 50% of TCG members originated from the communities where they were living and had stayed there for more than 10 years. They had been involved in marine conservation activities and felt that these efforts were paying off. Respondents cited improved livelihoods, increased awareness of importance of conservation and reduced destruction of the marine environment as some of the benefits of establishing community groups.

COMMUNITIES, COMPASSION AND CONSERVATION

Shannon L. McDonnell[1, 2]

[1] TREE Foundation, Chennai
[2] Tamil Nadu, India

This paper will examine the causes of wildlife depletion and outline the solutions which TREE Foundation has implemented over the last 8 years. TREE Foundation has always maintained that poverty and lack of education are the chief causes of natural resource depletion. For the purposes of this paper, the paper will concentrate on locals' use of endangered sea turtles and their eggs as a source of food and profit and how TREE Foundation successfully used

community engagement and betterment programs to halt the practice of poaching, including: Uniting government and fisherfolk to work toward conservation, Providing health services to the affected communities to win hearts and minds, Providing a stipend to local fisherfolk for work in conservation programs, Designing and implementing education programs targeting young students, Providing alternate income sources to fisherwives, Providing alternate protein sources for tribals dependent on endangered populations of sea turtles for primary nutritional needs. In addition to providing education and incentives for conservation, TREE Foundation has also developed eco tourism programs designed to encourage local populations to explore, examine and appreciate their natural resources. If we do not care for the communities in which we work to save the olive ridleys and the biodiversity of the region there can be no successful outcomes. As human beings are a part of the natural surroundings in which we work, we must show compassion to those communities in order to save our planet and ourselves.

FIRST ASSESSMENT OF MARINE TURTLE ACTIVITY IN THE DEMOCRATIC REPUBLIC OF CONGO

Franck Kashita Liou[1], Peter Lukamba Lundengo[1], Thomas M'fu Ntsanketi[2], and Micheline Kani Kani[1]

[1] OCPE (ong) KINSHASA/ Democratic Republic of Congo
[2] ICCN /MUANDA, MUANDA/ Democratic Republic of Congo

Three species of sea turtle are found in the Democratic Republic of Congo (DRC): the olive ridley (*Lepidochelys olivacea*), the leatherback (*Dermochelys coriacea*),and the green turtle (*Chelonia mydas*).in 1982,a law was established to protect threatened species in the DRC and along the Congolese coast. The DRC is also a signatory to the Memorandum of Abidjan for the conservation of sea turtles along Atlantic Africa. However, a study in November 2005 indicated that the main threats to sea turtles are direct consumption and commercial trade. In a period of two weeks, 85 olive ridleys, 37 leatherbacks, and 8 green turtles that had killed in the villages, in the market at Muanda and in fishing encampments were countend. More studies are now needed to identify the nesting areas and to determine which species nest in the DRC. The role of the local communities will also be taken into consideration to ensure an effective conservation and management progam.

A CITES "HOW-TO": GUIDELINES FOR IMPORTING AND EXPORTING SEA TURTLE TISSUE SAMPLES ACROSS INTERNATIONAL BORDERS

Erin L. LaCasella[1], Siri E. Hakala[1], Kelly M. Robertson[1], Danielle H.S. Abernethy[2], Jeffrey A. Seminoff[1], and Peter H. Dutton[1]

[1] National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, CA USA
[2] U.S. Fish and Wildlife Service, Office of Law Enforcement, San Diego, CA USA

Due to the decline of sea turtle populations worldwide, all sea turtle species except the Australian flatback are listed as Threatened or Endangered under the Endangered Species Act of 1973 (ESA) and are listed as Vulnerable, Endangered, and Critically Endangered on the World Conservation (IUCN) Red List. These listings have resulted in federal and international laws for protection against over-exploitation and extinction. In addition to the ESA and the Red List, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an important entity in Sea Turtle conservation. Because sea turtles are highly migratory, many collaborative scientific research projects extend across international borders and the exchange of sea turtle samples is essential to better understand the population status and distribution of sea turtles worldwide for their conservation and management. CITES is an international agreement between governments that regulates the trade of wildlife through a system of specific permits or documents to ensure that trade is legal, monitor the type and volume of trade and make certain that the trade is not detrimental to a species' survival. Under CITES regulations all species of animals and plants are categorized as Appendices I, II, or III which provide different levels of protection based on how threatened or endangered each species is considered. However, it is important to note that a species CITES category is not linked directly to its ESA or

Red List status. All sea turtles species are classified as Appendix I and therefore are subject to the most stringent international trade regulations in addition to domestic laws. Appendix I species require two CITES permits, one from the importing country and one from the exporting country. In addition to obtaining a CITES permit for sample import and export, the shipment of specimens must also be inspected and validated by the country's appropriate enforcement agency to be considered legal. This must be completed prior to importing samples into the U.S. and is strongly enforced by U.S. officials. Samples are subject to confiscation if the permit does not have this required validation. At the NOAA Fisheries-Southwest Fisheries Science Center (SWFSC) we have many international collaborators contributing samples to our tissue/DNA archive for permanent storage and for research projects. In many collaborators' experience, the process of obtaining a CITES permit can be confusing and the lack of consistency between countries has been, and continues to be, problematic. With experience in importing and exporting thousands of sea turtle samples over the past several years, SWFSC has gained a greater understanding of the CITES importation process. Regulations in the U.S. have become more stringent and this poster outlines optimal CITES procedures and lessons learned from various scenarios. Our goal is to provide guidance to facilitate the import and export process for future collaborative scientific research.

SAVING SEA TURTLES - ONE T-SHIRT AT A TIME*

Cynthia J. Lagueux[1], Cathi L. Campbell[2], and William A. McCoy[1]

[1] Wildlife Conservation Society, Pearl Lagoon, RAAS, Nicaragua
[2] Wildlife Conservation Society, Bronx, NY, USA

For more than 10 years, the Wildlife Conservation Society has been providing incentives to local fishers on the Caribbean coast of Nicaragua not to kill turtles by providing them with a reward (e.g., specially designed t-shirts) for any live sea turtle donated to the WCS conservation program for tag and release. Recently, we added other incentives (e.g., life jackets for multiple donations) to expand our outreach. The program has been successful not only at directly saving hundreds of sea turtles, especially hawksbills, but also has provided an opportunity for information exchange. We present a history of our incentive program, results from our efforts, challenges we faced and lessons learned.

BANNING SEA TURTLE EGG CONSUMPTION IN EL SALVADOR: THE ROLE OF HATCHERIES IN CONFLICT RESOLUTION

Michael J. Liles, Leigh A. Bernacchi, and Tarla R. Peterson

Texas A&M University, College Station, Texas, USA

The ubiquitous use of hatcheries worldwide underscores their importance as a tool for local sea turtle conservation. Hatcheries that purchase nests from local egg collectors for protection provide an alternative economic incentive to sale for consumption, encouraging the direct participation of coastal communities as important stakeholders in conservation initiatives. Despite their popularity, many sea turtle experts consider hatcheries a "last resort" for nest conservation due to potential biological consequences associated with clutch manipulation and poor management, such as low hatch success, biased sex ratios of hatchlings, and increased hatchling mortality. However, suggested alternatives often do not recognize or minimize human needs and can even generate conflict through competition with coastal communities over the fate of nests. While failure to adhere to established best practices that could mitigate many undesired biological outcomes is clearly of concern, the measurement of hatchery worth using short-term biological criteria only may not reflect its true value to long-term marine turtle conservation. To investigate the socioeconomic dimensions of hatchery implementation in a low-income nation with laws that prohibit the collection and sale of sea turtle eggs for consumption, between 2009 and 2010 we conducted an ethnographic study composed of open-ended, semi-structured interviews with 22 local egg collectors in El Salvador to better understand their perceptions of the ban on egg consumption and its implications to conservation. Following interviews with respondents, we performed an in-depth content analysis of the transcribed data by deconstructing the interview text into units of meaning and organizing them into themes. Four themes emerged that were common across interviews: 1) The primary value placed on sea turtles by

respondents was the economic value attached to egg sale, 2) Respondents viewed the use of hatcheries as the solution to economic hardship created by the ban on consumption, 3) All respondents explicitly stated that sea turtle nests not protected in hatcheries were sold for consumption, and 4) Most respondents desired more involvement in conservation processes and decision-making that they consider to be currently biased towards elite interests. With millions of sea turtle eggs collected each year throughout the world by often marginalized members of low-income nations, limiting the conservation focus to immediate biological outcomes fails to address the economic needs of coastal communities that are rooted in specific contexts of individual countries. Such privileging may discourage local participation, generate conflict, and hamper the achievement and sustainability of desired long-term conservation outcomes. We thank the Boone & Crockett Club, International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service, and the International Sea Turtle Symposium for financial support provided.

ENGAGING INDIGENOUS PEOPLE IN RESEARCH – A TORRES STRAIT EXAMPLE*

Frank Loban

Torres Strait Regional Authority

In the Torres Strait region of Australia, indigenous communities are becoming more engaged in doing research into turtle biology, migration and conservation. Since 2006 Torres Strait communities have been involved in the Dugong and Turtle Project and through this project, Aboriginal and Torres Strait Islanders have been given the opportunity not only to participate in research activities, but also to identify research priorities concerning turtles, developing marine turtle based research projects and also coordinating them. Between 2008 and 2010 communities have implemented 15 community based management plans in Torres Strait. With this development and endorsement by traditional owners of dugong and turtle community based plans, communities have been provided with the opportunity to identify research priorities for their region and community. Through close collaboration with traditional owners, Torres Strait Regional Authority, Torres Strait Island Regional Council, James Cook University (JCU), Maritime Safety Queensland and several other stakeholders, several research activities have been conducted in the Torres Strait. A key component of increasing the engagement of indigenous people in the Torres Strait in research has been the establishment of the Torres Strait Ranger Program. The Torres Strait Indigenous Ranger Program is being delivered in collaboration with the Torres Strait Island Regional Council and traditional owners. Traditional owners are now consistently involved in marine turtle and dugong research and monitoring activities. This has allowed for the exchange of traditional knowledge with contemporary turtle and dugong conservation issues and research methodologies. Through a four-year collaborative partnership with JCU, training has also been provided to traditional owners to develop their technical skills and increase community awareness of turtle management and conservation issues. In 2010 JCU staff conducted an evaluation of the marine turtle project. The evaluation sought to quantify changes to attitudes, skills, aspirations and knowledge of stakeholders in regard to marine turtle management. The results were very clear – Among other results, (1) Indigenous participants gained significant knowledge about western science protocols and methods as now have a better understanding of how science is used (2) research staff (from three universities) gained invaluable insight into customary approaches for monitoring and management and (3) staff from Government agencies outside of TS are more willing to incorporate traditional knowledge into western management and monitoring frameworks. Together with other positive changes, these improvements will lead to more effective monitoring and management of not only turtles, but other important species such as dugongs and the habitats they use. As representatives of Torres Strait Islander people we will present details of our cooperative projects. This will include discussion of (1) evaluation results, (2) overcoming the challenges indigenous peoples face in becoming engaged with research and finally will demonstrate, using examples of outcomes, how engaging indigenous people in the Torres Strait into marine turtle research activities are working and why Indigenous rangers in northern Australia are the next generation of turtle researchers and managers.

SEA TURTLE CONSERVATION IN THE RIVIERA NAYARIT, MEXICO: A LITERATURE REVIEW

Adrián Maldonado-Gasca[1] and Catherine E. Hart[2]

[1] Instituto Tecnológico de Bahía de Banderas. La Cruz de Huanacaxtle, Nayarit, Mexico
[2] Centro Universitario de la Costa, Universidad de Guadalajara, Puerto Vallarta, Jalisco, Mexico

Four species of sea turtles Olive ridley (*Lepidochelys olivacea*), Leatherback (*Dermochelys coriacea*), Hawksbill (*Eretmochelys imbricata*) and Black (*Chelonia mydas*) are registered in the Riviera Nayarit, Mexico. Despite 20 years of conservation efforts, information generated has remained in grey literature. With the aim of raising awareness of the importance of Nayarit to sea turtle populations, we conducted a review of grey literature and online resources. There are currently 7 Centers for Sea Turtle Protection and Conservation and 2 Sea Turtle Protection Camps registered in the state covering ~80 km of beach (Nuevo Vallarta 14, Litibú 5, San Francisco 6, El Naranjo 8, Platanitos – Playa Chila 17, San Blas 18, Los Corchos 6, Punta Raza 3.5 and Punta Mita 4). The activities at these centers usually include nest protection and environmental education. The olive ridley turtle is the most abundant species and its nesting has notably increased over the last 10 years with Nuevo Vallarta beach containing the highest nesting density in the northwestern Mexican Pacific (>350 nests/km/year). We also highlight that the Riviera Nayarit is a potential nesting and foraging area for the critically endangered Leatherback and Hawksbill turtles. CEH wishes to thank the International Sea Turtle Symposium, International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service for providing a travel grant to attend the Symposium. CEH receives a student scholarship from the Consejo Nacional de Ciencia y Tecnologia (Conacyt). AMG would like to thank M.V.Z. Miguel Angel Flores Peregrina for his valuable help and all those who work for the protection and conservation of sea turtles in Nayarit.

LOVING THE SEA TURTLES TO DEATH: EXAMINING STAKEHOLDER PERCEPTIONS AND THE POTENTIAL FOR COLLABORATION TO IMPROVE SEA TURTLE CONSERVATION IN THE ISLAND OF GILI TRAWANGAN, INDONESIA*

Allison McCabe and Sonya Graci

Ryerson University, Toronto, ON, Canada

There are many sea turtle conservation efforts around the world striving to protect sea turtle populations, and obtain crucial data to fill research voids. Collaboration is an effective method for creating successful programs to reach these goals. Collaboration allows various stakeholders to become involved and contribute. To identify how and if collaboration can occur in an island that's economy is dependent on marine tourism and the experience of the sea turtle, the island of Gili Trawangan in Indonesia was selected as a case study. The tourism industry in Gili Trawangan is approximately 95% of the GDP, and more than 80% of the local families are employed by tourism on the island (Graci, 2008). Dive tourism is the main attraction, with 12 dive shops located on this island of 6km in perimeter. The large population of sea turtles in the waters surrounding Gili Trawangan, it is often referred to as "The Sea Turtle Capital of the World" (WWF Indonesia, 2004). Gili Trawangan lacks practices specifically related to sea turtle conservation. This study aims to contribute by providing practical methods to help protect sea turtle populations in a collaborative manner. According to a World Wildlife Fund (2004) report on the economic aspects of sea turtles, "declines in sea turtle populations jeopardize jobs, tourism and coastal economies, especially in developing countries." Although the tourism industry has the ability to destroy sea turtle populations through improper management, this industry also has potential to protect sea turtle populations, and prevent the extinction of sea turtles (Caribbean Conservation Corporation, 2010; Choi & Eckert, 2009). Experience has demonstrated that stakeholder collaboration can play a vital role in sea turtle conservation. 50 semi-structured interviews were completed with all stakeholder groups in Gili Trawangan to gain an understanding of their perspectives on the potential for collaboration aiming to protect sea turtles. Selin and Chevez's (1995, p848) evolutionary model of tourism provided a strong base for interview questions. Stakeholder perceptions on

leadership, interdependence, sea turtle importance, existing networks, barriers and incentives were prime areas of exploration. Key themes and barriers that emerged during this research identify that lack of enforcement, corruption, high turnover of locals and expatriates living on the island, divide between locals and expatriates, education, communication, and management transparency all hinder the conservation of sea turtles, despite their importance to the stakeholders on the island. Current attempts at sea turtle conservation, although developed with good intentions, are contributing to various stakeholder dissatisfaction, resulting in tension between stakeholder groups. There is potential that the development of a strong partnership between stakeholders could help overcome the current barriers in sea turtle conservation in Gili Trawangan. This holistic study reveals true stakeholder perceptions and strives towards realistic sustainable sea turtle conservation in a small developing island reliant upon sea turtles as a tourism product. Recommendations using effective information diffusion, and the revelation of comparisons between stakeholder perceptions aims to help overcome important barriers to sea turtle conservation in Gili Trawangan, and act as a model for other small islands facing similar barriers.

REDUCING PLASTIC BAG USE TO PROTECT SEA TURTLES: THE ADVOCACY APPROACH

Madeline McKenna and Chris Pincetich

Sea Turtle Restoration Project, Forest Knolls, California, USA

Endangered sea turtles ingest plastic bags, mistaking them for the jellyfish they feed on. The outcome of plastic pollution ingestion is often fatal; the plastic bag causes sea turtles to starve and entanglement in plastic debris can cause a sea turtle to drown. Plastic bags are common in urban waste that enters our creeks, waterways, and is ultimately is released into the world's oceans. Under the U.S. Endangered Species Act, we are compelled to protect endangered sea turtles from all threats to their survival, which includes the threats posed by single use plastic bags and plastic debris. The Sea Turtle Restoration Project is currently engaged in advocacy efforts to stem the tide of plastic entering the oceans and threatening endangered sea turtles. Our Bag the Plastics campaign has contributed to successful bans of plastic single use plastic bags in both Los Angeles County and Marin County. The Bag the Plastics campaign will continue to educate local governments and coastal communities about the dangers that plastic pollution in our oceans pose to sea turtles and work to pass more plastic bag bans throughout the state of California and around the world.

THE PHOTO EXHIBITION OF SEA TURTLES

Mehmet Miras

NTV CNBC Istanbul, Turkey

This exhibition will consist of a visual demonstration of habitations of sea turtles in Turkey. The purpose of this exhibition is to introduce the importance of the preservation of their species that are almost extinct in Turkey through the lens of my photographs. There will be two types of species of sea turtles shown by the photographs: *Chelonia mydas* and *Caretta caretta*. Also the exhibition will have 50 of 30x40 dimensioned photographs.

PROYECTO HELP COLOMBIA: A FIRST STEP IN SEA TURTLE COMMUNITY BASED CONSERVATION IN COLOMBIA

Maria C. Monterrosa and Margarita M. Palomino

Fundacion Colombia Marina, Colombia

After three years working sea turtles nesting assessments in the Magdalena Department, Colombian Caribbean, Colombia Marina team developed a true relation with a fishermen committee established since 1960 in one of the most important beaches for nesting of *Caretta caretta*, and significant one for *Dermochelys coriacea*, *Chelonia mydas* and *Eretmochelys imbricata*: Mendihuaca Beach, between Mendihuaca and Guachaca Rivers. These years working with them, let us understand what many times we have read in papers: Sea turtles conservation status is a consequence of social situation. They let us to get in the problematic and show us, their will to become conservation allies. Colombia Marina is persuaded of the importance of community participation in the conservation process to obtain long-term results and be able to consolidate a strong model. M.Â. Marcovaldi, V. Patiri, J.C. Thomé (2005) affirm that one of the most important objectives in any conservation project, is to change the paradigm of the coastal communities about the interference between development- survival and protection of the natural resources. For many years the eggs and females of sea turtles have been income and food for these families, so, in order to stop the harvesting we had to find a model which resolve the profits issue and began to work in the education of the youngest thinking in the future life style. Having Projeto Tamar (Brasil) like the most successful model in sea turtle community based conservation, we began what we know is a long way, with a three work lines project. 1. Involving Community: The fishermen committee is our principal actor in the project. Looking for improve their income but with not financial possibilities of hire them to make beach patrols and protect the nests, we decided to strength their principal activity by: assisting them with gears and materials which could improve their fishing capture and increase their income; finding better commercialization conditions and improving their camp and kitchens on the beach. 2. Environmental education: Essential for the success, the program is targeting the youth and kids of the neighboring communities, with constant environmental education besides recreational and artistic afternoons, learning about sustainable development and conservation. The project is doing a sea turtle approaching campaign in the primary and high schools of the area. A recycled program was started and a sea turtle monument was done with the children participation. 3. Identifying alternatives activities: Workshops directed to the women´s community are part of the social inclusion tactic. This first one was a recycled paper workshop. We want to thank International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and the 31 International Sea Turtle Symposium for the travel grant awarded to Ma Carolina Monterrosa Colombia Marina Foundation wants to thank in particular the financial support provided by Rufford Small Grants Foundation, who has been supporting us from the start of this research in 2007. "Proyecto Help Colombia" is a life project in memory of Fernando Dias Pazeto.

LANDSCAPING FOR SEA TURTLES: NESTING HABITAT DESIGNS FOR THE HAWKSBILL SEA TURTLE, *ERETMOCHELYS IMBRICATA* ON A DEVELOPED BEACH, LONG ISLAND, ANTIGUA, WEST INDIES

Tara K. Muenz[1] and Jose R. Buitrago[2]

[1] The Jumby Bay Hawksbill Project
[2] The University of Georgia, College of Environment and Design

Nesting habitat loss or degradation is one of the major conservation challenges facing hawksbill turtles in the Caribbean region, which seemingly prefer to nest within maritime vegetation. The development of measures to protect their nesting habitat is crucial and involves many stakeholders. Together creatively with the Jumby Bay Hawksbill Project, a team of scientists, homeowners, horticulturalists and landscape architects have joined in an effort to restore turtle nesting habitat to one developed beach (Pasture Beach) on Long Island, Antigua. The Jumby Bay project has monitored a relict population of nesting turtles since 1987 on a beach that has seen much alteration over time of its native vegetative structure, particularly to the historic maritime forest. Within the past decade the project has collected specific information on nesting site preferences, which in turn has supported habitat restoration efforts on Pasture Beach. Although the preservation of maritime forest should remain as the first line of optimum effort, in some cases this is not an option. With this reality, the design concept of reintroducing habitat on Jumby Bay through vegetative plantings became known as 'beach gardens.' This conceptual design solution aims to return favorable nesting habitat to the beach, attracting turtles once again to areas that were once devoid of any vegetation due to development alterations, while also providing for the landscape interests of the homeowner. We will discuss the restoration efforts of the Jumby Bay project,in addition to future directions of efforts and initiatives to work with landscape professionals and developers in Antigua to aid in hawksbill nesting habitat conservation.

NO SILVER BULLET BUT A SILVER CLOUD: LESSONS LEARNED AND RECOMMENDATIONS FOR SEA TURTLE CONSERVATION TOURISM*

Brad Nahill[1], Chris Pesenti[2], Luis Garduno[3], Matt Humke[4], and Wallace J. Nichols[5]

[1] Co-Founder & Marketing Director, SEE Turtles, Beaverton, Oregon, USA
[2] Field Director, SEE Turtles, Beaverton, Oregon, USA & Founder, RED Sustainable Tourism, La Paz, Mexico
[3] Director of Operations, RED Sustainable Tourism, La Paz Mexico
[4] Director of Enterprise Development, Solimar International, Washington DC, USA
[5] Co-Founder, SEE Turtles, Beaverton, Oregon, USA & Research Associate, California Academy of Sciences, San Francisco, California, USA

Tourism is listed as a key strategy in nearly every official sea turtle conservation plan in the last 20 years. Done correctly, sea turtle tourism can have multiple positive benefits for conservation efforts including offering economic alternatives to illegal capture of turtles and eggs, generating new funding for conservation, and increased monitoring of key habitats - especially nesting beaches. However, if uncontrolled, tourism can also negatively affect sea turtles through unsustainable coastal development, generation of waste and pollution, and increased stress from close contact with humans. While tourism has successfully been used to support conservation in specific locations such as Tortuguero (Costa Rica), Matura Beach (Trinidad), and Mon Repos (Australia), many other sites inhabited by sea turtles have received little tourism visitation. While many turtle projects hope to develop tourism as a conservation strategy, few have the resources or technical capacity to develop a successful program. We explore lessons learned in developing an international market for sea turtle conservation tourism, including case studies of capacity building efforts in Mexico, Grenada, and Honduras. We also present recommendations on important areas of focus for conservation projects, considering starting a tourism program including determining which tourism niche markets are most strategic, understanding tourist expectations, and identifying and securing resources available to build operational capacity.

PUTTING THE USE OF MPAS FOR TURTLE CONSERVATION INTO PERSPECTIVE: COMPARING THE SUCCESS AND FAILURES OF LOGGERHEADS AND LEATHERBACKS IN SOUTH AFRICA*

Ronel Nel

Department of Zoology, Nelson Mandela Metropolitan University Port Elizabeth South Africa

Sea turtles have been harvested along the east African seaboard for centuries and reached a turning-point with the realisation that sea turtles are globally threatened by human activities. A review of successes and failures of conservation across the South-Western Indian Ocean region has indicated three significant challenges to protect loggerhead (Cc) and leatherback (Dc) turtles nesting in South-east Africa. The first challenge was to stop beach harvesting. Initial conservation efforts thus focused on protecting adult females and their nesting habitat by providing physical protection on, and off the beaches. This was achieved through a long-term beach monitoring programme

(which started in 1963), marine protected area proclamation (1979), and eventually world heritage status to the beaches and reefs harbouring turtles (in 1999). Beach harvesting has now effectively ceased in South Africa, with a significant recovery of loggerheads (from ~200 to 600 nesting females pa). Despite equal conservation attention, the leatherback population however, has remained stable but small with ~60 – 80 females nesting pa in SA. Research on the nesting biology of the two species suggested that the success of loggerheads may be in part due to skewed sex ratios with ~82% female production pa. The second major challenge was conservation spanning national boundaries. Individuals of both species nest on either side of the SA/Mozambique border within the same season. To enhance across border conservation, the strongest international conservation measures available were applied by SA i.e. RAMSAR site proclamation (1986), membership to CMS, IOSEA (2005) and the Atlantic (2007) turtle agreements, as well as CITES (1975) and initiating and supporting a beach monitoring and protection programme in Mozambique (which started in 1996). The product has been the proclamation of a new MPA in Mozambique (2009), contiguous with the world heritage site in SA, and the first marine trans-frontier conservation area (the Ponto Du Ouro-Kosi TFCA) on the horizon. Loggerheads and leatherback turtles are now protected irrespective of the side of the border they nest on. The third challenge, which remains the current biggest challenge, is off-shore protection. Sea turtles are legally-protected in South Africa but are still caught as bycatch primarily in long-line activities fishing for swordfish and tuna, and in shark/bather protection nets. Catch rates in shark nets seem to be proportional to population abundance with demonstrable effort on the part of conservation authorities to release turtles (caught in nets) alive. Long-line catches on the other hand indicate disproportionately high catch rates for leatherbacks i.e. a rate of two loggerheads for each leatherback (or 0.02 Cc to 0.01 Dc per 1000 hooks) whereas current abundances predict a ratio of ten to one Cc to Dc, respectively. With strong coastal conservation in place, it is time to prioritise offshore protection for both turtle species around the south of the African continent.

HOPE FOR SEA TURTLES IN THE ANAMBAS ISLANDS, INDONESIA*

Wallace J. Nichols[1], Nina Marliana[2], Pak Lahani[2], Yanin Kholison[2], Mabruri Tanjung[2], Abigail Alling[3], and Mark Van Thillo[3]

[1] California Academy of Sciences and OceanRevolution.org, Davenport, CA, USA
[2] Anambas Sea Turtle Project, Anambas Islands, Indonesia
[3] Biosphere Foundation, S/V Mir, Singapore

In 2009 a multi-faceted and collaborative sea turtle conservation program was initiated in the Anambas Islands, Indonesia, an archipelago of approximately 240 islands and islets in the South China Sea (3° 6′ 0″ N, 105° 40′ 0″ E). The project has three main components, known as the “conservation mosaic”: building a network of stakeholders, generating basic knowledge on sea turtle biology/ecology, use and threats, and communicating conservation solutions. The project is integrated with a coral reef restoration and monitoring project. Surveys indicate that up to twenty green turtles nest nightly on each of the main beaches on both Durai and Pehat Islands, with a small number of hawksbills on Pehat. This may represent several thousand nests annually. For nearly 40 years, up until 2009, 100% of eggs were collected and sold for human consumption and sea turtle nesting has declined approximately 75%. Now eggs remain in situ and are regularly monitored on Durai, where novel conservation agreements have been negotiated with the island’s non-resident owners and resident caretaker. Hundreds of thousands of hatchlings have returned to the sea for the first time in many decades. Further, green turtle mating was documented in the waters around Durai Island and juvenile, subadult and adult green and hawksbill turtles have been observed foraging year round on Anambas sea grass beds and coral reefs. Egg collecting, sea turtle hunting, bycatch in weirs (kelong), massive plastic pollution, and habitat destruction due to bomb and poison fishing and are the primary threats. Ocean protection outreach in grade schools is underway, including visiting lectures, field trips, books and posters. Extensive beach and feeding ground surveys will continue as the project expands to secondary islands within the archipelago and research will include studies of predation on hatchlings, as local fishermen state fish abundance has increased since sea turtle conservation began.

CONSERVATION AGREEMENTS FOR SEA TURTLE PROTECTION: THE CASE FOR A GLOBAL FINANCING MECHANISM*

Eduard Niesten[1], Heidi Gjertsen[2], Brian Hutchinson[1], Rod Mast[1], Sebastian Troeng[1], and Bryan Wallace[1]

[1] Conservation International
[2] Consultant

Conservation agreements have emerged as a particularly suitable tool for site-based sea turtle conservation initiatives. There are several examples of conservation agreements that protect sea turtle nesting beaches, the potential for addressing by-catch using the approach is being explored, and there is growing demand for investment in additional sites. For example, Conservation International and Natural Equity have been approached by resource owners or conservation practitioners in places as varied as Ulithe, Yap; Jamursba Medi and Warmon, Indonesia; Colombia; Panama; Nicaragua; and Liberia. In the conservation agreement model, conservation investors negotiate explicit contracts in which resource-users forego unsustainable activities in exchange for benefits that are conditional on conservation performance. Benefits may be in the form of cash, services, or goods, and are provided periodically upon verifying that conservation performance targets are met. Long-term sustainable financing is an essential element of successful conservation agreements. We discuss how a fund to support a global network of sea turtle agreements can be structured to secure multiple advantages for existing and future projects. First, the long-term payment streams that characterize most conservation agreements are best served by endowed trust funds. However, given the cost-effectiveness of the approach, many individual agreements may be too small to warrant establishment of an endowment effort; collectively, though, they form a strong case. Second, a global fund would also promote dissemination of the conservation agreement approach to encourage continued replication in additional sites of importance. Ideally, the fund would include a start-up grant facility to promote application of the approach by new actors at new sites. Third, a global fund dedicated to sea turtle conservation agreements would promote inter-project learning as well as facilitate scientific endeavors that benefit from a coherent network of turtle protection sites. A survey of existing sea turtle conservation agreement initiatives provides the empirical argument in favor of a dedicated global fund. However, given the existence of other funds that promote turtle conservation, it is important to clearly define the niche and added value of the proposed fund, and maximize opportunities for mutual reinforcement of the aims of the various existing turtle-related funds.

THINKING FOR THE FUTURE, EDUCATING IN THE PRESENT; ENVIRONMENTAL EDUCATION AND OUTREACH IN TORTUGUERO, COSTA RICA

Dagnia Nolasco and Emma Harrison

Sea Turtle Conservancy (formerly Caribbean Conservation Corporation)

Tortuguero, Costa Rica is one of the most important nesting beaches in the world for the green turtle (*Chelonia mydas*), and also supports smaller populations of leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*) turtles. The long-term conservation efforts of Sea Turtle Conservancy – STC (with more than 50 years experience working with sea turtles at Tortuguero), Tortuguero National Park (TNP) staff and the local community have been reflected in the documented recovery of the green turtle population nesting at the beach; STC has reported an almost 500% increase in annual nesting since the 1970's. Tortuguero, as a tourist location, has a rather transient population, with an influx of people who are drawn to the area by potential employment opportunities. As such, it is important to constantly raise awareness among community members about sea turtles, threats they face and conservation initiatives. STC's environmental education and outreach program aims to create consciousness in local children, young people and adults with respect to the importance of the area's sea turtles and their habitats. To conserve sea turtles and their vital habitats implies a need to understand the importance of living harmoniously with nature, searching for solutions to problems or changing attitudes to environmental issues such as pollution, climate change or the mismanagement of natural resources. STC, recognizing that education and community outreach are an integral part

of the successful Tortuguero program, employs a dedicated Outreach and Education Coordinator to liaise between STC, TNP and community leaders. To achieve the goal of raising community awareness, STC has conducted a variety of activities in recent years including educative talks about sea turtle biology and the local implications of climate change; campaigns to minimize the use of plastic bags in the village, and to reduce artificial lights on the nesting beach; the 'Eco-Wallet' Project that trains high school students to create products from recycled materials, which are sold to raise funds for the school; the Junior Research Assistant Program, which hopes to create future sea turtle conservationists; workshops that provide the community with the necessary tools to allow sustainable local development; a course for local teachers in sea turtle biology, laws and conservation efforts, and a celebratory event on World Turtle Day 2010. Furthermore, STC also participates in other community events, such as TortuFest, an annual cultural and musical festival, and the Eco-Caribbean Festival organized by TNP. STC takes every available opportunity to reach out to local community members and international visitors to Tortuguero, to provide information about the work it conducts in the area. This paper will discuss the innovative methods being used by STC to effectively raise local awareness about sea turtle survival threats and conservation initiatives. The continued success of STC's Tortuguero program is dependent on community support, which can only be given with an adequate understanding of the relevant issues.

PROTECTING SEA TURTLES THROUGH SCIENCE-BASED FISHERY REGULATIONS

Michelle B. Nowlin, Patrick Duggan, Jenna Wallis, and Courtney Shepherd

Duke University Environmental Law and Policy Clinic, Box 90360, Durham, NC
27708, USA

Conservationists and policy-makers are concerned that bycatch of sea turtles in commercial fishing gear – especially gillnets – is a significant source of mortality contributing to population. Mitigation of fisheries' interactions with juvenile sea turtles is particularly important, as protection of this age class is critical to recovery efforts. North Carolina's estuaries serve as important foraging grounds for juvenile green, loggerhead and Kemp's ridley sea turtles. They also serve as important grounds for North Carolina's commercial fishing industry, including southern flounder, which are caught using gillnets. The settlement of a lawsuit brought by the Karen Beasley Sea Turtle Rescue and Rehabilitation Center against the North Carolina Division of Marine Fisheries models an approach for protecting juvenile sea turtles through better fisheries management practices. Loggerheads, greens and Kemp's ridleys are protected pursuant to the Endangered Species Act (ESA) as threatened or endangered species. The ESA prohibits the "taking" of these species, except as authorized by an Incidental Take Permit or Statement under either Section 10 or 7, respectively. After mass strandings of sea turtles ensnared in gillnets in 1999 and 2000, the National Marine Fisheries Service (NMFS) issued ITP #1528 to the NC Division of Marine Fisheries for an area of the Pamlico Sound (PSGNRA), authorizing the take of 252 turtles per year during the southern flounder season. No other part of the state's waters is covered by an ITP. The ITP was ineffective at reducing bycatch. Within the PSGNRA, the observed catch levels were high enough to trigger early closure of the waters to commercial fishing in three of five years covered by the permit. Moreover, mandatory observer coverage levels were not consistently maintained, resulting in alleged violations of allowable bycatch rates based on extrapolation formulas. In addition, bycatch was occurring in other parts of the state not covered by an ITP, in direct violation of the ESA's take prohibition. To redress these violations and protect sea turtles, the Beasley Center filed a lawsuit against the state. After several months of negotiations, the parties reached a precedent-setting agreement that enforces the ESA and minimizes interactions between gillnets and sea turtles, protecting both the fishery and sea turtles. The management measures included in the settlement agreement were based on published scientific findings of post-release mortality, observer coverage, and gear modifications, among others. The agreement also allows for adaptive management based on observer findings. Implementation of the settlement measures began in May 2010. Observer reports show marked reductions in sea turtle bycatch – and verbal reports indicate reduction in bycatch of other species as well. Additionally, reduction in flounder bycatch may result in the state's early attainment of catch-reduction goals in its own fishery management strategy.

BOCAS DEL TORO PROVINCE AND THE NGÖBE-BUGLÉ COMARCA; REGIONALLY IMPORTANT AREAS FOR THE CONSERVATION OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) ON THE CARIBBEAN COAST OF PANAMA*

Cristina Ordoñez[1], Genaro Castillo[2], Ana Maria Vazquez[3], Huascar Miller[3], Juan Ramos[4], Arcelio Gonzalez[3], Carlos Fernadez[3], Anne B. Meylan[5], Peter A. Meylan[6], and Emma Harrison[7]

[1] Sea Turtle Conservancy (Formerly Caribbean Conservation Corporation), Bocas Del Toro, Bocas del Toro Province, Republica of Panama
[2] Asociacion para la Proteccion de los Recursos Naturales Ngobe Bugle, Playa Chiriqui, Comarca Ngobe Bugle
[3] The Endangered Wildlife Trust, Bocas del Toro Province, Republic of Panama
[4] Asociacion Amigos y Vecinos de la Costa y Naturaleza, Bocas del Toro Province, Republic of Panama
[5] Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, St. Petersburg, Florida, USA
[6] Eckerd College, St. Peterburg, Florida, USA
[7] Sea Turtle Conservancy (Formerly Caribbean Conservation Corporation), Apartado Postal 246-2050, San Pedro, Costa Rica

In Bocas del Toro Province and the indigenous Ngöbe-Buglé Comarca, on the Caribbean coast of Panama, there exist feeding areas, migration routes and nesting beaches for four species of marine turtles: leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), green turtle (*Chelonia mydas*) and loggerhead (*Caretta caretta*). For hundreds of years, marine turtles have been an important resource for communities in Bocas del Toro Province. The sale of hawksbills and their shell has historically been a significant source of income for the local economy, while green turtles have predominantly been used for subsistence. During the early 1990s should be a colon, the commercialization of leatherback eggs also provided some revenue to local communities. Since 1989, however, several sea turtle research and conservation initiatives have been established in the province, in collaboration with local indigenous communities. Findings from these studies have subsequently revealed the global significance of the area for leatherback nesting populations. Chiriquí Beach, located within the Ngöbe-Buglé Comarca, is one of the most important leatherback nesting beaches in the world, with over 4,000 nests recorded each year. Through the expansion of monitoring activities within the province it is being observed that other nesting beaches in the province are also supporting significant numbers of leatherback females each year, including beaches within the San San Pond Sack Wetland - Sixaola Beach (350 nests), San San Beach (300 nests), Soropta Beach (360 nests), and Long Beach (150 nests) which is located within Bastimentos Island National Marine Park. This paper will discuss the importance of the nesting beaches within Bocas del Toro Province and the Ngöbe-Buglé Comarca with respect to leatherback turtles; it will provide details on the current status of the nesting population and trends observed at different nesting sites in the last five years. It will also highlight the principal threats to leatherbacks and their critical habitats in the region, and report on the success of on-going conservation programs.

OPORTUNITIES FOR REGIONAL ALLIANCES PROMOTING ENVIRONMENTAL EDUCATION IN LATINAMERICA

Natalia Ortiz[1], Joanna Alfaro-Shigueto[1], Jeffrey C. Mangel[1], Alejandra Cornejo[2], and Nadia Balducci[1]

[1] Pro Delphinus, Lima, Peru
[2] Cedepesca, Buenos Aires, Argentina

The World Ocean Network (WON) is an international network that brings together museums, aquariums, educational institutions and NGOs, and has as a main objective the raising of public awareness about the importance of the ocean. Each institution within WON works independently, however by participating in the Network, these organizations have

the opportunity to share their work and how they are able to inspire others and impact their communities. The WON is supported by the UNESCO's Intergovernmental Oceanographic Commission and by the United Nation Environment Programme in the context of its Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities. In Latin America, starting in 2009, the WON created a Sub-Regional Network to promote activities of the network in the region. This 'Red Océano Mundial', (ROM), has gathered 14 agencies from 11 countries, including Argentina, Brazil, Chile, Costa Rica, Cuba, Colombia, Ecuador, Mexico, Peru, Uruguay, and Venezuela. The Peruvian marine research and conservation NGO Pro Delphinus (PD) has had a long running program on environmental education and public outreach to promote sea turtle conservation, targeting fishing communities along the entire Peru coast, and reaching out to school children and university students, fishermen, fishing families and local authorities. PD has been a member of the ROM since 2008. Participation in the ROM has helped PD broaden and enhance the scope of our work on marine environmental education. For example, in late 2009, a campaign to collect trash from around the port of Ilo in southern Peru was completed with the support of the local fishing associations. Also, beginning in 2009, PD has participated in WON celebrations of the 'World Ocean Day' in conjunction with local schools and has used this as an opportunity to distribute the WON 'Passport of Citizen of the Ocean' to students. These are now two annual activities for PD and are examples of how the ROM has helped enhance our organization's educational program. Here we describe the Pro Delphinus educational program's collaboration with the World Ocean Network.

WHAT IS CONSERVATION PHOTOGRAPHY? EVALUATING VISUAL COMMUNICATION'S ROLE IN SEA TURTLE RESEARCH AND OUTREACH*

Neil Ever Osborne[1], Deanna Del Vecchio[2], Wallace J. Nichols[3], and Molly Steinwald[4]

[1] Trent University, Peterborough, Ontario, Canada
[2] TakingITGlobal, Toronto, Ontario, Canada
[3] California Academy of Sciences, Davenport, California, USA
[4] Phipps Conservatory, Pittsburgh, Pennsylvania, USA

Photography has been used as a conservation tool since its influence in creating the first U.S. national park to protect wilderness in the 1860s. Today, when the majority of the world's citizens reside in built environments, away from nature, and technology heavily connects societies' ways of life, there is both great need and great opportunity for including strategic visual communications in environmental conservation. Conservation photography, photography that empowers conservation, and other artistic visual communications are being increasingly used in environmental science, outreach and education activities. We examined and assessed the effectiveness of conservation photography in terms of its level of participation and specific role in documentation and outreach in three case studies in which research scientists, educators, and policy makers collaborated. While substantial research is necessary in order to quantify the significance of photography in conservation, our results indicate the advantageous nature of this visually communicative platform for disseminating scientific information and conservation messages. We suggest ways in which present day environmental scientists and conservation practitioners can employ the use of visual imagery in their own work.

DEVELOPMENT OF AN ACTION PLAN FOR THE RECOVERY AND CONSERVATION OF SEA TURTLES THROUGH STAKEHOLDER PARTICIPATION: THE EXPERIENCE IN MACHALILLA NATIONAL PARK, ECUADOR*

Micaela Peña[1] and John Frazier[2]

[1] Universidad Internacional Menéndez Pelayo, Quito, Ecuador
[2] Smithsonian Institute, Virginia, USA

As is common elsewhere, sea turtles in Ecuador face many and increasing threats. Machalilla National Park (MNP) has been identified as the most important area for sea turtles in continental Ecuador, with regionally significant feeding and nesting areas for hawksbills (*Eretmochelys imbricata*) and black turtles (*Chelonia mydas*). Although MNP was

established in 1979, and Ecuadorian legislation protects all sea turtles since 1990, numbers nesting at MNP have declined markedly over past decades. The park lacks a comprehensive conservation strategy for sea turtles, and various threats to turtle conservation are widely known. Unfortunately, most conservation activities have been developed in a vertical (top down) manner, without regard for local actors. As a result conservation plans lack understanding and popular support, and prove inefficient in the long run. MNP is surrounded by more than eight small communities totaling more than 14,000 people who rely on fishing and tourism, and continually interact with sea turtles and their habitats. In order to develop and carry out a conservation plan with viable alternatives for diverse interest groups, it is essential to assess the socio-cultural issues and understand the needs and perceptions of diverse stakeholders around MNP. In order to involve diverse stakeholders in the development of an action plan a program was proposed in consultation with officials of MNP. Interviews were carried out with local people to know their points of view, values, beliefs and attitudes in relation with sea turtles. These were followed by nine workshops with local stakeholders of different interest groups, including: artisanal fishermen, tourist guides and boat captains, and scientific and government sector. During each workshop a conceptual model was conducted with the participants' perceptions about which threats are the most important for the conservation of sea turtles and their habitats. Participants discussed causes for the threats and actions to mitigate these. The use of sea turtles and their products has been common in the area, but lately it has decreased, and the present day use of sea turtles is primarily for tourism. Twenty-five threats on sea turtles and their habitats were identified during the workshops; among the most important are marine pollution with solid and chemical wastes, by-catch, disturbance of the different habitats, and destruction of nests by dogs. Control of access to nesting beaches and zoning of key areas, raising awareness, education, communication and active participation of several groups are among the most important actions proposed. Participants' opinions were solicited and incorporated in the planning and local stewardship of marine and costal resources was promoted, using sea turtles as flagship species. Stakeholders were encouraged to take active roles in developing and implementing a conservation plan for which they will have ownership and responsibility. The exercise can be used as a model for other areas.

THE EMERGENCE OF ASSOCIATIONAL LIFE IN MEXICO'S WILD WEST: PIONEERING CIVIC PARTICIPATION, SEA TURTLE CONSERVATION, AND ENVIRONMENTAL AWARENESS IN BAJA CALIFORNIA SUR*

Andrew J. Schneller[1] and Patricia A. Baum[2]

[1] The School for Field Studies-Center for Coastal Studies, Salem, Mass, USA
[2] EcoEducadores Verde y Azul, Todos Santos, BCS, Mexico

This research explores the contributions of the sea turtle conservation movement in Baja California Sur (B.C.S.), Mexico, to the growth of associational life in the state. Mexico has historically been known as a country with a traditionally weak associational life. Yet, the activities of sea turtle NGOs and community groups presented a unique case study to better understand the social, political, and strategic factors that have contributed to voluntary civic engagement and the environmental successes of the movement. Through 799 interviews and surveys with public stakeholders, this research utilized Sabet's (Democratization 2:410–432, 2008) focus on political opportunity, efforts to reform informal rules, and supportive social networks, as an explanatory framework to help describe the emergence of associational life. We found that the sea turtle conservation movement in B.C.S. has become accessible to a diversity of interests and individuals. We found unexpected results in the extent of federal environmental agency complaisance in regard to the involvement of NGOs in conservation programs and environmental policy decisions that have traditionally been the sole domain of the Government of Mexico.

OFF-SHORE POWER BOAT RACES IN INSHORE BAYS- THE VALUE OF RESIDENT TURTLES TO THE LOCAL COMMUNITY

Andrea D. Phillott[1,2], R.N.A.M Ishara P. Warakagoda[1], and Anushka P.H. Yaddehige[1]

[1] Asian University for Women, 20 M.M. Ali Road, Chittagong 4000, Bangladesh,
[2] Sea Turtle Foundation, PO Box 1190, Townsville, QLD 4810, Australia

The Australian Offshore Powerboat Club has held 4 races in Cleveland Bay, adjacent to Townsville, Queensland, Australia, annually since 2007. The event is sponsored by the Townsville City Council and attracted ~35,000 spectators in its inaugural year. More than 20 boats, racing at speeds of up to 220km/hr, complete up to 16 laps of a 6 nautical mile course. The course is established in inshore waters less than 3m deep. Cleveland Bay is inhabited by green sea turtles (*Chelonia mydas*) feeding on the vast seagrass beds. Boat strike is recognised as an important threat to vulnerable and threatened species of sea turtles in Australia. Sea Turtle Foundation conducted an oral survey during the race in 22nd June 2008 to gauge adult spectator perceptions of the threat to local turtles. Participants were invited to answer for simple questions requiring 'yes' or 'no' answers. Responses from the 184 participants indicated the majority (77%) were locals and present on the beachfront specifically to watch the race (84%). There was high awareness of the resident turtles of the bay (72%) and concern for their safety during the race (82%). Townsville citizens (77%) were more aware of the resident turtles than visitors to the area (58%). Results suggest that spectators had knowledge of the presence of turtles and were concerned about the risk of boat strike, but placed a greater value on sport and entertainment than wildlife safety.

SEA TURTLES: A HISTORICAL RECORD OF NATURAL HERITAGE IN THE REGION OF LOS CABOS, BCS, MEXICO*

Graciela Tiburcio Pintos[1], Raquel Briseño Dueñas[2], and Harumi Fujita[3]

[1] H. IX Ayuntamiento de Los Cabos, B.C.S. and Universidad Autónoma de Baja California Sur. Los Cabos, B.C.S. Mexico
[2] BITMAR-Unidad Mazatlán, ICMyL- UNAM, Mazatlán, Sinaloa México
[3] Centro Instituto Nacional de Antropología e Historia B.C.S. Mexico

The biogeographic region of Los Cabos was a territory occupied by ethnic Pericú extending from Buena Vista to Cabo San Lucas, Baja California Sur, Mexico. The early occupations of this region dates from the Middle Holocene (between 7000 and 5000 years ago). We will present results of historical research related to the abundance and diversity of marine turtles, as well as knowledge and use of this natural resource by the first humans who colonized the coastal zone, with special emphasis on archaeological findings in the site denominated as El Médano, in the municipality of Los Cabos. We continue with documentation and testimonial which describe domestic use by the new inhabitants who occupied the region after the extermination of ethnic groups. We include the period of commercial overfishing by international and then national industries, which collapsed the sea turtle populations. We also describe the transition to the early work of conservation and research on marine turtles. Both local and regional perspectives have led to a successful and integrated conservation program, The organization recently celebrated its first decade in 2010, promoted by the local municipal government. This project of recovery of the sea turtles pretends to mitigate current threats to nesting habitat in the region of Los Cabos, BCS, which must be protected and enforced, since Los Cabos is one of the most important tourist destinations in Mexico.

TURTLE HATCHERIES IN SRI LANKA: CURRENT STATUS AND THEIR CONTRIBUTION TOWARDS SEA TURTLE CONSERVATION*

R.S. Rajakaruna[1], E.M.L. Ekanayake[1,2], T. Kapurusinghe[2], and K.B. Ranawana[1]

[1] Department of Zoology, University of Peradeniya, Sri Lanka
[2] Turtle Conservation Project, Madakumbura, Panadura, Sri Lanka

Hatcheries are used as an ex situ conservation tool of sea turtles in some countries. However, the contribution of turtle hatcheries towards conservation of sea turtles is highly debated. Seven sea turtle hatcheries are currently in operation along the southern and southwestern coast of Sri Lanka. A questionnaire survey was carried out in October 2010 to assess the current status of the hatcheries. All the hatcheries are operated by private owners and their prime motive is profit, relying on tourists for their viability. However, all the current hatcheries operate throughout the year, unlike in the past when some were closed during tourist season off season. The common practice is to buy turtle eggs from suppliers at the rate of about 8-15 LKR (< 0.15 USD) and bury them in an enclosure within the hatchery. They buy all the eggs that suppliers bring even during tourist off season. Egg incubating enclosures are well protected from predators and emergence of hatchlings occurs unaided. However, except for one hatchery, sand was piled up on the nest which may have an effect on incubation temperature and hatchling emergence. "Head starting" is practiced in all the hatcheries. None of the hatchery enclosures allows free crawling of the hatchlings to the sea upon hatching. On emergence, hatchlings were trapped within the enclosures overnight. These were collected next morning and placed in tanks. A varying percentage (70% to 95% depending on the hatchery) was released to the sea the following night and the rest were used for display. Rearing tanks were all clean with sufficient space for the hatchlings. Overall condition of the tanks was up to the standards except for two hatcheries where freshwater collects into tanks when it rains. All the hatcheries keep juveniles (3 to 5) and hatchlings (20 to 200) to attract tourists. Juveniles (4-5 years old) were often released to the sea when feeding becomes costly and it is highly unlikely that they survive long in the wild. Currently, none of the hatcheries is involved in any collaborative research or serious conservation work. Even though the collection of turtle eggs from the wild is illegal, these eggs are open access resource. However, once the eggs are collected and sold to hatcheries they become a "private property" and can be protected by the hatchery owners. Some argue that private ownership of wildlife might be an effective means for conservation which can also be applied to sea turtles if there is specific ownership and clear legal responsibilities. Issuing a hatchery operator license and renewing it yearly after evaluating the progress is to be considered. Hatchery practices can be monitored by submission of regular reports by the hatchery operator and through periodic inspections. Even though hatchery operators used to keep records and send regular reports to relevant authorities before tsunami, this has not happened for the last five years. A scientifically managed hatchery can effectively recoup the vast number of turtle eggs that would otherwise be lost to poachers and natural causes such as predation and erosion.

INTEGRATING SEA TURTLES IN THE GAP ANALYSIS PROJECT: AN ASSESSMENT OF THEIR DISTRIBUTION AND CONSERVATION STATUS IN MARINE AND COASTAL CONSERVATION AREAS

Martha P. Rincon-Diaz[1], Mariano Solórzano[1], Suhey Ortíz-Rosa[2], Maria Isabel Herrera-Montes[1], Maya Quiñones[1], Jessica Castro[1], Nilda Jiménez[3], Ben Crain[1], and William Gould[1]

[1] USDA Forest Service International Institute of Tropical Forestry, Jardín Botánico Sur, 1201 Calle Ceiba, Río Piedras, PR00926-1119.
[2] Department of Marine Sciences, University of Puerto Rico, Mayagüez. PO Box 9000 Mayagüez, Puerto Rico 00681
[3] Department of Natural Resources and Environment. P.O. Box 366147 San Juan, Puerto Rico 00936

The relationship among terrestrial and aquatic habitats affects the spatial distribution of animals, hence government policy makers and natural resource managers must often consider the complex land and seascapes matrix in order to develop conservation management plans. Throughout their life cycle, marine turtles use distinct feeding, breeding,

migratory, developmental, and nesting habitats in both pelagic and coastal areas. These habitats are affected in their structure and function by the influence of freshwater habitats and surrounding terrestrial ecosystems. Critical habitats for sea turtles are included in conservation areas of Puerto Rico and the US Virgin Islands (USVI) including natural marine reserves, no-take zones and marine extensions of terrestrial reserves that maintain the connection between terrestrial and aquatic habitats. Even though habitats for turtles are included in conservation areas there is a need to evaluate strategies of conservation that help to protect species and habitats. The GAP analysis project is developing an integrated terrestrial and aquatic database of over 1200 species, including the hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) sea turtles, in order to better identify their critical habitats in Puerto Rico and the USVI. The project's methodology includes habitat description and mapping, species regional and local distributions, species conservation status, species occurrence and distribution within protected areas, and conservation priorities – combined with existing Puerto Rico and USVI terrestrial GAP databases. We present preliminary results of this analysis, focused on sea turtles and indicating advances in the development of habitat maps, species explicit/real and predicted distributions, and an assessment of protected areas in PR and the USVI. We expect to show an important tool for sea turtles' conservation to be implemented in other areas of the Caribbean, and also to receive a feedback from experts on biology and conservation of sea turtles that improve our analysis.

CHEER FOR THE TURTLES: BRIDGING THE GAP BETWEEN MONITORING AND PUBLIC OUTREACH

Nathan Jack Robinson[1] and Pilar Santidrián Tomillo[2]

[1] Department of Biological Sciences. Purdue University. West Lafayette. IN 47907, USA
[2] Department of Bioscience and Biotechnology, Drexel University, Philadelphia, PA 19104, USA

'Cheer For The Turtles' (CFTT) is an educational initiative that aims to raise global awareness about the conservation status of sea turtles. The primary concept is to translate standardized monitoring data into an easily comprehensible and engaging form that can be freely distributed online and thus granting anyone the opportunity to follow the efforts of an ongoing sea turtle conservation project in real-time. Since November 2010, CFTT has worked in parallel with the long-term monitoring program based at Parque Nacional Marino Las Baulas, Costa Rica. This region contains the beaches of Playa Grande, Ventanas and Langosta, which together host the largest density of nesting leatherback turtles (*Dermochelys coriacea*) in the eastern Pacific Ocean. Nightly patrols on all three beaches are conducted continuously throughout the nesting season, which extends from October to March. As a result, it is possible to distinguish individual turtles upon each encounter throughout the nesting season. We used the monitoring data collected during the 2010 / 11 season to compose informative and jargon-free narratives that followed the activities of six leatherback turtles over their nesting period. The narratives detailed the circumstances and success of each nesting event. As the season advanced, the focus of the narratives shifted to cover the progress of the nests that had been laid by the six chosen turtles. These narratives were made available as real-time updates every two weeks via the CFFT website (http://www.goldringmarinestation.org/Goldring/CheersForTheTurtles.html). To maintain long-term interest in the program, a competitive element was included in the form of a 'Turtle Savior Award', which was bestowed upon the turtle that produced the most hatchlings over the course of the season. The turtles were also competing for 'cheers' (votes) from the sites followers as they championed their favorite turtle. Each update was accompanied by an educational fact sheet, which expanded upon a different aspect of sea turtle biology or monitoring methodologies. By merging monitoring data with public outreach, the CFTT program presented a novel format for educating people about sea turtles and marine conservation. The potential benefits of public outreach such as this are multifaceted and may include a widening of potential volunteer networks, generation of donations, and providing international support for policy-based conservation initiatives.

SEA TURTLE AND DUGONG AWARENESS PROGRAM FOR WESTERN PROVINCE, PNG

David Roe[1] and Andrea D. Phillott[2]

[1] Sea Turtle Foundation, PO Box 1190, Townsville, QLD 4810, Australia
[2] Asian University for Women, 20 M.M. Ali Road, Chittagong 4000, Bangladesh and Sea Turtle Foundation, PO Box 1190, Townsville, QLD 4810, Australia

In recognition of their traditional hunting and fishing sea country, Western Province (Papua New Guinea) Treaty peoples can hunt in Australian Torres Strait waters under the Torres Strait Treaty Act 1984. However, community representatives are concerned at decreased numbers of sea turtles and dugongs and wish to have an active role in ensuring these animals remain in the Torres Strait region for future generations to enjoy. Conservation work is well advanced in the Australian side of Torres Strait, but lacking in the Western Province. Sea Turtle Foundation facilitated a series of meetings and workshops PNG Treaty communities to produce a Sea Turtle and Dugong Awareness Program. The program includes a community information resource "Flippers and Flukes" and accompanying workbook for students.

OCEAN CONNECTORS/CONECTORES DE LOS OCEANOS; PROMOTING SEA TURTLE CONSERVATION THROUGHOUT FRIENDSHIP

Antonio Diego Fernández Rozada[1] and Frances Kinney[2]

[1] Grupo Tortuguero de las Californias, La Paz, BCS, México
[2] Propeninsula, San Diego, California

In 2010, Grupo Tortuguero de las Californias adopted part of a Project that Propeninsula started a few years ago, and that has been run by Frances Kinney, Education Program Manager, for the last years. Together both organizations established a link build upon environmental education. Ocean Connectors/Conectores de los Oceanos it's a project that generates consciousness and knowledge about sea turtle habitat, threats and conservation issues in low income six graders from La Paz and San Diego. On top of all the results, the project promotes friendship in kids from both countries. The glue that puts all this together is the green sea turtle migration that occurs from the Sea of Cortez all the way to the feeding grounds in San Diego California. Every classroom we have visit this year welcomes us with smiles and excitement, it's not only the stickers and the reusable bags we give as prices, to the kids that show a real commitment and understand the link in between using plastic bags and dead sea turtles due to pollution in the oceans. The kids love the project because of the letters, the San Diego kids send a letter, in Spanish to the kids in México, and that is where the magic starts, the idea is not only to teach the kids about sea turtles, the goal is to connect them, to generate friendship gravitating around sea turtles. From September to November the first classroom visits have to be done, 600 hundred kids, 20 classrooms approximately, at least 5 schools in each country and of course a lot of letters. After the first visit the kids from California get to go on a field trip where they receive the letters from there Mexican new friends and get to experience firsthand about sea turtles in San Diego (currently GTC its trying to get funding for the field trips in México). During the first months of 2011 the kids from La Paz receive their letters while the first steps of conservation and friendship had hopefully been established in kids from both countries. In the past 4 years almost 10,000 letters with a sea turtle conservation message have crossed the border.

CONSERVATION OF MARINE TURTLES IN LIBERIA

Andrew S.Tokpa[1] and Manjula Tiwari[2]

[1] Save My Future Foundation (SAMFU)
[2] NOAA Fisheries, Marine Turtle Ecology Program, Southwest Fisheries Science Center

The Save my Future (SAMFU) Foundation, a local non-governmental organization established in 1987 with the mission of facilitating and promoting participatory community-based sustainable natural resource management and development in Liberia carried out a survey in 2002 and confirmed the presence of four species of marine turtles in Liberia's territorial waters: green turtles, leatherbacks, olive ridleys, and hawksbills. Four major sites have been identified and designated as significant nesting and foraging habitats in southeastern Liberia, with important nesting areas at Borgor point in Rivercess County, Bafu bay in Sinoe County, Picnicess in Grand Kru county and Kablaken in Maryland County. Most of the threats affecting sea turtles along the coast of Africa are not exclusive to Liberia, although their accumulated effect makes the situation particularly challenging for the well-intentioned conservationist. Poverty of coastal inhabitants is often associated with the absence of basic infrastructure and services, such as clean water, health care, transportation and access to basic commodities. Where sea turtles are relatively abundant, they are considered significant sources of food and income, and villagers depend on them to supplement their fishing and crop harvests. Since 2000 we have worked with these communities especially at Borgor point. Twenty veteran sea turtle hunters were hired and trained in species identification and data collection methodologies. These monitors patrol the beach to monitor nests, protect nesting turtles, and record poached nests. A dug- out canoe and an outboard motor are provided to the fishing cooperative along with other standard fishing gears to improve their fishing activities thereby increasing their fish catch so that the surplus can be sold to make up for income and protein sources lost from the sale and consumption of sea turtle meat. A water well has also been provided to the community to serve as a source of clean drinking for the inhabitants of the community. The project works hard to ensure that sea turtle harvest is minimized with the collaboration of local communities.

THE ACTIVITY REPORT OF SEA TURTLE RESEARCH COLLEGIUM, TUMSAT, JAPAN

Ai Sakabe, Shun Hukazawa, Eriko Tanaka, and Mai Takase

Tokyo Univertiy of Marine Science and Technology, Tokyo, Japan

Sea Turtle Research Collegium (SRC) in Tokyo University of Marine Science and Technology, Japan is composed of only undergraduate students and activities are completely apart from member's majors. The purpose of the collegium is to arouse other researchers, especially students, to extend the sphere of their activities. In addition most of Japanese students study groups of sea turtles are still independent, so we want to strengthen the link between each other. We introduce SRC's activity below. The main activities of SRC are stranding research with NPO group, volunteering at the Port of Nagoya Aquarium in sea turtle's in vitro nesting season, attending sea turtle conferences in Japan, measuring of Heisaura Beach, taking study trips to Ogasawara Island and Kuroshima Island, and hosting educational activity. SRC goes to the stranding research with NPO group Everlasting Nature of ASIA (ELNA). With the collaboration of ELNA, SRC collects digestive system samples. We identify what sea turtles were eating before stranding and by doing, we aim to locate their last feeding ground, which could be the place of death: if we could identify the area, there are chances of finding the cause of death. SRC's activities are based in Tokyo, which have few natural sea coasts: we are restricted from wild sea turtle research. Therefore we try to get hands-on experience in different ways. We volunteer at the Aquarium for the sea turtles invivo nesting season. Members of SRC learn about nesting by watching for mateing behavior in the screen, and by checking the clutches during the nesting. From the same reason above, SRC take short trips to famous nesting places in Japan during summer vacation. Those places are Ogasawara, which is famous for Green turtle breeding and Kuroshima Island, which has a laboratory for Sea Turtle Association of Japan. We go to those facilities to research and to work as volunteers. In addition, we participate in Japanese Sea turtle symposium every year to learn about latest topics and make friendship with other researchers. Furthermore, we have student community for sea turtle research club in Japanese universities but we don't have chances to interchange between them. With the collaboration of Kagoshima National University's and Mie National University's sea turtle research group, SRC organized first Japan Student Conference on sea turtle two years ago. The participants presented their research and discussed general to ethical topics. SRC's new activities are measuring of Heisaura Beach in Chiba prefecture, nesting beach of the loggerhead sea turtle, and creating the opportunity for children to learn about marine environment through sea turtles. The children who live in urban city have very little knowledge of marine lives and we aim to give them a chance to learn about it. By doing the activities above, we were able to get experience and make the foundation for SRC's next generation. For example, we gradually contracted student network. In fact, the participants increase every year and we wish to spread the connection from now on. We also expect to progress the activities in future.

SEA TURTLE RANGERS, A NEW OPTION FOR PROTECTING PUBLIC BEACHES IN NICARAGUA

Salvador Sanchez, Feliz Reyes, and Liza Gonzalez

Paso Pacifico, Km 15, Carretera Ticuantepe, Ticuantepe, Nicaragua

In Nicaragua, there are four key protected areas with sea turtle nesting habitat. Public agencies charged with protecting sea turtle nests have limited budgets and are unable to protect the full extent of nesting habitat across these protected areas. Conservation efforts should seek to supplement public agency protection efforts in developing countries where government agencies are underfunded. We present some of the key elements of Paso Pacifico's highly successful sea turtle ranger program which is led by members of the local community in southwestern Nicaragua. We consider that the program must initiate with a transparent recruitment process targeting members of communities located near to protected areas and with a historical conflict with sea turtle protection efforts. Second, the program must include ranger training that goes beyond sea turtle monitoring to include ranger professionalization and the building of other skills in areas such as first aid and tourism. Finally, the program must include a system of incentives that reward rangers for quality performance and that build the esteem of the rangers in the sight of the community. Rangers may become ambassadors for conservation in their communities, and thereby gain the trust of local people faster and more reliably than conservation organizations themselves. We conclude the poster by sharing some of the lessons learned through this ranger program during its first three years. These lessons include the need for increased scientific training and coordination and also the need to increase community outreach. Protected areas created to benefit nesting sea turtles would benefit by involving local communities as rangers, tour guides, and para-biologists.

TRANSFORMATIONAL LEADERSHIP FOR TURTLES: CREATING SYNERGY BETWEEN BUSINESS AND CONSERVATION

Sherri Sarratore

Quelonios Sea Turtle Conservation Camp, Pacuare National Reserve, Costa Rica

The Leatherback sea turtle is critically endangered and their populations are continuing to decline due to loss of habitat, overfishing and poaching by humans. Their diet consists primarily of jellyfish and can consume hundreds in a day. The extinction of this creature would shift the balance of biodiversity of all marine life to create an overpopulation of jellyfish, and what will this mean for other creatures such as humans? Well… jellyfish are very unpleasant and when stung can create welts, swelling and loss of feelings in affected parts and if stung enough one could possibly die through paralysis and drowning. Imagine someday there will be jellyfish warnings at many of our top tourist destinations, thus decreasing money spent in hotels and restaurants, and more importantly a decrease in employment for the communities and families that depend on tourism for their livelihood. Yet we often do not correlate the decrease or loss of one species with the profound and permanent affect on our own quality of life, hence the preservation of marine biodiversity creates many leadership opportunities! Traditionally any company faced with the challenge of decreasing business has two options 1. Cut back on expenses, downsize or 2. Invest, diversify or create opportunities. Due to the recent economic downturn companies have cut back and downsized so much it has affected the morale of a nation. We are feeling more financial stress and more uncertainty towards our future than ever. Thus, it is in business's best interest to modernize challenges and an option to cutting back is giving back through moral choices such as Corporate

Social Responsibility (CSR) programs and maximizing eco-tourism opportunities. More than ever the key to global competitiveness will be the capability of institutions around the world to continuously transform. Transformational leaders must be prepared to deal with a world in which resources are increasingly scarce and change happens more rapidly. Turtle conservation projects are adapting to the needs by creating sustainable opportunities for communities. Instead of poachers selling turtle eggs for money Quelonios del Caribe in the Caribbean coast of Costa Rica is hiring ex-poachers to become stewards of the turtles through training them to be guides to save the eggs. Thus not cutting back and eliminating jobs but through training and creating new opportunities resulting in a balanced sustainable community that increases the population of the turtle instead of decreasing through consumption. Businesses can maximize stakeholder wealth by helping to achieve sustainable goals through not by cutting back but through giving back and becoming transformational leaders in all business sectors. If we could teach endangered species organizational leadership then the turtles would be able and communicate and inspire people what their needs are, and thus there would probably not be a biodiversity problem. The problem is that turtles do not have a voice and they need passionate people and businesses with transformational leadership abilities to organize for them to create a world that succeeds through giving back.

OPTIMIZING U.S. ENDANGERED SPECIES ACT PROTECTION BY INTEGRATING RECOVERY PLANNING, SECTION 7 CONSULTATIONS, AND INCIDENTAL TAKE AUTHORIZATIONS: A SEA TURTLE CASE STUDY*

Courtney Shephard

Duke Environmental Law and Policy Clinic, Duke University School of Law

The U.S. Endangered Species Act (ESA) is one of the world's strongest species protection instruments. Pursuant to section 2 of the Act, all Federal departments and agencies are obligated to conserve and protect listed species. Protection under the ESA consists of three distinct aspects: the recovery plan, section 7 consultation and biological opinion, and legal incidental take. These three elements must be integrated to meet the goals and intentions of endangered species protection. Harmonizing the management actions specified in the recovery plans with the conservation recommendations in the biological opinion is crucial to ensuring that the jeopardy finding in the biological opinion correctly accounts for all factors influencing the survival of the species. Recovery plans and biological opinions are based on scientific assessments of the characteristics, size, and threats facing populations of listed species; incidental take authorizations incorporate political, social, and economic factors. Often take statements and the conclusions of recovery plans are not reconcilable, yet incidental take continues to be authorized. The average recovery plan for a species is highly detailed, identifying a multitude of actions recommended for conservation. The feasibility of recovery actions is constrained by a variety of factors, e.g. the availability of monetary resources. Take of the endangered species is directly contradictory to the purposes of the recovery plan, but it is routinely authorized because it is a necessary component to balance the social and political reality of species protection. Currently, the amount of authorized sea turtle take is unjustified—data are incomplete, modeling is faulty, and permits fail to consider the cumulative effects of the take. The sea turtle take authorized in the Gulf of Mexico and South Atlantic shrimp trawl fishery (2002) is one of the most egregious examples of the failure to integrate recovery plans and biological opinions with take authorizations for the six species of endangered and threatened sea turtles. Using the Gulf of Mexico and South Atlantic shrimp trawl fishery as a case study, this paper addresses the reasons for this lack of harmonization between the protection elements provided for by the ESA, and provides recommendations for improving the efficiency and effectiveness of ESA protection within the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Stephen Roady, Master's Project Advisor & Attorney, Earthjustice; Michelle Nowlin, Supervising Attorney, Duke Environmental Law & Policy Clinic; Ryke Longest, Director, Duke Environmental Law & Policy Clinic; Jean Beasley, Executive Director, Karen Beasley Sea Turtle Rescue & Rehabilitation Center; Nicholas School of the Environment, Duke University; International Sea Turtle Society Western Pacific Regional Fishery Management Council; U.S. Fish and Wildlife Service; U.S. National Marine Fisheries Service; International Sea Turtle Symposium.

SEA TURTLES AND THE FOSSIL FUEL FRENZY

Teri Shore[1], Jill St. John[2], and Jacki Lopez[3]

[1] Turtle Island Restoration Network, Forest Knolls, California, USA
[2] Wilderness Society of Western Australia, West Perth, Western Australia, Australia
[3] Center for Biological Diversity, San Francisco, California, USA

From the Gulf of Mexico to the remote coastline of Northwestern Australia, the expansion of oil and natural gas extraction and exploration in marine habitat around the global is an imminent threat to the recovery and survival of sea turtle populations. While oil from the BP-Deepwater Horizon deepwater well gushed into the Gulf of Mexico at the peak of sea turtle nesting season, the Chevron corporation broke ground on its massive Gorgon liquid natural gas (LNG) project on top of a Australian flatback nesting beach on a small island off the coast of Northwestern Australia. In the Gulf, more than 1,100 sea turtles were harmed or died directly or indirectly from the BP spill and the long-term effects on populations remain unknown. New deepwater oil drilling is starting up again with little attention to the plight of sea turtles including the critically endangered Kemp's ridley – a species impacted 30 years ago by the 1979 Ixtoc oil spill that oiled its beaches. Australian flatback and other sea turtle nesting and foraging habitat is under threat from to a dozen LNG projects are slated for start-up or expansion to tap offshore natural gas reserves to meet rising demand for fossil fuels. All the multinational oil companies are involved: BP, BHP Billiton, Chevron, Shell, ExxonMobil and regional companies such as Woodside Petroleum. In a precursor to the oil disaster in the Gulf, the deepwater Montara oil rig off Australia's Kimberley coast in the Timor Sea poured nine million gallons of oil into the ocean before exploding and burning down in late 2009. These richly biodiverse waters are important to sea turtles as well as humpback whales. These and other oil disasters did not deter the U.S. government from rewarding Exxon-Mobil with $3 billion in financing from the tax-payer funded Import- Export Bank to build a LNG project in Papua New Guinea without adequate evidence of environmental review. The pipeline will cut through sea turtle and dugong feeding areas, seagrass habitat and coral reefs and rip apart mangrove, rainforest and human communities. The fossil fuel frenzy in the oceans is global and rapid. We have little if any scientific knowledge about the harm from each project yet alone the cumulative impacts to the marine environment and sea turtles in particular. Many expansions are occurring in areas of significant ocean biodiversity and where scientific assessments have never been completed. In this presentation, the authors will identify key oil and gas projects of concern in places important to sea turtles. Using these examples, they will discuss the need for clear and quantifiable protective measures and accident response to prevent destruction of sea turtle habitat and marine biodiversity. For while the fossil fuel frenzy may be short-lived in relationship to sea turtle life cycles, it has the potential to contribute significant harm to already declining sea turtle and marine life populations and prevent their survival and recovery in the long-term.

DOCUMENTING VOLUNTEER EFFORT IN GEORGIA, NORTH AND SOUTH CAROLINA, USA USING AN ONLINE SEA TURTLE VOLUNTEER DATABASE ON SEATURTLE.ORG

Kelly Sloan[1], Michael Coyne[2], Mark Dodd[3], Matthew H. Godfrey[4], DuBose Griffin[1], and Arturo E. Herrera[1]

[1] South Carolina Department Natural Resources, Marine Turtle Program
[2] SEATURTLE.ORG
[3] Georgia Department Natural Resources, Wildlife Resources Division
[4] North Carolina Wildlife Resources Commission

Volunteers are integral to sea turtle conservation, especially nest protection and stranding response. Nongovernmental organizations, state and federal agencies cannot accomplish critical recovery objectives without volunteer support. Volunteers locate nests, relocate nests threatened with tidal inundation, protect nests from predators, evaluate hatching success after emergence and collect data on stranded sea turtles. Documenting volunteer activities allows resource managers to 1) quantify the value of the resource to its constituents, 2) measure the workload needed to manage the resource and 3) capture in-kind cost-share monies for grant match, imperative during the current economic climate.

With approximately 2003 volunteers, 71 beaches and three states (Georgia = 177, North Carolina = 700, and South Carolina = 1126), the task of quantifying volunteer time previously has been calculated on an ad hoc basis. In early 2010, Georgia, North and South Carolina sea turtle conservation coordinators worked with seaturtle.org to develop an online process to capture work carried out by volunteers (http://www.seaturtle.org/volunteer). Beginning in April 2010, volunteers were asked to voluntarily register with seaturtle.org and enter their hours, mileage and expenses into a database. Out of 2003 volunteers, 647(32%) participated. Total hours, mileage and expenses were 30,771, 98,525 and $852.97, respectively. Monetary value was calculated using $16.26 per hour (rate for South Carolina on http://www.independentsector.org), $0.50 per mile (South Carolina mileage reimbursement rate) and actual value for expenses. Total value with 32% participation was $583,356. This value provided significant in-kind grant match. Although individual participation was low (32%) during this pilot year (most likely due to low or infrequent computer use by volunteers), the in-kind match captured far exceeded the amount needed by all three states. Using a 75:25 cost-share, $583,356 matched $1,750,068 in grant monies. Using a 90:10 cost-share (in the case of a federal multi-state grant), $583,356 matches $5,250,205 in grant monies. As state funding through appropriated and revenue funds decrease, both operating funds and match potential necessary to support conservation programs will decrease. Therefore, the value of volunteers continues to be essential, not only in support provided to state conservation programs, but potential in-kind contribution. By working with seaturtle.org to implement a streamlined process to capture the value of volunteer effort, Georgia, North and South Carolina sea turtle conservation programs are able to continue to operate and protect sea turtles despite diminishing state support.

ADVOKIDS

Zander Srodes, Becca Gelwicks, Katy Neiswender, and Rocio Johnson

Sea Turtle Conservancy Gainesville, Florida USA

Sea Turtle "AdvoKids" is an innovative program of the not-for profit, Sea Turtle Conservancy. It is an online club just for kids who are dedicated to the protection of endangered sea turtles around the world through volunteerism. AdvoKids is a youth-driven program, which means that it is organized and run by its young members. This is done by an interactive, exclusive social networking website designed just for kids! AdvoKids is a great opportunity for youngsters to mobilize their community and contribute to the Sea Turtle Conservancy's global effort to save the world's sea turtle population. Sea Turtle AdvoKids is currently recruiting proactive youth looking to impact sea turtles, make like minded friends, and earn community service hours. The participants will collaborate through an online forum and will have the ability to make decisions towards the future of the organization. A youth board will engage in the leadership of the association. These board members will be in charge of all club related decisions. The Sea Turtle Conservancy will provide the logistical support for the club and help out with anything beyond the ability of the youth participants. Members will also be required to contribute to the online community. They will do this by uploading photos and videos of the projects on which they are currently working. The club participants will also be required to post quarterly blog entries to the site. The Sea Turtle Conservancy will also monitor all submissions on the website to ensure its content is age appropriate. Activities: Members will be asked to make a one year commitment and participate in four activities throughout the year. These include: conducting educational presentations, hosting a local clean-up, fundraising to support conservation and an event of their choice. The members will have the ability to be imaginative in the way they design their outreach activities. The Sea Turtle Conservancy will provide ideas and information to ensure the students accomplish their tasks. Current status: Sea Turtle AdvoKids has not officially launched. The venture will be up and running prior to January of 2011. The groundwork has been completed. It is time to circulate the idea so that kids will join and add their voice to the conservation movement. Their first task will be to establish a youth board that will shape the direction of the club. Goals: The immediate goal for 2011 is to have 10-20 youths completing activities through the course of the year. The initial participants will be from the Gainesville, Florida area. Having the youngsters nearby will allow Sea Turtle Conservancy the ability to provide hands on support for those first to enroll. Their first task will be to establish a youth board that will shape the direction of the club. Long term goal: Is for AdvoKids to be a global club with a limitless squad all working together as advocates for sea turtles. The club will provide monetary fund's and mobilize youth involvement in the conservation efforts to sea turtle related threats around the world.

CONSERVING LOGGERHEADS UNDER U.S. LAW WITH NGO ACTIONS

Todd Steiner[1], Teri Shore[1], Elizabeth Griffin[2], Dave Allison[2], Brendan Cummings[3], and Miyoko Sakashita[3]

[1] Turtle Island Restoration Network, Forest Knolls, California, USA
[2] Oceana, Washington D.C., USA
[3] Center for Biological Diversity, San Francisco, California, USA

Loggerhead sea turtles have been considered a single global population and listed as a threatened species since 1978 under the U. S. Endangered Species Act. Since then loggerhead populations have failed to recover, continue to decline dramatically and remain at risk of extinction due to many threats – including the incidental capture, injury, and death in commercial fishing gear. Loggerheads have declined by at least 80 percent in the North Pacific and could become functionally or ecologically extinct by the mid-21st century if additional protections are not put into place. The majority of female loggerheads in Northwest Atlantic population nest in Florida, which accounts for 90 percent of total loggerhead nesting in the United States. Loggerhead nesting in Florida declined by 25 percent from 1998 to 2010. Here the authors review how the protections of the Endangered Species Act (ESA) can and are being leveraged for better sea turtle conservation for North Pacific and Northwest Atlantic loggerheads, and ultimately global populations. The ESA provides an avenue for public participation through a petition process in its mandate for conserving and recovering imperiled species. Accordingly, three non-governmental organizations, Turtle Island Restoration Network, Oceana and Center for Biological Diversity, filed citizen petitions requesting the U.S. government uplist loggerheads from threatened to endangered classification, and identify distinct population segments for better management of loggerhead sea turtles. In response to the petition, the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) found that uplisting the loggerheads was warranted. The scientific status review substantiated the claims of the citizen petitions, finding that both North Pacific and Northwest Atlantic loggerheads were "currently at risk of extinction." In early 2010, the U. S. government proposed that the global loggerhead population be divided into nine distinct populations of which seven, including the North Pacific and Northwest Atlantic populations, be reclassified as endangered. Once the rulemaking is finalized, the new population and status designations under the Endangered Species Act should significantly improve global loggerhead sea turtle conservation. First, reclassification from threatened to endangered highlights the urgent need for reducing threats to these populations among decisionmakers and the public. Second, the designation of distinct population segments will improve our understanding of scientifically relevant baselines for each population against which to analyze impacts of threats like fisheries bycatch, habitat destruction, and ocean pollution. Third, it will trigger increased protections in key loggerhead nesting, breeding, and feeding habitat through the designation of critical habitat, as required by the ESA. Finally, the designations may also foster improved research and public awareness by reinforcing the uniqueness of each distinct population and its special connection to the beaches and waters it inhabits.

PROTECTING SEA TURTLES THROUGH PUBLIC HEALTH ADVOCACY

Buffy Martin Tarbox, Teri Shore, and Todd Steiner

Turtle Island Restoration Network, Forest Knolls, CA, USA

One of the largest threats to sea turtles worldwide is industrial long-line fishing, which targets large predatory swordfish and many tuna species. Swordfish and tuna also contain high amounts of mercury. Unfortunately, in the pursuit of swordfish and tuna, thousands of sea turtles perish as incidental bycatch. One of the most significant public health risks to women of child-bearing age and children is exposure to the neurotoxin mercury. According to the U.S. Environmental Protection Agency, the number one source of mercury exposure in the U.S. is from eating contaminated seafood. Swordfish and many types of tuna species contain hazardous levels of mercury, yet the United States government has failed to take action and still allows high mercury seafood to be caught and sold and does not require mercury advisory signs to be posted. Unsuspecting fish eaters are purchasing high-mercury swordfish and tuna at supermarkets, putting their health at risk and unknowingly contributing to sea turtle mortality. To expose the toxic

levels of mercury in tuna and swordfish being sold at supermarkets across the nation, GotMerucry.org, a project of Turtle Island Restoration Network initiated Operation Safe Seafood, a nation-wide mercury in seafood testing project. GotMercury.org has tested 145 samples of swordfish and tuna for mercury levels, all purchased at grocery stores, supermarkets and local fish markets from across the United States. Each sample was analyzed by an accredited laboratory. The Food and Drug Administration (FDA) has a mercury action level of 1 parts per million (ppm), yet nearly 40 percent of the samples included in Operation Safe Seafood were well above the 1 ppm, putting women and children at risk for health problems associated with mercury exposure. The average mercury level for the 61 swordfish samples was 1.33 ppm, well above the federal mercury action level. The average mercury level for the 84 tuna samples was .510, although the tuna ranged from 2.97 ppm to <0.1 ppm, a variable that clearly demonstrates the unstable levels of mercury present in tuna. By informing fish eaters the dangers of toxic levels of mercury in swordfish and tuna, the GotMercury.org project is protecting the health of mothers and children while also indirectly reducing the demand for fish species caught by industrial long-line fleets and helping sea turtles to thrive in their natural habitat.

MARINE TURTLE CONSERVATION: A DIAGNOSTIC TOOL FOR SUCCESS*

Cali Turner Tomaszewicz[1,2], Aly Flemming[1], Michelle Lande[1], and Dani DiIullo[1]

[1] Center for Marine Biodiversity and Conservation, University of California San Diego, Scripps Institution of Oceanography, La Jolla, California, USA
[2] Current: Ocean Discovery Institute, San Diego, California, USA

Here we present a diagnostic tool for successful marine turtle conservation as developed by a group of graduate students at University of California San Diego's Scripps Institution of Oceanography's (SIO) Center for Marine Biodiversity and Conservation (CMBC). This diagnostic tool is meant to be used by organizations and groups, located anywhere in the world, to assist in the evaluation of current or future marine turtle conservation efforts. The goal is to assist program managers and members in identifying, prioritizing and addressing weaknesses to make conservation programs more efficient – both biologically (marine turtle population recovery) and economically. Challenges facing marine turtle conservation, and all natural resource conservation for that matter, are especially complex. Furthermore, resources, both human and monetary, are limited. A successful program is one that uses its resources in the most efficient way possible – where the greatest numbers of turtles are protected and survive. This tool will help programs identify where resources may be utilized more efficiently by highlighting seven factors, arranged by priority in four tiers which should be addressed in order for a program to be successful in the long term. These tiers mandate the incorporation of scientific, social, political and economic factors. By first defining "success" in terms of outcomes as opposed to outputs, conservation programs may better define program goals and objectives. We readily acknowledge that this is in no way a prescriptive tool for conservation programs; but instead, this tool was developed through the review of several prescriptive programs, papers, and management resources. These other resources present, at a much higher level of expertise, the specifics on how to implement and make necessary changes or addition to conservation programs. Instead, this tool is based upon the key themes in each of these prescriptive conservation resources to create the seven factors in the four tiers of this diagnostic tool. This diagnostic tool can be used as a first step for conservation programs wanting to assess and improve the efficiency of their work. In the diagnostic tool, the top tier includes: 1) Basing foundation on local socioeconomic and cultural conditions and practices; 2) Matching varying scales – ecological, spatial, and social; 3) Harnessing local and external knowledge; the Second Tier continues: 4) Facilitating and utilizing a strong, responsive legal capacity; and 5) Identifying and addressing limitations; Tier Three: 6) Promoting longevity and adaptability; and finally, Tier Four: 7) Sharing and learning from practices. This diagnostic tool is a self-evaluation tool, offered at zero-cost to all conservation groups, and is available as a turn-key service at a website hosted by SIO's CMBC: http://cmbc.ucsd.edu/Research/student_research/turtle_conser/ . Here, we present the approach to developing the diagnostic tool, describe the structure of the tool itself and how the tool may be used, and invite conservation programs to utilize the tool and assist in making this a useful and valuable resource for marine turtle conservation.

RESULTS OF THE NESTING BEHAVIOR OF MORE THAN TWO DECADES OF CONSERVATION OF THE TURTLE *CARETTA CARETTA* AND *CHELONIA MYDAS* IN THE CENTRAL COAST OF QUINTANA ROO, MÉXICO

Miriam Tzeek[1], Alejandro Arenas[1], Leonel Gómez[1], and Roberto Herrera[2]

[1] Flora, Fauna y Cultura de México A.C, Carretera Chetumal-Puerto Juárez km 282, Playa del Carmen, Quintana Roo, México. CP 77710
[2] El Colegio de la Frontera Sur, Av. Del Centenario Km. 5.5 Chetumal, Quintana Roo, Mèxico. CP 77900

The Marine Turtle Conservation Program, Riviera Maya-Tulum takes place in central coast in the state of Quintana Roo, Mexico, and it is located between Playa del Carmen and Sian Kaan Biosphere reserve. The main characteristic of this program is its continuity (more than 2 decades). Currently, 13 nesting beaches are protected, covering 36 km of coast (in 8 of them daily night routes are made and in the other 5, morning prospections are done every 15 days). The nesting population of marine turtle in studied area are: caguama turtle (*Caretta caretta*), white turtle (*Chelonia mydas*), and sporadicly the carey turtle (*Eretmochelys imbricata*) and the laud turtle (*Dermochelys coriacea*). In the program different institutions have participated, and currently is on charge of Flora, Fauna y Cultura de Mexico AC. In this works, is only presented, by standardization motives, the results of these species nesting in studied beaches, from the beginning of the program until nowadays. These are: Paamul, Aventuras DIF, Chemuyil, Xcacel, Tankah, Kanzul, Caapechen and San Juan. We must remark the importance to the size of these beaches, because the shortest one measure about 300 mts. and the longest one is about 5.5 km. We have obtained that, since 1989 until 2010 (preliminaries), these 8 beaches have recorded 41,952 nests of white turtle, which represents 85.45% of total nests counted in the whole program until now. With respect of caguama turtle, the beaches have recorded 23,806 nests (80.92% of global total); 10 belongs to the carey one (100%) and only 2 belongs to the laud one (100%). Respecting to the white turtle, in this year it has been observed the highest season in number of nests recorded along the whole program. For the caguama one, it only increased in 17% compared to last year, being the 1995 season, the one with most number of nests recorded for this population. To make this work, the statistical package Microsoft Excel 2007 was used. The statistical analysis of nests registered in the studied area reflects a tendency to increase the population of white turtle since the beginning of the program until now. Nevertheless, in 2009 it is observed an atypical behavior, registering the lowest season in last 5 years. But, in last 3 years it is observed for caguama turtle a trend to increase the amount of nests, although is not significant. It will be presented a physical description of each beach according to the trends. We discuss the behavior for beach of the trends. It is recommended to go on with the monitoring program of nests in these beaches and also make more precise studies with respect of population tendencies analysis.

MYTHOLOGICAL LINKAGE OF MARINE SPECIES TO MANAGEMENT - AN EFFECTIVE STRATEGY FOR MARINE TURTLE CONSERVATION IN INDIA?

Sanjay Upadhyay

Advocate Supreme Court of India and Managing Partner, Enviro Legal Defence Firm , NOIDA-U.P., India

Modern regulatory and policy frameworks and other modern techniques may be necessary conditions for effective marine species management but not necessarily sufficient conditions. There is a need to re-emphasize the historical and mythological significance of species so that local communities, who are not so familiar with modern management strategies, can relate to such traditions and thus prove to be more effective in managing biodiversity of marine areas. Thus for example In India the “Kacchapa” or the turtle has been used in various traditional ways in folk tales to demonstrate its endurance at the sea, in various forms of cultural expressions, its reverence as a deity and thus its significance as a species. This paper makes a case for using mythological deities and tales, along with modern regulatory approaches, to impart the knowledge of conserving flagship species such as turtles and hence the marine ecosystem to ensure better marine protected area management.

MEDASSET (MEDITERRANEAN ASSOCIATION TO SAVE THE SEA TURTLES) – A UNIQUE APPROACH TO CONSERVATION

Lily Venizelos[1] and Roger Poland[2]

[1] MEDASSET, 1c Licavitou St., 106 72 Athens, Greece
[2] Operation Wallacea, Wallace House, Old Bolingbroke, Lincolnshire, PE23 4EX UK

MEDASSET, an International pioneering NGO with its roots going back to 1983, is registered in Greece and the UK. When constituted in 1988, it was and still is the only organization working exclusively on marine turtle conservation and education throughout the Mediterranean. Core funding by the founder enabled the organization to pursue monitoring, research, conservation and education projects in European, Near Eastern and North African Mediterranean countries: these activities have been fully backed by key international intergovernmental organizations and further supported by sponsors and fundraising. Internationally, MEDASSET has made a major contribution towards the legal framework protecting sea turtles and has carried out important projects such as a 7,880 km survey of Mediterranean coastline, not only discovering new nesting sites but confirming the absence of turtles in key areas. Amongst hundreds of activities it has helped to pioneer satellite tracking in the Mediterranean, investigated the effect of fishing on sea turtle populations and carried out ongoing yearly assessments of major nesting areas: these findings have been presented to the Bern Convention at the Council of Europe and have resulted in the adoption of significant conservation strategies to protect sea turtles. One of its most important activities has been lobbying and campaigning and this helped towards the establishment of the Zakynthos National Marine Park (1999). It has initiated many campaigns with its recent success against chemical pollution on the important green turtle nesting beach in Kazanli, Turkey. Endangered green turtles in the Mediterranean have been a conservation priority for MEDASSET since 1989. There have been several other successful campaigns such as the ban on the sale of turtle meat and blood in Egypt (1998) and since 1996 there has been an on-going campaign on the impact of 'Small Garbage" to marine life which has spread successfully beyond Europe to India. The release of captive turtles held in Monaco, Egypt, Tunisia, Italy, Albania have made exciting stories to increase public awareness. The EuroTurtle website (1997) was the first interactive educational website devoted to sea turtles and is maintained by MEDASSET: it has an estimated 1,500,000 hits annually from 50 different countries and has received several awards. Other innovative ventures such as "Niretta the *Caretta*" for creative learning and Environmental Education kit, "The Mediterranean Sea, a Source of Life" in three languages, have put MEDASSET at the forefront of public awareness and education. It has been MEDASSET's enthusiasm, persistence, imaginative approach, hard working and highly active lobbying and campaigning at every level that has made it a unique organization. MEDASSET never shies away from getting involved in conservation projects especially where research had never been carried out before and where little or no commitment to sea turtle conservation exist, thus consciously choosing the 'hard way' in helping to develop turtle conservation in the Mediterranean. Until MEDASSET's campaign for the protection of sea turtles on Zakynthos (Greece), few had heard of this now famous sea turtle site or even knew of the existence of such magnificent animals in some countries of the Mediterranean.

TOWARDS A SELF FINANCING SEA TURTLE CONSERVATION PROGRAMME IN MAFIA ISLAND, TANZANIA*

Lindsey West, Catharine Joynson-Hicks, Omari Abdallah, and Boniventure Mchomvu

Sea Sense, PO BOX 105044, Dar es Salaam, Tanzania

The Mafia archipelago is the most important nesting site in Tanzania for green turtles (*Chelonia mydas*). Occasional hawksbill (*Eretmochelys imbricata*) nests are also recorded. In 2001, community based nest monitoring commenced in Mafia. Beach surveys were undertaken and interviews were held with local fishers to help identify sea turtle nesting beaches. Since then, trained community members have conducted early morning foot patrols on a daily basis throughout the year, at six key nesting sites. Nests are located and identified by day track counts. Data is collected on nesting species, nest location and frequency of nesting activity. Threats to nesting females and incubating eggs are also recorded and any nest under threat from poaching, predation or tidal inundation is translocated to a safer area. All nests are monitored until hatching and then excavated to assess hatching success. Standard protocols are used for all monitoring and protection techniques as described in Eckert *et al*., 1999. Survey efforts have remained constant since 2002. Year to year fluctuations in nesting frequency have been recorded, ranging from 136 nests laid in 2003 to 247 nests in 2008. The average is 179 (SD±39) nests per year. There are seasonal patterns in nesting activity with peak nesting for green turtles occurring in April, May and June. Peak nesting activity for hawksbill turtles appears to be in January and February although this data is taken from a sample of only 28 nests. Approximately 60% of all sea turtle nests in Mafia are laid in Juani Island, a small island to the south – east of Mafia. Seven known nesting beaches averaging 200 metres in length are actively monitored. Nesting density in Juani Island is approximately 114 nests / km. Since the establishment of a sea turtle conservation programme in Mafia, over 2,600 nests have been recorded and monitored. The presence of a community monitoring network has contributed to the reduction in nest poaching from over 80% in 2001 to 2% in 2009. A community nest incentive scheme has also been implemented whereby modest financial incentives are given to those who report sea turtle nests. The successful engagement of local communities in sea turtle conservation in Mafia has facilitated the development of a sea turtle ecotourism initiative. Visitors to Mafia are guided to turtle nesting beaches by local 'Turtle Tour Guides' who have received training in sea turtle biology and conservation and visitor management. There is growing interest in the initiative and it is starting to generate essential revenue. All revenue raised through sea turtle ecotourism is directed back into turtle conservation efforts. With careful management, sea turtle ecotourism has the potential to create a sustainable source of income that could finance the community based sea turtle programme in Mafia Island.

WORKING WITH CELEBRITIES TO RAISE AWARENESS AND DRIVE SEA TURTLE CONSERVATION USING TRADITIONAL AND NEW MEDIA*

Elizabeth G. Wilson, Matt Littlejohn, and David Allison

Oceana

Celebrity participation in sea turtle conservation can be an effective way to raise awareness and attract new supporters to the sea turtle conservation movement. Public awareness is critical to efforts to strengthen protections for sea turtles. Celebrities are poised to uniquely engage the public through various forms of traditional and social media. Oceana produced two sets of celebrity public service announcements (PSAs) with three female actresses for our PSA campaign "Getting Sea Turtles Off the Hook." The goal of the campaign is to increase exposure for sea turtle conservation and raise awareness about the proposed U.S. Sea Turtle Protection Act. The first PSA series, staring actress Kate Walsh (Private Practice), included video, print and radio PSAs. The PSAs were distributed to traditional media and were also pushed out via a variety of social media tools including blogs, twitter, web videos, facebook, and hulu ads. The print PSA ran in O Magazine, Arrive, Coastal Living and Harvard Business Review. The TV PSAs also ran on the ABC and Lifetime television networks and the radio PSA has been played more than 1,000 times. In addition, Walsh discussed her trip and her work with Oceana with Ellen DeGeneres on Ellen and with Jimmy Kimmel on the Jimmy Kimmel Live show. PSAs have become one of the main sources of web traffic for Oceana. Angela Kinsey (The Office) and Rachel Harris (The Hangover) co-star in the second Oceana sea turtle PSA, which was released late 2010 in anticipation of the expected introduction of the Sea Turtle Protection Act in the U.S. Congress in 2011. Celebrity participation in conservation issues can provide numerous benefits including driving news stories and talk show appearances, drawing traffic to an organization's website, engaging the public, and raising Congressional attention to an issue. This Oceana initiative provides an example for organizations around the world on how to use celebrity participation in campaigns as a social pathway to drive sea turtle conservation.

BACK TO THE ROOTS OF THE SEA TURTLE MOVEMENT; HARNESSING LOCAL LORE TO LOCATE CRITICALLY ENDANGERED HAWKSBILL TURTLES IN THE EASTERN PACIFIC*

Ingrid L. Yañez[1] and Alexander R. Gaos[1,2]

[1] Eastern Pacific Hawksbill Initiative, San Diego, California, USA
[2] San Diego State University, San Diego, California, USA

How does one study a species teetering on the brink of extinction and about which almost nothing is known? In the case of sea turtles, seeking out the help and knowledge of coastal community members, particularly fishers who depend on the ocean for their existence, has proven to be an extremely successful method. Indeed, early turtle researchers such as Archie Carr and Henry Hildebrand harnessed local lore to confirm the existence of now-famous sea turtle sites such as Tortuguero, Costa Rica, and Rancho Nuevo, Mexico. Despite its roots in the early sea turtle movement, the use of local knowledge remains underutilized in contemporary research efforts. Until recently most scientists thought hawksbills had been essentially extirpated in the eastern Pacific Ocean. In 2007 we began interviewing fishers and visiting coastal communities in northwest Mexico to glean information on whether hawksbill turtles could still found in the region and if so, where and in what quantity. During our survey trips we compiled a wealth of knowledge on the species, including observations of numerous individuals and several recently caught specimens. This was particularly shocking as the population was virtually undocumented at the time and considered by most to be past the point of no return. Over the course of the subsequent two years we continued engaging community members to locate hawksbills and their habitats along the Pacific coast of Mexico, Nicaragua, Costa Rica and Panama. In all cases we were able to gather crucial information on hawksbill nesting and foraging rookeries, while observing/capturing numerous individuals of the species. These findings have played a key role in the establishment of several ongoing hawksbill conservation projects in the region and in helping catalyze the optimism that currently exists for recovery of the species in the eastern Pacific. Herein we discuss the 3-year investigative effort, highlighting the crucial role local knowledge has played in elucidating the presence of critically endangered hawksbills and how similar efforts can assist in researching other highly elusive wildlife species. We gratefully acknowledge the financial support of People's Trust for Endangered Species, International Sustainable Seafood Foundation, Southwest Fisheries Science Center (NOAA), National Fish and Wildlife Foundation and the US Fish and Wildlife Service.

ADVOCACY TOWARDS HOLISTIC LEGAL PROTECTION OF TURTLES IN MALAYSIA*

Rahayu Zulkifli and Preetha Sankar

WWF-Malaysia, Petaling Jaya, Malaysia

The protection of turtles, specifically marine turtles has been a priority of WWF-Malaysia for many decades. Our work on turtles extends from various on-the-ground projects from nesting habitat protection, scientific research, community education and awareness to policy advocacy at the National and State levels. However, without a robust and comprehensive legislation, the protection and conservation of turtles will neither be holistic nor effective. Under Schedule 9 of Malaysia's Federal Constitution (the supreme law of the country), the power to legislate on matters relating to turtles comes within the purview of the various State Governments, and not the Federal Government. This has resulted in the Federal Government not being able to force the States to take any proactive conservation measures, which in turn, has resulted in State Legislations that lack uniformity, and contain numerous weaknesses and loopholes that fail to provide turtles with effective protection against all threats impacting them. This also has led to a situation where the Federal Government is not able to meet its international obligations to protect turtles and their habitats because it cannot legislate on turtles. To initiate a change in the current legal framework that pertains to turtles, WWF-Malaysia in April 2009 launched the Egg=Life campaign. More than 100,000 signatures were collected from the public who among other things, supported the call for an amendment to the Federal Constitution which would transfer the power to legislate on turtles to the Federal Government. WWF-Malaysia hopes to highlight via the presentation at the symposium, the fundamental basis for the launch of the Egg=Life Campaign, the justification and reasoning that led to the call for an Amendment to the Federal Constitution, the route this advocacy strategy has taken, as well as the advocacy progress towards achieving this goal.

Foraging, Physiology, and Movements

ROLE OF OCEAN CURRENTS IN SHAPING THE STOCK COMPOSITION OF THE GREEN TURTLE AGGREGATION AT THE GORGONA (COLOMBIA) FORAGING GROUND*

F. Alberto Abreu-Grobois[1], Diego F. Amorocho[2], Richard D. Reina[3], Peter Dutton[4], and Nathan F. Putman[5]

[1] Unidad Académica Mazatlán, Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Apartado Postal 811, Mazatlán, Sinaloa, México 82000
[2] Centro de Investigación para el Manejo Ambiental y el Desarrollo, Cra 1 Oeste 9-89, Apto 301, Cali – Colombia
[3] School of Biological Sciences. Monash University, Clayton, Victoria 3800, Australia
[4] Southwest Fisheries Science Center, 3333 North Torrey Pines Court, La Jolla, CA, USA
[5] University of North Carolina - Chapel Hill

The analysis of stock composition for green turtles at the Gorgona Island (Pacific Colombia) foraging site (FG) suggesting contributions not only from the nearby Galapagos rookery but also from rookeries located both in the northern portion of the East Pacific and the West Pacific prompted us to analyze plausible long distance ocean current drift scenarios that could explain these linkages. To assess potential pathways we mined data from two NOAA programs: the Ocean Surface Current Analyses in Real Time and the Global Lagrangian Drifters. We addressed questions that could provide insight into the "lost years" for the species: Can the patterns and scope of Pacific surface ocean currents explain connectivity between the implicated source rookeries and the Gorgona FG? What would be plausible drift times for juveniles entrained in oceanic currents from natal sources to the vicinity of the Gorgona FG? Would region-wide periodic events such as ENSO have significant effects on the long distance transport capacity of implicated current systems? Data from drifter buoys deployed within 10° latitude and longitude of the green turtle rookeries of FFS (N=127), Revillagigedos and Michoacan (N=84), and Galapagos (N=349) were used, while for the western Pacific, we selected drifters deployed in an area within lat 5°S to 15°N and long 130°-170°E (N=609). None of the buoys deployed in the FFS area drifted anywhere near Gorgona, most travelled due W-NW, or NE. Buoys set off western Mexico described a variety of trajectories, some moving westward with a few of these reaching distant zones in Central and Western Pacific, some entering zones around the Baja California Peninsula, others heading South to areas near Gorgona. Buoys deployed near Galapagos headed mostly due WSW, some WNW, and a smaller portion due East. The largest portion of buoys deployed in the W Pacific headed due West and NW, a few moved eastward and a single one drifted across most of the Pacific to an area very near Central America. These observations suggest that passive drift on ocean currents is plausible from rookeries in western Mexico and Galapagos but not from Hawaii, in general agreement with the stock composition drawn from the genetic analysis. The route from the western Pacific to Gorgona FG confirms the plausibility for West-East drift of pelagic stage green turtle juveniles, though of lower frequency compared with the reverse. Data from the selected drifters reaching the Gorgona vicinity illustrated specific routes and travel duration: from western Mexico to Gorgona (N=2) 400-500 days; from Galapagos to the Gorgona region (N=1) about 120 days; from about 2°N/165°E in the Western Pacific to 7°N/89°W (N=1) about 607 days. Velocity and direction vectors for the North Equatorial Counter Current, implicated in the trans-Pacific dispersal, indicate stronger eastward transport during El Niño years, suggesting that transport of WPacific juvenile turtles to the Gorgona FG though probably infrequent, could occur through periodic pulses associated with this event. Combining these results with genetic analyses provides a powerful means to test life history hypothesis and can aid focusing of region-wide conservation strategies.

HOME RANGE AND MIGRATION OF EAST PACIFIC GREEN TURTLES TAGGED IN COCOS ISLAND NATIONAL PARK, COSTA RICA, USING SATELLITE AND ACOUSTIC TELEMETRY*

Randall Arauz[1], Todd Steiner[2], Diego Amorocho[3], Javier Carrion[4], and Jeffery Madrigal[1]

[1] Programa Restauración Tortugas Marinas, Costa Rica
[2] Turtle Island Restoration Network, California, USA
[3] Centro de Investigación Para el Manejo Ambiental y el Desarrollo, Colombia
[4] Universidad Autónoma de Baja California Sur, México

Cocos Island National Park was established in 1978. Located 532 km, southeast of Puntarenas, this oceanic island has a land surface of 24 square km and enjoys a 22.2 km radius of protected waters. Four species of sea turtles have been recorded in Cocos Island, East Pacific green turtles are the most common, although hawksbills, leatherbacks and olive ridleys are also seen. A large portion of the post nesting open ocean migration route of critically endangered Pacific leatherback turtles as they leave their most important rookery in the East Pacific, located on Costa Rica's mainland, has already been shown to include the territorial waters (EEZ) of Costa Rica and Ecuador, that surround the Cocos Island and Galapagos Islands. The largest remaining nesting rookery for Pacific green turtles is at the Galapagos Islands, with fewer numbers nesting in Central America and Mexico. Furthermore, an important feeding and rearing site for this species has been identified in Gorgona Island, Colombia. It is currently not known where adult or juvenile green turtles found at Cocos Island National Park emanate from. If these turtles utilize either the Galapagos, or the coast of Costa Rica for reproduction, they may share migration routes with East Pacific leatherbacks. If they utilize Gorgona during juvenile development stages, it is necessary to establish the existence of connectivity and migratory patterns. A sea turtle monitoring program initiated in Cocos Island in March of 2009. A total of 65 sea turtles turtles have been caught by hand while scuba diving (63 Pacific green turtles and 2 hawksbills), all of which were tagged externally with metal flipper tags. Two East Pacific green turtles have been satellite tracked using Wildlife Computer Spot 5 Tags, five green turtles and one hawksbill were tagged using Sirtrack Kiwistat tags, and two green turtles were tagged using Wildlife Computer MK-10 tags. Eleven green turtles and one hawksbill were also outfitted with VEMCO V16 acoustic tags. A photographic record of all sea turtles is being kept of the right and left profile of the face for photo ID, as well as the carapace. Tissue samples are taken from all individuals for later genetic analysis. So far, the data collected show that a significant population of juvenile and adult green turtles, as well as juvenile hawksbill turtles, use the habitats along the northern rim of the Island to forage, and possibly as a rearing area for juveniles as well, where individuals may stay for years until they take towards a pelagic existence. Home range analysis shows an area of high intensity use between Manuelita and Dirty Rock. Tag attachment methods and retention time are compared. The knowledge generated is expected to assist the establishment of management measures, such as increasing the marine protected around around Cocos Island National Park, and creating corridors between Costa Rica, Ecuador, and Colombia, where sea turtles are protected from fisheries during times of high interaction.

COMPOUND SPECIFIC STABLE NITROGEN ISOTOPE ANALYSIS OF AMINO ACIDS: NEW INSIGHT INTO TURTLE ECOLOGY*

Karen Arthur[1], Brian Popp[1], Stacy Hargrove[2], George Balazs[2], Scott Benson[3], and Jeff Seminoff[3]

[1] Department of Geology and Geophysics, University of Hawaii, 1680 East-West Rd, Honolulu, HI 96734 USA
[2] Pacific Islands Fisheries Science Center, NOAA, 2570 Dole Street, Honolulu, HI, 96822 USA
[3] Southwest Fisheries Science Center, NOAA, 3333 North Torrey Pines Court, La Jolla, CA 92037 USA

Ecologists have long used the nitrogen isotopic composition of an animal's tissues as an indicator of the animal's trophic position within a food web. However, there are a number of assumptions that must be met in order to satisfactorily interpret bulk tissue del15N values in terms of trophic position, including knowing the isotopic composition at the base of the food web and the expected enrichment in 15N at each trophic step. Compound specific

nitrogen isotope analysis of amino acids (CSIA-AA) is a novel tool that can alleviate some of the challenges associated with the interpretation of bulk tissue del15N values. Some AAs, such as phenylalanine, retain the isotopic composition of source nitrogen at the base of the food web, whereas other AAs, such as glutamic acid, are significantly enriched in 15N as they move through the food web. As such, source and trophic information can be obtained from the tissue of just the consumer without need for prey items or basal food web samples. In this presentation we will introduce CSIA-AA as a new tool in the marine turtle ecologist toolbox and provide two examples of how it can be applied to studies of turtle foraging ecology and migration. Firstly, we present CSIA-AA evidence to support prior observations of the different foraging strategies of different species of marine turtle. Secondly, we demonstrate that a strong bimodal distribution in the bulk nitrogen isotopic composition of skin samples collected from leatherback turtles nesting at Jambursba Medi, Indonesia were the result of the two groups of turtles foraging in regions with differing nitrogen cycling regimes at the base of the food web rather than the turtles feeding at different trophic levels. We believe that CSIA-AA provides important insight into the interpretation of bulk nitrogen isotopic data and that it will prove to be a integral component of foraging, migratory and, potentially in the future, physiological studies of marine turtles.

FEEDING PATTERN OF GREEN TURTLES EXPLOITING AN INTERTIDAL SEAGRASS MEADOW*

Katia Ballorain[1], Jérôme Bourjea[2], Stéphane Ciccione[3], Jean-Patrice Robin[1], Manfred Enstipp[1], and Jean-Yves Georges[1]

[1] Université de Strasbourg, IPHC, CNRS, UMR7178, Strasbourg, France
[2] Institut Français de Recherche pour l'Exploitation de la Mer de La Réunion, Le Port, La Réunion, France
[3] Kelonia, l'Observatoire des tortues marines, Saint Leu, La Réunion, France

Sea turtles are long-distance migratory species for which foraging behaviour prior to the nesting season may have important consequences on individual life history traits. Green turtles feed primarily on shallow coastal seagrass and algae meadows that often place them in tidally-influenced foraging areas. In our study, we investigated the daily feeding pattern of green turtles exploiting an intertidal seagrass meadow at Mayotte Island in the south-western Indian Ocean, where seagrasses are fully or partially emerged from the sea according to a semi-diurnal tidal regime. Ten green turtles (ranging from 85 to 104 cm SCCL) were equipped with an electronic time-depth recorder and concurrently directly observed during underwater surveys. Their mean daily feeding time ranged from 9 to 14.6 h d-1 and was related to the daily tidal range. Our results show two different responses of green turtles to the seagrass accessibility, suggesting that green turtles exhibit individual feeding strategies. In the first one, which concerned seven individuals out ten, feeding activities were mainly performed during the day and the daily feeding time was related to the seagrass accessibility time. Green turtles performed their maximal daily feeding duration when the seagrass meadow was continuously accessible over 24 hours. In the second one, which concerned three remaining individuals, green turtles fed during both day and night and maintained a constant daily feeding time whatever the tidal regime was. Thanks to fine-scale sampling of feeding activities, we also estimated the mean daily gross energy intake of green turtles (ranging from 84 to 103 cm SCCL) from 3 200 to 7 600 kJ d-1. Quantifying the food intake of sea turtles is of crucial importance to determine their energy requirements and ultimately their role in marine food webs. Further investigations are now needed to measure the daily digestible energy intake and compare it to the daily energy expenditure thanks to a current project of estimate energy expenditure in resting and swimming green turtles using body acceleration.

MOVEMENTS OF JUVENILE LOGGERHEADS IN THE SOUTHWESTERN ATLANTIC*

Caren Barceló[1], Andrés Domingo[2], Philip Miller[3], Leonardo Ortega[2], Bruno Giffoni[4], Gilberto Sales[4], Lianne McNaughton[5], Maria Marcovaldi[4], Selina S. Heppell[1], and Yonat Swimmer[6]

[1] Oregon State University, Corvallis, Oregon, USA
[2] Dirección Nacional de Recursos Acuáticos, Montevideo, Uruguay
[3] Centro de Investigación y Conservación Marina (CICMAR), Canelones, Uruguay
[4] Projecto TAMAR, Fundação Pró Tamar / ICMBio, Salvador, Bahia, Brazil
[5] Joint Institute for Marine and Atmospheric Research, University of Hawaii
[6] NOAA Fisheries, Honolulu, Hawaii, USA

In the Southwestern Atlantic (SWA) off the coasts of Uruguay and Brazil, juvenile and sub-adult loggerhead sea turtles (*Caretta caretta*) are very abundant and frequently incidentally captured by pelagic longline fisheries. There is a need to improve our understanding of turtle behavior and habitat use in this region to identify high use areas and reduce fishery interactions. We used satellite telemetry to characterize the broad-scale behavioral patterns, inter-seasonal variability and general high use areas of 27 bycatch juvenile and subadult loggerheads turtles released from pelagic longline fishery between July 2006 and March 2010 (mean CCL: 61.8±6.9 cm, range: 49-83 cm). The mean turtle tracking duration was 259±159 days, during which time turtles moved between latitudes of 25 to 45°S and longitudes 35 to 54°W. Turtles traveled a mean minimum distance from release location of 6,050±3,630 km. The areas of highest use for all the tracked turtles were located over the continental shelf and slope within the Uruguayan and Brazilian EEZs, as well as oceanic international waters off the continental slope of southern Brazil. Maximum dive depth recorded varied by turtle between 100 and 300m depths, and two turtles demonstrated dives to depths close to the bottom within the 200m isobath. The overall mean SST encountered by tracked turtles was 19.8±2.3°C (range: 10.21°C-28.4°C) and turtles showed an affinity for mesotrophic/eutrophic chlorophyll a values (mean: 0.458±1.012 mg m-3). Latitudinal movements varied by season and sea surface temperature, however seasonal differences were observed with bathymetry or Chl a concentrations. We also present preliminary results from a first-passage time analysis preformed on these data to determine whether turtles exhibit distinct scales of movement, and whether those scales of movements are associated with mesoscale environmental features. Overall, in concert with other studies conducted in the region, our analyses demonstrate the need to focus further regional and international collaborative efforts on habitat use research for the management of sea turtles in this area.

MOVEMENTS AND HIGH-USE AREAS OF WESTERN PACIFIC LEATHERBACK TURTLES*

Scott R. Benson[1], Tomo Eguchi[2], Peter H. Dutton[2], David G. Foley[3], Helen Bailey[4], Creusa Hitipeuw[5], Betuel Samber[6], Ricardo Tapilatu[7], Vagi Rei[8], Peter Ramohia[9], John Pita[9], and Barbara Block[10]

[1] Protected Resources Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, c/o Moss Landing Marine Laboratories Norte, Moss Landing, CA, USA
[2] Protected Resources Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, La Jolla, CA, USA
[3] Environmental Research Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Pacific Grove, CA, USA
[4] Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, MD, USA
[5] World Wide Fund for Nature-Indonesia, Jakarta, Indonesia
[6] KSDA II Papua, Forestry Department, Sorong, Papua Barat, Indonesia
[7] Marine Laboratory, The State University of Papua (UNIPA), Manokwari, Papua Barat, Indonesia
[8] Office of Environment and Conservation, Boroko, National Capital District, Papua New Guinea
[9] The Nature Conservancy, Honiara, Solomon Islands

[10]Tuna Research and Conservation Center, Stanford University, Hopkins Marine Station, Pacific Grove, CA, USA

The western Pacific leatherback (*Dermochelys coriacea*), one of three genetically distinct stocks in the Indo-Pacific region, has declined markedly during past decades. This diverse metapopulation nests year-round at beaches of several western Pacific island nations and has been documented through genetic analysis and telemetry studies to occur in multiple regions of the Pacific, including waters of the eastern and central North Pacific, the western South Pacific, the South China Sea, and the Sea of Japan. The objective of this study is to synthesize results of 126 satellite telemetry deployments conducted on leatherbacks at western Pacific nesting beaches and at one eastern Pacific foraging ground during 2000-2007, to provide a large-scale picture of movements, high use areas, and habitat associations and to support ecosystem-based management and conservation. Nesting beach deployments were conducted in Papua New Guinea (PNG) and Solomon Islands during boreal winter (December-February), and in Papua Barat, Indonesia (PBI) during boreal summer (July-August) and winter. Deployments at distant foraging grounds off California, USA were conducted during September. A Bayesian switching state-space model (SSSM) was applied to raw Argos-acquired surface locations to estimate daily positions for each turtle. The SSSM provided a posterior distribution of behavioral mode for each daily location, from which a probability of transit (Ptransit, t) was derived to infer behavior (transiting vs. foraging). Monthly areas of high use were identified for post-nesting periods using kernel density estimation. There was a clear separation of migratory destinations for boreal summer vs. boreal winter nesters, and leatherbacks used multiple large marine ecosystems (LMEs) as foraging destinations. Individuals nesting in PBI during boreal summer moved either to the temperate North Pacific Ocean, including the Kuroshio Extension or the California Current, or to tropical waters of the South China Sea, remaining north of the equator at all times. Foraging habitats included diverse pelagic and coastal regions exhibiting a wide range of mechanisms that are known or expected to aggregate leatherback prey, including mesoscale eddies, coastal retention areas, and current boundaries. In contrast, individuals tagged at the same PBI beaches during January-February and leatherbacks tagged in PNG and the Solomon Islands moved into tropical and southern hemisphere LMEs, including the East Australia Current, the New Zealand Shelf, and tropical Indonesian seas. These regions are also characterized by mesoscale eddies, stationary fronts, or coastal retention areas. Western Pacific leatherbacks thus exploit diverse ecological processes that can aggregate gelatinous prey in different ways throughout the Pacific basin. Use of the most distant, temperate LME (California Current) required a 10-12 month trans-Pacific migration and commonly involved multiple years of migrating between high-latitude summer foraging grounds and low-latitude eastern tropical Pacific wintering areas without returning to western Pacific nesting beaches. In contrast, tropical foraging destinations in the South China Sea and Indonesian seas were reached within 5-7 months and appeared to support year-round foraging, potentially allowing a more rapid return to nesting beaches. Based on these considerations, we hypothesize that demographic differences are likely among nesting females using different LMEs.

HOME RANGE AND FORAGING ECOLOGY OF JUVENILE HAWKSBILL SEA TURTLES AROUND ROATÁN, HONDURAS

Melissa D. Berube[1,2], Stephen G. Dunbar[1,2,3], Klaus Rützler[4], and William K. Hayes[1]

[1] Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, CA 92350
[2] Turtle Awareness and Protection Studies (TAPS), Reef House Resort, Roatán, Honduras
[3] Protective Turtle Ecology Center for Training, Outreach and Research, Inc. (ProTECTOR)
[4] Smithsonian Institution, National Museum of Natural History

The hawksbill (*Eretmochelys imbricata*) is one of seven species of sea turtle. It is listed as critically endangered and has suffered population declines of 80 % worldwide, and 95 % in the Caribbean. Understanding habitat use, migration routes, and foraging ecology are important for conservation efforts and implementing management strategies. The objectives of this study were to determine the home range of juvenile hawksbills, the abundance of available dietary items in resident juvenile versus non-resident sites, and the diet of juvenile hawksbills on inshore reefs in Honduras. This study was initiated to determine if there is a link between home range size, food availability, and diet for juvenile hawksbills in Honduras. We found that the home range of juvenile hawksbills in the study area is small. Minimum convex polygon for all juvenile hawksbill re-sightings was less than 1 km2, and the core area of activity for all re-sightings combined was less than 6 km2. The abundance of dietary items, *Pseudopterogorgia elisabethae*,

Pseudoptergoria sp. and *Spirastrella coccinea*, differed significantly between resident and non-resident juvenile sites. The results of compositional analysis to assess the difference between the availability of prey items in the turtle-occupied habitat, and those consumed by the juvenile hawksbills, differed significantly using parametric testing, but did not differ significantly using randomization. Prey abundances ranked *Chondrilla caribensis* > *Geodia Gibberosa* > other species. Discriminate function analysis showed that the chosen predictors were able to differentiate between non-resident and resident sites and correctly classified non-resident sites 76.2 % of the time and resident sites 92.6 % of the time. The diet of juvenile hawksbills was mostly comprised of sponges, but also included small amounts of other organisms. We report the presence of the sponge, *Melophlus ruber*, in hawksbill diets for the first time. These findings indicate that juvenile hawksbills in the area of Roatán, Honduras are primarily, but not indiscriminately, spongivores. We suggest that the small home range size established by these juvenile hawksbills is likely the result of a large abundance of high quality prey items available in their foraging habitat, although further studies are warranted.

POST-NESTING MOVEMENTS AND HIGH USE INTERNESTING AREAS FOR EAST PACIFIC GREEN TURTLES NESTING IN COSTA RICA

Gabriela S. Blanco[1], Stephen J. Morreale[2], Jeffrey A. Seminoff[3], Rotney Piedra[4], Frank V. Paladino[5], and James R. Spotila[1]

[1] Department of Biology, Drexel University, Philadelphia 19104 USA
[2] Department of Natural Resources, Cornell University, Ithaca, New York 14853 USA
[3] NOAA- National Marine Fisheries Service, Southwest Fisheries Science Center, 3333 N. Torrey Pines Ct., La Jolla, California 92037 USA
[4] Parque Nacional Marino Las Baulas, Ministerio de Ambiente, Energía y Telecomunicaciones Apartado 10104-1000, San José, Costa Rica
[5] Department of Biology, Indiana-Purdue University, Fort Wayne, Indiana 46805-1499 USA

We attached hydrodynamic satellite transmitters by tether to 13 East Pacific green turtles (*Chelonia mydas*) during their internesting and to 10 green turtles after their last nesting event. The goal of this study was to identify high use internesting areas and migration routes of green turtles nesting on Nombre de Jesús and Zapotillal in the Pacific Coast of Costa Rica, and to determine areas in need of protection. During internesting a fixed Kernel density analysis showed that high use areas were particularly close to the nesting beaches; utilization distribution polygons of 50% and 95% included 4.5 km^2 and 53.9 km^2, respectively. The post nesting migrations were characterized by coastal movements ranging from 5-1091 km. Two turtles were local residents in the Gulf of Papagayo in Costa Rica; four moved an intermediate distance to the South of Nicaragua, one turtle moved to Panama, two moved to the area near the Gulf of Fonseca in Nicaragua and Honduras and one moved to El Salvador. The high concentration of nesting turtles and the lack of long-distance movements during the internesting period underscores the extensive use of the vicinities of the nesting beach by resting turtles. The restricted range of movements during internesting indicates that the waters off Nombre de Jesús are of great importance for East Pacific green turtles, and likely a crucial location for conservation of this population. Our study also suggests that some green turtles nesting in Nombre de Jesus and Zapotillal may spend all their life as adults along the coast of Central America. Those beaches are of great importance because they help to sustain the East Pacific green turtle population in Central America. Also, there is a resident subpopulation, where nesting occurs on Nombre de Jesús and foraging occurs in the Gulf of Papagayo, those being only 5 km apart, emphasizing the importance of Costa Rica for the conservation of this population. The coastal nature of their movements makes them vulnerable to human activities. The fact that the turtles are swimming through different countries makes management more complex and call for conservation agreements between nations.

FORAGING IN PERIPHERAL HABITATS: ATLANTIC HAWKSBILLS IN SEAGRASS PASTURES*

Alan B. Bolten and Karen A. Bjorndal

Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, Gainesville, FL 32611 USA

Anthropogenic effects on habitats can affect the distribution of organisms and result in higher proportions of populations inhabiting formerly peripheral or sub-optimal habitats. Therefore, conservation efforts should not necessarily be limited to core or optimal habitats. Survival outlook of populations of endangered species may in fact be better in peripheral or sub-optimal habitats as a result of anthropogenic factors in core habitats. Understanding the ecology and demography of populations in these peripheral habitats is critical for appropriate conservation and management of both habitats and species. Hawksbills are closely associated with coral reef and other hard-bottom habitats in the Caribbean; seagrass pastures are peripheral habitats. With the decline in quality and quantity of coral reefs, seagrass habitats may become more important for hawksbills. We use data from a 30-year mark-recapture study of hawksbills in the southern Bahamas to assess the quality of a seagrass habitat for hawksbills. Size distribution, residence times, and body condition index for the seagrass hawksbill aggregation are similar to those of hawksbill aggregations over Caribbean reefs. Somatic growth rates of seagrass hawksbills are in the upper range of those reported for reef hawksbills. Based on these parameters, peripheral seagrass habitats can support healthy, productive hawksbill aggregations.

CONSERVATION OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) IN THE SHALLOW WATERS OF AEOLIAN ARCHIPELAGO (SICILY, ITALY)

Valeria Casciello[1], Miriam Paraboschi[1], Gianluca Benzi[1], Gianni Insacco[2], and Monica F. Blasi[3]

[1] Filicudi WildLife Conservation, Stimpagnato, Filicudi (ME), Italy
[2] Centro Regionale Recupero Fauna Selvatica e Tartarughe Marine, Comiso (RG), Italy
[3] Filicudi WildLife Conservation, Stimpagnato, Filicudi (ME), Italy - Soc. Coop. Monitoring Natural Resources, Via Tiberina 149, Rome, Italy

Few studies have assessed fine-scale distribution of the loggerhead sea turtle (*Caretta caretta*) in the Mediterranean Sea. As part of its complex biological cycle, this species selects different habitat types at different periods in its life cycle. Starting in 2007, a conservation project was implemented in the shallow waters around Filicudi Island (Aeolian Archipelago) in the north west of Sicily (Italy). Dedicated boat-surveys and visual sampling were conducted in summer periods in the study area (200 Km2). The curved carapace length (CCL) and standard dimensions of rescued individuals were measured. Information on kind and percentages of threats on rescued individuals were also obtained from the database of the rescue center of Comiso (Sicily, Italy). We used a kernel distribution analysis (50% and 95% probability) to determine the distribution of sighted individuals, and we used the MCP method to compare the dimensions of observed feeding areas with the dimensions of other known Mediterranean feeding areas. All analyses were completed using ArcGIS 9.2. In addition, we investigated the space structure of the environment used the turtles through multiple regression analysis. The study area was divided into a grid of 200 cells, each cell = 1Km2, for which both encounter rate and habitat covariates were calculated. Most sighted individuals were sub-adults and were distributed in the shallow waters located along the northwest shore of the island. This area has optimal physiographical conditions and it could be a feeding ground, underlying its importance in the conservation of the species. Fishing activities are also massive in this area. During the study period, the majority of rescued individuals were found with injuries associated with interactions with long-lines. Marine traffic can also produce injuries to individuals near the sea surface and in the northwest shore of the island, there is a greater risk of direct impact with ferries that pass through this zone. In addition, increased pollution and the presence of plastic debris during the summer period may pose a threat to turtles. We are planning to use these data for the future development of the Marine Protected Area of the Aeolian Archipelago. A conservation program focused on this species would help decrease rates of injuries and mortality.

STOMACH TEMPERATURE TELEMETRY INDICATES LEATHERBACK SEA TURTLES MAINTAIN ELEVATED, STABLE BODY TEMPERATURES AT HIGH LATITUDE FORAGING GROUNDS*

James Casey[1], Mike James[2], and Amanda Southwood Williard[1]

[1] University of North Carolina at Wilmington, Wilmington, North Carolina, USA
[2] Dalhousie University, Halifax, Nova Scotia, CAN

The leatherback sea turtle (*Dermochelys coriacea*) frequents high latitude (>45ºN) waters between late summer and early winter. Previous studies have demonstrated that leatherbacks migrate to these waters to take advantage of a seasonal abundance of prey, but the thermal adjustments associated with exploitation of cold water habitats are not well understood. We provide the first real-time recordings of body temperatures for free-swimming adult leatherbacks (N=7) resident in the Gulf of St. Lawrence (southern boundary: E of 55º43' W, N of 45º57' N) between 20 Aug. 2009 and 13 Oct. 2009. Turtles (female, N=4; male, N=3) were captured offshore Nova Scotia, Canada using a break-away hoop-net from a research vessel. Captured turtles were brought onboard the research vessel to be weighed, measured, tagged with a satellite-linked transmitter (model Mk10-AL, Wildlife Computers), and fed a stomach temperature pill (model STP3, Wildlife Computers). Following instrument deployments, turtles were released at the site of capture and tracked using the Argos satellite system. Body temperature (Tb) data were acoustically transmitted from the stomach temperature pill to the externally-mounted satellite-linked transmitter at 2-min. intervals (resolution: 0.1ºC). The satellite-linked transmitter then relayed the Tb data, along with information on location and dive patterns, to the Argos system. Doppler derived Argos satellite locations for turtles were compared to sea surface temperature (SST) measured by instruments onboard NOAA's Polar Operational Environmental Satellites (POES) to assess thermal gradients between leatherbacks and their temperate habitat. Leatherback Tb data were successfully obtained for a period ranging from 9-57 days. A total of 5,059 to 25,233 Tb records were obtained while turtles were resident in the Gulf of St. Lawrence. The mean (±1S.D.) daily Tb for all turtles combined was 26.2±0.6ºC (range: 25.7º±1.3º to 27.3º±0.5ºC) and was significantly higher than the mean daily SST experienced by turtles (16.7±1.2ºC; range: 15.6º±1.8º to 19.0º±1.5ºC; Wilcoxon test, Z = 2.28, P = 0.02). The mean daily temperature gradient between turtle Tb and SST was 9.8±1.2ºC for all turtles combined (range: 7.4º-11.8ºC). Comparisons between turtle Tb and SST confirm that leatherbacks maintain elevated, stable body temperatures at high latitude foraging grounds. Interestingly, leatherbacks displayed a pattern of gradual cooling of Tb during the daytime (08:00 to 17:59 h) and warming of Tb during the nighttime (21:00-04:59 h). Because the stomach temperature telemeters were recording temperatures in the gastrointestinal tract, these data suggest that leatherbacks may be ingesting cold prey primarily during the daytime while resident at high latitude. Their ability to increase core temperatures during the nighttime suggests that metabolic heat production or behavioral modifications other than basking may contribute to thermoregulation in cold water habitats.

COMPARATIVE STUDY OF SEA TURTLE POPULATION IN TWO ESTUARIES IN BAHIA MAGDALENA, BCS, MEXICO

Alfonso Antonio Romero Castro and Gustavo Hinojosa Arango

The School for Field Studies. Pto San Carlos, BCS, Mexico

All species of sea turtles are listed either as endangered or critically endangered by the IUCN. In Mexico, commercial extraction between 1950 and 1980 resulted in a considerable decrease of sea turtle populations. A complete ban on sea turtle consumption by 1990 aimed to prevent further deplete of their numbers. Illegal fishery and bycatch still a significant treat to these organisms in coastal communities such as those within Bahia Magdalena. This study compares results from sea turtle monitoring at two heavily used estuaries in the bay. Different efforts have been carried out to understand sea turtle distribution within the bay and their abundance to understand the importance of these areas as nurseries and feeding grounds for sea turtles. Our findings show high site fidelity at the medium geographical scale, with turtles never been observed to change or visit other estuaries in the bay. These findigs have high importance to conservation efforts when evaluating the different tools for management and protection.

SATELLITE TRACKING CONFIRMS THE USE OF STABLE ISOTOPES TO INFER FORAGING GROUNDS OF LOGGERHEAD TURTLES (*CARETTA CARETTA*) NESTING ON FLORIDA'S EAST COAST*

Simona A. Ceriani[1], James D. Roth[2], Daniel Evans[3], and Llewellyn M. Ehrhart[1]

[1] University of Central Florida, Orlando, Florida USA
[2] University of Manitoba, Winnipeg, Canada
[3] Sea Turtle Conservancy, Gainesville, Florida, USA

Loggerhead nest numbers in Florida, home to 90% of loggerhead nesting in the southeastern U.S., have been declining since 1998 for unknown reasons. One hypothesis proposed for this decline is a change in foraging that could lead ultimately to a change in reproductive parameters. We explored the link between foraging ecology and reproduction to gain more information on adult foraging behavior and locations of key foraging grounds, which is essential for the development of appropriate management strategies. We also investigated the effectiveness of stable isotopes to trace foraging ecology and migratory routes. Loggerheads (n=13) nesting at the Archie Carr National Wildlife Refuge were fitted with satellite tags, and tissue samples were collected for carbon and nitrogen stable isotope analysis. Telemetry identified three major migratory pathways and associated foraging grounds: (1) a seasonal shelf-constrained North-South migratory pattern between Virginia and North Carolina, (2) a year-round residency in southern foraging grounds and (3) a residency in the waters adjacent to the breeding area. Half of the individuals we tracked moved north, demonstrating for the first time that the mid-Atlantic coast of the United States represents an extremely important foraging ground for the Peninsular Florida Recovery Unit. Both δ13C and δ15N signatures differed among groups associated with foraging areas. Post-hoc analysis revealed that each migratory group differed in δ13C, while δ15N differed only in loggerheads of southern foraging grounds. No tracked females left the continental shelf, suggesting that isotopic differences among females may not be attributed to a neritic/oceanic strategy. On the contrary, we found a North-South latitudinal gradient in δ13C isotopic values, with northern individuals being the most 13C depleted and southern samples the most 13C enriched. This suggests that a latitudinal gradient may play a relevant role in explaining differences in isotopic signatures among females nesting at the Carr Refuge. We also investigated the relationship between fitness parameters and foraging strategies. Females using northern and southern foraging grounds were larger than individuals residing in proximity to the breeding ground, but northern and southern groups did not differ from one another. We found no differences in clutch size among groups after correction for body length. For seven of the 13 females with tagging history, no differences in remigration interval were found among migratory groups. Stable isotopes hold great promise when used as intrinsic markers to trace foraging habits and migratory connections, but several assumptions still need to be tested to interpret isotopic patterns found in the marine realm. Our results suggest that stable isotope analysis can be used to infer foraging strategies and residence areas for loggerheads nesting on Florida's east coast in lieu of more expensive satellite telemetry. We suggest using stable isotopes to assign turtles to foraging regions, allowing population-level estimates of reproductive parameters among foraging areas.

NEW PACIFIC GREEN TURTLE FORAGING GROUND AT DULCE GULF, SOUTH PACIFIC COAST OF COSTA RICA

Didiher Chacon[1], David Rojas[2], Adi Barash[2], and Claudio Quesada[3]

[1] WIDECAST Latin American Program Coordinator
[2] WIDECAST Osa Program
[3] WIDECAST Costa Rica Caribbean Projects

During the second half of 2010, we conducted 30 in-water surveys in the Dulce Gulf in the Osa region of Costa Rica (8º 38.4351 N, 083º 22.1342 W) in order to provide information about the use of foraging ecosystem and abundance of the specie in the area. We deployed 250 m long sea turtle entanglement nets at different locations inside of the Gulf. All captured turtles captured tagged and their biometrics were recorded, also we collected tissue samples for DNA studies. A total of 54 green turtles were collected during 105 hours of effort, resulting in a CPUE of 0.5143 turtles/hour. The

mean size of captured turtles 79.28 cm CCL (range = 53.5-91.8 cm). There were only two recaptures during the project period. Only adult females and subadults were observed. The highest rate of capture was associated with tidal period, likely associated with movements into or away from the foraging ground; we found no evidence of seasonal changes in abundance. A satellite tag was deployed on adult female, to monitor her foraging movements inside the Dulce Gulf. An evaluation of the foraging areas revealed large aggregations of *Gracilaria* sp. on rock button in combination with sand, mud, and sponge areas, particularly along mangrove coastline (*Rhizophora mangle*) and river mouths. The most important threats observed were sedimentation from rivers, plastic litter, incidental interactions with fishing gear, and presumably pesticides due to runoff from agriculture activities as oil palm plantations, cattle raising and rice plantations.

HAWAIIAN GREEN TURTLES UP AND DOWN THE ANAHULU RIVER

David L. Clarke[1], George Balazs[2], and Stacy Hargrove[2]

[1] Iolani High School, 563 Kamoku St. 96826 Honolulu Hawaii. USA
[2] Pacific Islands Fisheries Science Center, NOAA Fisheries, 2570 Dole Street, Honolulu, Hawaii USA

Green turtles (*Chelonia mydas*) have become very numerous and popular in Hawaii. Tourists flock to see them on the North Shore of Oahu most notably at Laniakea Beach causing traffic congestion and safety concerns. Here we provide preliminary information on what may be some of the densest concentrations of green turtles in the Hawaiian Archipelago outside of seasonal nesting at French Frigate Shoals. Green turtle movements were monitored by visual counts at the Anahulu River mouth at Haleiwa for a total of 9 evening and 2 morning observation sessions during the months of September and October 2008- a period of almost no surf or rainfall on Oahu's North Shore. During 22 hours of observation 968 green turtle sightings were made moving either upstream or downstream. 122 (12.6%) were recorded as being juveniles.

REPRODUCTIVE MIGRATIONS AND LOCAL MOVEMENTS OF BLACK TURTLES (*CHELONIA MYDAS*): TELEMETRY AND FLIPPER TAGGING OFFER NOVEL INSIGHTS FOR CONSERVATION PLANNING

Catherine E. Hart[1], Gabriela S. Blanco[2], Michael S. Coyne[1], Carlos Delgado[3], Brendan J. Godley[1], T. Todd Jones[4], Antonio Resendiz[5], Jeffrey A. Seminoff[6], Matthew J. Witt[1], and Wallace J. Nichols[7]

[1] Centre for Ecology and Conservation, The University of Exeter, Cornwall Campus, Penryn, Cornwall, UK
[2] Biology Department, Drexel University, Philadelphia, Pennsylvania, USA
[3] Instituto de Investigaciones sobre los Recursos Naturales, Universidad Michoacana, Morelia, Michoacán, México
[4] NOAA, Joint Institute for Marine and Atmospheric Research, Pacific Islands Fisheries Science Center, Honolulu, Hawaii, US
[5] Instituto Nacional de Ecología, Dirección General de Vida Silvestre, Secretaria de Medio Ambiente y Recursos Naturales, Ensenada, Baja California, México
[6] NOAA – National Marine Fisheries Service, Southwest Fisheries Science Center, Torrey Pines Ct, La Jolla, California, US
[7] California Academy of Sciences, Golden Gate Park, San Francisco, California USA

The status of many marine vertebrates implores an increased understanding of the factors determining population distribution and coincident threats. Here we combine published data from traditional flipper tagging and early satellite tracking studies with additional satellite tracking data (n=12) to further describe patterns of movement of black turtles (*Chelonia mydas*) to and from nesting rookeries in Michoacán, Mexico and within foraging grounds in northwestern Mexico. We tracked three turtles on their homing migrations (1337-2928km) from foraging grounds in the Gulf of

California, along the east coast of the Baja California peninsula to the breeding grounds of Michoacán, and three post-nesting females from Colola beach, Michoacán to foraging grounds in Southern Mexico and Central America (941.3-3020km). A further six turtles were tracked within their Gulf of California foraging grounds giving preliminary insights into the scale of ranging behaviour. Turtles undertaking long-distance migrations showed a tendency to follow the coastline. Deployment duration within the foraging grounds were of limited duration (9-53 days) but were sufficient to show that foraging individuals typically ranged upto 691.6km (maxima) from release site location. We combine all data to create best available distributional patterns and contextualise these movements with a range of data layers that offer insights into potential threats faced. We suggest that this integrated approach is useful for developing more appropriately focused conservation efforts, especially as further spatially explicit threat layers become available. CEH wishes to thank the International Sea Turtle Symposium, International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service for providing a travel grant to attend the Symposium. CEH receives a student scholarship from the Consejo Nacional de Ciencia y Tecnologia (Conacyt).

VERTICAL HABITAT UTILIZATION OF IMMATURE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN U.S. MID-ATLANTIC SHELF WATERS*

Heather L. Haas[1], Ron Smolowitz[2], Matthew Weeks[2], Henry Milliken[1], and Eric Matzen[3]

[1] National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA, USA
[2] Coonamessett Farm Foundation, East Falmouth, MA, USA
[3] Integrated Statistics, Woods Hole, MA, USA

The United States (U.S.) Mid-Atlantic region is an important foraging ground for loggerhead sea turtles, but due to complications involved with locating and capturing these immature turtles on their foraging grounds, we know relatively little about the large, immature turtles that occupy the offshore Mid-Atlantic region. For this study, we used a 95' commercial fishing vessel rigged with crow's nest (rising 60' above the waterline) to locate immature loggerheads in an area known to have overlap between immature loggerheads and commercial fishing activity (roughly 50-100 miles offshore of Delaware and New Jersey). We then deployed a small boat (14') to capture turtles using a large dipnet. From 2009-2010, we captured and satellite-tagged 16 immature loggerhead sea turtles (61 - 97 cm CCL). We attached Sea Mammal Research Unit's (SMRU) Fastloc GPS Satellite Relay Data Loggers (SRDLs) to the second central carapace scute. The shortest transmission period was slightly longer than a month, and the longest was longer than a year. Most tags are still actively transmitting. For the present analysis, we focus on examining the vertical habitat utilization of the tagged immature loggerheads while they inhabited U.S. Mid-Atlantic shelf waters. Understanding vertical habitat utilization can improve density estimates from aerial or shipboard surveys by estimating the proportion of turtles available to be seen by observers. Here we present the average proportion of time that tagged turtles occupied the top 2 meters of the water column during typical aerial survey effort (8am to 8pm). Understanding vertical habitat utilization can also help design and evaluate bycatch reduction devices. For example, in the scallop dredge fishery, there is one gear modification (turtle chain mat) that is expected to reduce turtle injuries associated with water column interactions and a different gear modification (turtle excluder dredge) that is expected to reduce turtle injuries associated with benthic interactions. Here we present the average proportion of time that tagged turtles occupied bottom (or near-bottom) habitats while in areas that overlap with substantial commercial fishing effort. This project was funded through the multi-agency Atlantic Marine Assessment Program for Protected Species (AMAPPS) and the sea scallop industry through their research set aside program.

USE OF SOUTH FLORIDA'S PROTECTED AREAS AND THE GREATER CARIBBEAN BY THREATENED AND ENDANGERED MARINE TURTLES TAGGED IN THE DRY TORTUGAS

Kristen M. Hart[1] and Ikuko Fujisaki[2]

[1] U.S. Geological Survey, Southeast Ecological Science Center, Davie, FL, USA
[2] University of Florida, Ft. Lauderdale Research and Education Center, Davie, FL, USA

Establishment of marine protected areas (MPAs) is one tool for protecting both natural and cultural resources from significant pressure by human activity. In the Dry Tortugas National Park (DRTO) located 112 km west of Key West in the Florida Keys, a Research Natural Area (RNA) was designated in January 2007 to set aside ~74 km2 of the Park as a no-take preserve to restore ecological integrity by minimizing human influences. DRTO harbors several key benthic habitats that are important for federally protected marine turtles, including threatened loggerheads (*Caretta caretta*), endangered hawksbills (*Eretmochelys imbricata*), and endangered green turtles (*Chelonia mydas*). In addition, the sandy beaches of DRTO provide suitable nesting habitat for all three species. To address whether and to what extent the no-take area of the RNA is used by marine turtles, we initiated a study in 2008 to 1) characterize the size classes of each species present in the park; 2) quantify the amount of time tagged individuals of all three species spend within various zones of DRTO and within the larger network of MPAs that comprise the Florida Keys National Marine Sanctuary (FKNMS); and 3) determine regional linkages to other foraging sites and nesting beaches. Methods of turtle capture include intercepting reproductive females on one of two major nesting beaches and capturing additional turtles of various sizes and both genders using in-water capture techniques (i.e., rodeo, dip nets). Tracking methods include satellite and acoustic telemetry to determine movements of individuals over time and space. To date, satellite-tracking of reproductive loggerhead females revealed that the inter-nesting habitat used by loggerheads in all years was outside the RNA, but still within the park boundary. Additionally, these female loggerheads departed DRTO after approximately 2.5 to 3 months of residence and migrated to locations off the southwest coast of mainland Florida, the Bahamas, and just north of the Yucatan Peninsula in Mexico. Satellite-tracking of hawksbills since August 2008 revealed that all three turtles were resident in the park until May 2009 and June 2010, when two turtles departed DRTO waters and migrated to Cuba; the other hawksbill was resident in DRTO until the summer of 2010. Finally, satellite-tracking of subadult and adult green turtles captured in the water revealed residence within the park, in an area of lush, relatively shallow-water seagrass that is outside the RNA; this very same area was used intensively during inter-nesting by satellite-tagged green turtles intercepted on the beach. These data represent the first satellite-tracking data for turtles at DRTO, and results show a new understanding of regional connectivity of marine turtles and their habitats. Such data will contribute to determining the effectiveness of the RNA and the FKNMS for protecting threatened and endangered marine turtles and their requisite habitats, and the development of more effective decision-support tools to adaptively manage coral ecosystems and MPAs in South Florida.

FORAGING ECOLOGY OF LEATHERBACK TURTLES OFF CALIFORNIA BASED ON VIDEO AND ARCHIVAL TAGS*

Jim Harvey[1], Scott Benson[2], and Bill Watson[1]

[1] Moss Landing Marine Labs
[2] National Marine Fisheries Service

A portion of Pacific leatherback turtles (*Dermochelys coriacea*) nesting in the western tropical Pacific forage in the California Current system during the boreal autumn. With minimal disturbance we attached time-depth-recorders and videocameras on the carapace of Leatherback turtles using suction cups These devices were used to characterize foraging behavior, including detailed dive profiles and quantitative data on prey selection and consumption rates. Deployments indicated that leatherbacks performed shallow dives (10-20 meters) into or through the thermocline, consuming jellyfish aggregated above the thermocline during their slow ascent back to the surface. Video data from four deployments revealed that leatherbacks targeted the jellyfish species with the greatest carbon content (*C. fuscescens*), selected only the most carbon-rich portions of each prey animal, and consumed multiple jellyfish per dive.

Potential variation in the use of distant foraging areas with diverse prey species may have important implications for leatherback growth and reproduction.

GIANT TURTLES PURSUE GIANT JELLIES: EVIDENCE FROM ANIMAL-BORNE CAMERAS IN CANADIAN WATERS*

Susan G. Heaslip[1], W. Don Bowen[2], and Michael C. James[1]

[1] Dalhousie University, Halifax, Nova Scotia, Canada
[2] Bedford Institute of Oceanography, Department of Fisheries and Oceans, Dartmouth, Nova Scotia, Canada

Understanding the foraging behavior of marine turtles has been hindered by a lack of knowledge about how prey are encountered and captured. Previous studies of the foraging behavior of leatherback turtles (*Dermochelys coriacea*) have inferred foraging from diving behavior and dive-shape. Animal borne-cameras provide direct estimates of prey encountered and other components of predation. Given the difficultly in recovering such data-logging units, most studies have been conducted during the breeding season when turtles may not be foraging. We used concurrently collected dive data and video from animal-borne cameras to describe the foraging behavior and prey encountered by free-ranging turtles in temperate waters. At this time of year, turtles are building up the energy reserves required for reproduction. Video, time-depth, and location data were collected using a camera system with integrated time-depth recorder, radio-receiver, and time-release deployed on 15 leatherback turtles near Cape Breton, Nova Scotia, Canada. Video was recorded continuously during daylight hours and averaged 1 hour and 20 minutes per turtle (range 0:08 – 3:09 h) in duration. A total of 402 prey captures were recorded from 12 turtles (both male and female). Lion's mane jellyfish (*Cyanea capillata*) was the dominant prey identified, and all prey attacked were mostly eaten. Results from linear mixed-effects models showed that turtles increased foraging time with increasing number of prey encounters ($pp>0.1$ and $p>0.05$. Prey handling time increased linearly with prey size ($p<0.001$). Our study demonstrates the feasibility of using animal-borne cameras to study feeding behavior of leatherback turtles during the non-breeding season.

SATELLITE TRACKING REVEALS: LOGGERHEAD TURTLES NESTING IN LIBYA PREFER TO FEED ON THE TUNISIAN PLATEAU

Sandra Hochscheid[1], Al Mokhtar Saied[2], Atef Ouerghi[3], Salih Mohamed H. Dryag[2], and Flegra Bentivegna[1]

[1] Stazione Zoologica Anton Dohrn, Napoli, Italy
[2] Environment General Authority (EGA) - Marine Conservation section, 13793 Tripoli, Libya
[3] Regional Activity Center for Specially Protected Areas, Tunis, Tunisia

With 1,770 km, Libya's coastline is the longest of any African country bordering the Mediterranean and from recently initiated surveys it appears that Libya may host one of the biggest loggerhead turtle nesting colonies in the region. The adjacent waters are important foraging and overwintering grounds for both green and loggerhead turtles that migrate there after nesting farther to the east. We aimed at elucidating whether the local loggerhead turtles use the Libyan habitats as well or whether they migrate to distant foraging grounds elsewhere. In the summers of 2009 and 2010 five females (A – E) were equipped with ARGOS satellite transmitters after they finished nesting on beaches in the Gulf of Sirte. The females left their nesting area between 6 July and 2 August and moved in a westward direction along parallel routes either close to the coast ($n = 3$) or slightly offshore (50 km). They took between 11 and 19 days to arrive at the foraging grounds, travelling between 310 and 641 km at an average rate of 36 km/d. The foraging grounds were located on the Tunisian shelf and in the Gulf of Gabés area, and up to the Libyan-Tunisian boarder. For turtles B and D transmissions ceased as soon as they arrived at their apparent destination. This may be attributable to the turtles' death, although other unknown reasons may have caused the transmission failure. The other turtles remained in areas with a maximum radius of 18 km and ranging in seafloor depths mostly between 10 and 50 m and up to 100 m for turtle A.

This foraging ground preferred by the Libyan turtles is also frequented by loggerhead turtles nesting in Greece, Israel, Northern Cyprus, Tunisia and Turkey. The occurrence of turtles from various rookeries throughout the Mediterranean not only highlights the importance of the Tunisian plateau as a foraging ground, but also calls for urgent conservation measures to reduce the demonstrated high mortality in fishery's bycatch. Our results indicated the location of potential key zones for fisheries regulations, where more than one turtle stayed within a small area.

POST-NESTING MIGRATION AND INTER-NESTING MOVEMENTS OF FOUR LOGGERHEAD TURTLES *CARETTA CARETTA* NESTING IN IONIAN CALABRIA (SOUTHERN ITALY)

Barbara Host[1], Salvatore Urso[2], Laura Sena[1], Resi Mencacci[1], Paolo Luschi[1], and Antonio T. Mingozzi[2]

[1] Department of Biology, University of Pisa, Italy
[2] Department of Ecology, Calabria University, Rende, Italy

The Southern coast of Ionian Calabria (Southern Italy) was recently recognized as the most important nesting ground for the loggerhead turtle (*Caretta caretta*) in Italy, accounting for about 70% of the total nesting events documented nationwide. However, no information is at present available on the migratory behaviour of this population, including the location of their feeding grounds. Furthermore, beach patrolling activity only covers a portion of the potential nesting area, and this may lead to an underestimation of the number of nests laid along the entire coastline. To fill these gaps, satellite tracking was used to reconstruct the internesting movements and the postnesting migratory routes of Calabrian nesting turtles and to identify their feeding grounds. The experiments, which constitute the first attempt done on females nesting in Italy, were conducted in 2009 and 2010 through the monitoring of four females. The two turtles marked in 2009 (Zeffiria and Esperia) were monitored only during the postnesting migration, while the two turtles marked in 2010 (Lacinia and Kalabria) were also followed during their last inter-nesting period. This made it possible to localize the last nest of the season of these two individuals, which were laid 4.25 km (Lacinia) and 0.60 km (Kalabria) away from the previous one. During the internesting period, both turtles did not remain in the waters close to the nesting beaches but engaged long-distance movements in the oceanic areas south of the nesting beaches (maximum distance attained: Lacinia 100 km; Kalabria 160 km), successively returning to the nesting area with a looping route. Three of the four turtles migrated towards the continental shelf along the coast of Tunisia, where the two 2010 turtles were located for several months while residing in a spatially-limited foraging area in the neritic environment. For the other turtle (Esperia), anomalous diving-data indicating no submergences was received for a few days after its arrival in the waters around Djerba, Tunisia, and this led to the hypothesis that it could have been captured by local fishermen. The second 2009 turtle (Zeffiria) remained throughout the tracking period in a relatively ample oceanic area offshore South-eastern Sicily, likely following an oceanic foraging strategy.

EVIDENCE OF MULTIPLE ONTOGENTIC SHIFTS OF GREEN TURTLES ALONG THE LOWER TEXAS COAST*

Lyndsey N. Howell[1], Kimberly J. Reich[1], Donna J. Shaver[2], and André M. Landry[1]

[1] Sea Turtle and Fisheries Ecology Research Laboratory, Texas A&M University, Galveston, Texas, USA
[2] Division of Sea Turtle Science and Recovery, National Park Service, Padre Island National Seashore, Texas, USA

The lower Texas coast provides essential developmental habitat for a growing population of juvenile green turtles (*Chelonia mydas*). Historical mark-recapture data and anecdotal observations indicate post-pelagic cohorts initially recruit to jetty structures and channel entrances where they reside for an undetermined period prior to recruiting to inshore habitats of the lower Laguna Madre and adjacent bays (hereafter referred to as LLM). This binary ontogenetic shift in habitat is hypothesized to occur with a subsequent change in diet: from omnivory in the pelagic stage to a diet of primarily algae at the jetties, with a subsequent shift to sea grasses as juvenile greens migrate into the inshore

ecosystems. Sea turtle scute is a continuously growing tissue which retains a record of diet and habitat use. Analysis of δ13C and δ15N signatures in successive layers of scute from post-pelagic and juvenile green turtles provides a chronological record of important transitional stages. Scute samples were collected from 115 post-pelagic and juvenile green turtles (15.5 to 69.6 cm [SCL max]) that stranded in Texas' LLM (n=41), jetty passes into coastal bay systems, and on adjacent Gulf of Mexico beachfronts (n=74) from 2007 to 2009. Sample collection was restricted to fresh dead turtles without evidence of disease or long term illness that would affect foraging behavior. Dietary analysis of the upper gastrointestinal tract was completed for each turtle from which scute samples were analyzed. Integration of stable isotope and gut content analyses confirmed the anecdotal observations and hypotheses that post-pelagic green turtles recruiting to the lower Texas coast occupy jetty habitats prior to transitioning to the LLM. "Jetty turtles" ranging from ~ 18 to ~ 35 cm SCL forage primarily on algae in the passes. Upon reaching ~ 35 cm SCL, turtles make a rapid shift in habitat and diet, moving from the jetties into the LLM where their algal diet changes to one of sea grasses. Understanding the dynamics of green turtle diet and habitat use throughout lower Texas coastal waters is imperative to ongoing efforts to conserve and manage habitats critical to this species' recovery.

ANALYSIS OF DIGESTIVE SYSTEM CONTENTS FROM STRANDED SPECIMEN OF LOGGER HEAD TURTLE IN KANTO AREA

Shun Hukasawa, Ai Sakabe, and Eriko Tanaka

Tokyo University of Marine Science and Technology, Tokyo, Japan

Tokyo University of Marine Science and Technology (TUMSAT) Sea Turtle Research Collegium (SRC) has been collecting and analyzing digestive system contents from stranded Logger Head sea turtle from year 2003 up until now. Our research could not have been done with out the full cooperation of NPO Association, Everlasting Nature(ELNA). From the samples collected, we especially focused on human artifacts, shells, ascidians, fishes, algaes, and crustaceans. First, by analyzing those contents, we assumed that human artifacts doesn't necessarily lead to loggerhead turtles' death and from that aspect, we have discussed about what contents can give us a clue about causes of loggerhead's stranding in Kanto area. We would like to present here our analysis of digestive system contents from point of view of by emergence rate, by months, and by epigone of Kuroshio Current. From the samples collected, we have come to the conclusion that the top six of most appeared articles of digestive system contents were found in about the same amount when looked at from yearly basis. Also from analyzing the animals found in the digestive system, we assume that loggerheads can dive down to at least 200 meters deep to about 1000 meters to forage. To add to that, from the analysis of Kuroshio current, we assume that stranded body of loggerheads in the Kanto Area's coast, can be assumed to have came near the coast by the effect of Kuroshio current and it's epigones, have fed near the coast, and have died near the coast. Our final goal in future, is to hypothesize the reason why Logger Head Turtle strand on beaches on Kanto Area by analyzing those contents.

SEA TURTLE DIET IN OCEANIC ENVIRONMENTS OFF PERU: STABLE ISOTOPE MIXING MODELS RESULTS FOR GREEN, LOGGERHEAD AND OLIVE RIDLEY SEA TURTLES*

Shaleyla Kelez[1,2], Jeffrey A. Seminoff[3], and Larry B. Crowder[1]

[1] Duke University Marine Lab, Beaufort, North Carolina, USA
[2] ecOceanica, Lima, Peru
[3] Southwest Fisheries Science Center, La Jolla, California, USA

The foraging ecology of sea turtles in the open ocean remains a poorly researched subject. Most studies have been conducted with loggerhead sea turtles *Caretta caretta* in the North Pacific, North Atlantic and Mediterranean Ocean and only a few have been conducted with green turtles *Chelonia mydas* and olive ridleys *Lepidochelys olivacea*. Moreover, there are no studies involving multiple species in the same oceanic region. In this light, we studied the foraging ecology of three sea turtle species: loggerheads, greens and olive ridleys captured in oceanic environments off Peru, in the southeastern Pacific Ocean. We collected skin samples of 138 sea turtles that were incidentally captured by

long lines vessels and 65 samples from 19 potential prey taxa. The potential prey were collected using a plankton net towed from a fishing vessel during both day and night. The majority of collected species had already been reported as prey of sea turtles based on stomach content and/or esophageal lavage analysis. These include pelagic crabs *Planes* sp., pelagic gooseneck barnacle, *Lepas anatifera*, purple-striped jelly, *Pelagia noctiluca*, blue button *Porpita* sp., and blue sea slug, *Glaucus atlanticus*. We also included samples from the two species most commonly used as bait in pelagic longline fisheries off Peru; Humboldt squid, *Dosidicus gigas* and chub mackerel, *Scomber japonicus*. The bait samples were included to test the importance of longline baits in the diet of oceanic sea turtles. We used stable carbon (δ13C) and nitrogen (δ15N) isotope analysis to investigate trophic ecology of sea turtles because this technique can provide a comprehensive view of a consumer's diet. Stable isotope values were determined for all turtle and prey tissue samples. We used the Bayesian isotope mixing model Stable Isotope Analysis in R (SIAR) to estimate the contribution of different sources to the diets of all three turtle species. SIAR is a preferred mixture model when having multiple potential prey species because this method allows incorporation of natural variation and uncertainty. Results of the mixing models will be presented for each sea turtle species. These model outputs depict diverse diets for each species, but pinpoint the prey groups with highest contribution to each species' diet. Models also reflect varying importance of longline baits among turtle species. To our knowledge this is the first multispecies study of sea turtle trophic ecology in oceanic environments. The results will add greatly to our understanding of oceanic life stages and the conservation of sea turtles in the Southeast Pacific.

DIETARY SHIFTS IN THE ONTOGENY OF GREEN SEA TURTLES IN THE CENTRAL PACIFIC

E. Brooke Kelly[1], Katherine W. McFadden[1], Kimberly J. Reich[2], Eleanor J. Sterling[3], and Eugenia Naro-Maciel[4]

[1] Columbia University, Department of Ecology, Evolution and Environmental Biology, New York, New York, USA
[2] Texas A&M University at Galveston, Sea Turtle and Fisheries Ecology Research Lab, Galveston, Texas, USA
[3] Center for Biodiversity and Conservation, American Museum of Natural History, New York, New York, USA
[4] College of Staten Island, City University of New York, Biology Department, Staten Island, New York, USA

Juvenile green turtles (*Chelonia mydas*) are thought to shift from an omnivorous to an herbivorous diet when they recruit from pelagic to neritic developmental grounds. However, the individual and population level variability of this shift has not been extensively studied. Stable isotopes of carbon and nitrogen (δ13C and δ15N) provide information on diet and trophic position, thus offer a tool to better understand the ontogeny of foraging behavior in sea turtles. The Palmyra Atoll National Wildlife Refuge, a remote uninhabited atoll in the Central Pacific, currently serves as a major foraging ground for green turtles, yet little is known about the ecology of this population. Inshore neritic habitats, like those of Palmyra Atoll, may act as juvenile developmental areas and important adult foraging grounds for green turtles. However, the presence and timing of ontogenetic shifts, stage specific foraging habits, and spatial variation in foraging habits, are all unresolved areas of green turtle foraging ecology in the Palmyra Atoll population. Keratinized tissue from carapace scute samples provides a unique opportunity to examine the foraging ecology of sea turtles because scute tissue retains isotopic information from the time of tissue formation. Successive scute layers provide a chronological history of temporal scales in foraging behavior and therefore may be analyzed to identify more precisely when dietary shifts occur during recruitment to foraging grounds. Two scute biopsy samples, posterior (oldest tissue) and anterior (youngest tissue), were collected from each live-captured green turtle from 2008 to 2010. Size classes were determined using curved carapace length (CCL) as a proxy for age resulting in juvenile (<60 cm), sub-adult (60cm - 85cm) and adult (85 cm≤) size classes. A total of 23 juveniles, 40 sub-adults and 22 adults were sampled. Prey items, such as epiphytic turf algae, macroalgae and sponges, were also collected for stable isotope analyses. The anterior scute sample was used for the determination of the proportional contributions of each prey type (invertebrate, macroalgae, turf algae, etc.) to size class diet using stable isotope mixing models (data pending). The posterior scute sample was used to compare the isotopic concentrations of successive 50 μm layers of each scute. Successive sampling of juvenile samples will allow for an examination of resource use over time, providing insight on the timing of ontogenetic shifts (data pending). Using δ13C and δ15N ratios to determine the spatial and temporal variation in sea turtle foraging habitat will help fill an important gap in our knowledge of sea turtle ecology and identify critical areas for sea turtle

habitat conservation at Palmyra. This study will also contribute to a better understanding of the variation in ontogenetic diet shifts of juvenile green sea turtles as they recruit to neritic foraging grounds

PELAGIC HABITAT CHARACTERIZATION OF LOGGERHEAD TURTLES, *CARETTA CARETTA*, IN THE SOUTH PACIFIC OCEAN (2008-2009): INSIGHTS FROM SATELLITE TAG TRACKING AND ENVIRONMENTAL DATA*

Donald R. Kobayashi[1], Richard Farman[2], Denise M. Parker[3], Jeffrey J. Polovina[1], Alice S. Ren[4], Marc Rice[5], and George H. Balazs[1]

[1] NOAA Pacific Islands Fisheries Science Center, 2570 Dole Street, Honolulu, Hawaii, 96822, USA
[2] Aquarium des Lagons, B.P. 8185 Nouméa, 98807, Nouvelle-Calédonie
[3] Joint Institute for Marine and Atmospheric Research, 1315 East-West Road, Silver Spring, Maryland 20910 USA
[4] Duke University, Durham, North Carolina, 27708, USA
[5] Hawaii Preparatory Academy, 65-1692 Kohala Mountain Road, Kamuela, Hawaii, 96743, USA

The location and migration behavior of loggerhead turtles is of importance to the protection of the species, particularly in the high seas. In the North Pacific, work on loggerhead turtle migrations to minimize bycatch resulted in the discovery of the Transition Zone Chlorophyll Front as a migration corridor and foraging area. Similar work has yet to be done in the South Pacific. This study presents the preliminary investigations on loggerhead turtle movements in the open ocean of the western South Pacific using 42 captive-reared juveniles (19 months of age) tagged and released in a group off of the coast of New Caledonia. The turtles were tracked using SPOT-5 ARGOS satellite tags. The satellite position data was processed through a state space model (SSM) to produce corrected, daily tracks. The description of the habitat was accomplished using various satellite remotely-sensed data and other data products including sea surface temperature, ocean color, sea surface height, geostrophic currents, wind stress curl, bathymetry, and earth magnetic field data. For most variables, gradients were examined as well. The analysis was primarily a resource selection experiment with the environmental variables deemed possible turtle resources. The variable as found on the closest pixel resolution to the turtle's location was taken as the utilized portion of the resource. The available portion of the resource was taken from a circle of habitat centered on the release point and with an expanding radius at a rate determined by the swimming behavior of the turtles. The relative percentage of time occupying a value of the resource was compared to the relative abundance of that value within the habitat circle using a Kolmogorov-Smirnov test. For the variables where the cumulative distributions differed significantly, the difference between the percentage of time the turtle spent at that level of resource and the percentage of temporal and spatial abundance of that level was analyzed using an index of selectivity. Of the 16 variables tested, 7 were significant. Contrary to the findings in the North Pacific, the habitat area in the South Pacific appears to encompass a much larger spatial region. The loggerhead turtles appear to travel to three distinct habitat areas: the Tasman Sea between Australia and New Zealand; north and east towards Fiji, Kiribati, and the Cook Islands; and off of the east coast of New Zealand between 40-45 degrees South. There was evidence of turtles using the East Australian Current to forage, with some tracks circling along the coast of Australia. An analysis of turtle location in various EEZs and the high seas indicated that the majority of time was spent within various EEZs in the South Pacific.

EXAMINING PHYSIOLOGICAL CONDITION WITH NOVEL BIOMARKERS*

Lisa Komoroske[1,2], Lizabeth Bowen[1,2], and A. Keith Miles[1,2]

[1] UC Davis, Davis, CA, USA
[2] USGS Western Ecological Research Center, Davis, CA, USA

Environmental stressors can exert sublethal impacts on organisms that may in turn affect fitness and population dynamics. The current knowledge of these relationships in marine turtles is very sparse because conventional

laboratory studies are difficult to conduct on sensitive, long-lived vertebrates. We developed novel biomarkers to investigate relationships between stressors and physiological condition using gene expression profiling. The fundamental advantage of this approach is that the response of many genes providing transcriptional messages can be quantified from a small amount of blood, serving as proxies for proteins and cellular regulation. We investigated relationships among pollutants, pathogens, and metabolic and immunological function in green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles. We compared gene expression profiles of marine turtles inhabiting anthropogenically altered environments to clinically healthy, captive individuals. This approach has great potential in marine turtle research because it yields important insight into immune function and subsequent health of free-ranging animals while utilizing minimally invasive, field-friendly sampling methodology.

LOGGERHEADS IN THE GULF OF MEXICO: OIL, TRACKS, AND COMMON USE AREAS DETERMINED BY NRDA STUDY

Margaret M. Lamont[1], Kristen Hart[2], Tony Tucker[3], and Raymond R. Carthy[4]

[1] Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida, USA
[2] USGS, Davie Field Office, 3205 College Avenue, Davie, Florida, USA
[3] Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, FL USA
[4] U.S. Geological Survey, Florida Cooperative Fish and Wildlife Research Unit, Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida, 32611

After an oil spill, immediate response is enacted to rescue wildlife, clean the habitat, and ensure public safety. But these response activities only address short-term harm and therefore federal management agencies are entrusted to assess long-term impacts through the Natural Resource Damage Assessment (NRDA) process. As part of the Deepwater Horizon oil spill, we initiated an NRDA work plan to assess impacts to nesting loggerhead turtles. Data collection began in late-July 2010 at three key sites that spanned the North to South extent of loggerhead rookeries in the Gulf of Mexico: St. Joseph Peninsula in NW Florida, Casey Key in SW Florida, and the Dry Tortugas off Key West, Florida. These sites represent three genetically distinct loggerhead nesting subpopulations. Sample collection included swiping the carapace, satellite-tagging nesting females, and collecting blood, epibionts, and one viable egg during nest deposition. In addition, samples of nest contents were collected after hatching from all loggerhead nesting beaches in Alabama and Florida. For NRDA sampling, we satellite-tagged 4 nesting loggerhead females on the St. Joseph Peninsula, 5 on Casey Key, and 7 in the Dry Tortugas. All physical samples collected were taken to the NRDA sample facilities and are being analyzed by NRDA laboratories. Satellite tracks of tagged turtles are available to the public on www.seaturtle.org. Although the NRDA samples have been transferred to a NRDA contracted lab for analysis, we examined tracks from loggerheads satellite-tagged as part of the NRDA work plan, along with satellite tracks from turtles previously tagged in non-NRDA projects, for a synthetic snapshot of areas in the Gulf common to all three nesting subpopulations. Although marine turtles spend the majority of their lives at sea, much less is known about their oceanic life than about their time on nesting beaches. Satellite telemetry has revealed two mixed stock foraging grounds shared by the three subpopulations: off the Yucatan Peninsula, Mexico and off the SW Florida coast. These tracks indicated a high level of shared foraging resources by nesting subpopulations of Gulf loggerheads. More information on the migratory pathways to and from these foraging areas, characteristics of these areas, and composition of turtle assemblages using these sites is in development. Because turtles spend a remigration interval of multiple years at foraging grounds, consideration of these areas and the turtle activities that occur within these areas should take place when conducting marine spatial planning exercises and when developing spatially-explicit management plans. In addition, shared use of foraging areas among management groups should be acknowledged when developing recovery plans for nesting subpopulations. This study demonstrates the importance of synthesizing localized studies into a broader geographic view particularly when investigating species with global distributions. It also highlights the importance of collaborations among Principle Investigators working in different study areas, which has been one unexpected and positive result of the Deepwater Horizon oil spill.

A TWO-METHOD APPROACH FOR INVESTIGATING THE HEARING CAPABILITIES OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)*

Ashley L. Lavender[1], Soraya M. Bartol[2], and Ian K. Bartol[1]

[1] Old Dominion University, Norfolk, Virginia, USA
[2] Virginia Wesleyan College, Norfolk, Virginia, USA

Sea turtles are one group of endangered marine animals potentially impacted by rising levels of anthropogenic sound production. According to a limited number of electrophysiological and morphological studies, sea turtles appear to be low frequency specialists. These electrophysiological studies have not been correlated with behavioral responses, an important step for comprehensive hearing assessment. Due to the global nature of auditory evoked potentials (AEPs), audiograms solely based on electrophysiological measurements may underestimate the auditory threshold at low frequencies. For this project, we collected both behavioral and auditory evoked potentials (AEPS) from loggerhead sea turtles (*Caretta caretta*). All experiments were conducted at the NOAA Fisheries Service Galveston Laboratory (Texas, USA). AEPs were collected using Tucker Davis Technologies (TDT) System 3 hardware and software together with a J9 underwater speaker to deliver acoustic stimuli and acquire time-locked bioelectrical data. A hydrophone recorded sound pressure levels at the turtle during stimulus delivery. An effective protocol for restraining and submerging the turtle was developed, and the turtle was positioned just below the air-water interface to facilitate voluntary breathing. A three-electrode array was inserted below the frontoparietal scute and inactive skin of the lateral neck. Tone bursts (50 ms duration with 10 ms rise-fall time) of known frequencies (50 Hz to 1200 Hz) were presented in descending order of intensity and in opposite polarities to reduce electrical and myogenic noise. Averaged responses were Fourier-transformed, and both the time and frequency domain waveforms were used for threshold analysis. Behavioral audiograms were recorded using a two-response, forced-choice approach, whereby the turtles were required to vary behavior according to presence or absence of sound, permitting a behavioral measure of acoustic sensitivity. A stimulus delivery and data acquisition system was custom-designed in-house for this study using National Instruments hardware and LabVIEW software. TDT hardware and software were also used to generate acoustic stimuli, collect hydrophone data, and calculate sound pressure levels. Using squid to reinforce correct responses, individual turtles were subjected to a multi-step conditioning procedure to establish associations between experimental apparatus and signal presence/absence. Threshold was determined using both the percentage of correct responses and the calculation of response time for each block of trials. AEP and behavioral audiogram analyses indicate that sea turtles respond to low frequency sounds (50-1000 Hz). As hypothesized, the behavioral data display a lower threshold for each frequency throughout the range tested. These data provide two independent measures of hearing frequency range and threshold and promise to serve as an integral component of future assessment plans that address impacts of sound on sea turtles. The presenting authors would like to thank the Joint Industry Programme for monetary support (JIP 22 07-14); Ben Higgins and the NOAA Fisheries Service Galveston Laboratory staff for logistical support; the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service, International Sea Turtle Symposium and the Old Dominion University BGSO for travel assistance. This research was conducted under USFWS Permit TE-676379-5 and FWC Permit MTP 10-015.

TROPHIC AFFINITIES OF GREEN TURTLES IN SAN DIEGO BAY DETERMINED VIA STABLE ISOTOPE (D13C, D15N) ANALYSIS: A COMPARISON OF TWO POPULAR ISOTOPE MIXING MODELS*

Garrett Lemons[1], Rebecca Lewison[2], Lisa Komoroske[2], Alexander R. Gaos[2], Chun-Ta Lai[2], and Jeffrey A. Seminoff[1]

[1] NOAA/NMFS Southwest Fisheries Science Center
[2] San Diego State University

Stable isotope analysis (SIA) has been increasingly used to establish the trophic status of marine vertebrate consumers such as sea turtles. The application of stable isotope mixing models has also expanded, and several such tools are now available to move beyond elucidation of trophic status and statistically estimate the relative contributions of potential diet items in the overall diet of marine turtles. In this study we use SIA and isotope mixing models to determine the trophic status and dietary complexity of green turtles (*Chelonia mydas*) at a highly urbanized bay along the southern-most coast of California USA. The green turtle is recognized as endangered by IUCN and CITES and is the subject of ongoing conservation efforts worldwide. Key to effective conservation and monitoring of this species is understanding their foraging behavior and dietary needs. Therefore, our goals were to calculate the relative trophic position of green turtles, determine their most important prey species, and compare the output of two popular multisource stable isotope mixing models (Isosource and stable isotope analysis in R, SIAR) to develop recommendations for applications of mixing models in future SIA studies of sea turtles. We measured the stable carbon (δ13C) and nitrogen (δ15N) values of 87 green turtles and 175 potential diet items (including marine algae, seagrasses, sessile and mobile invertebrates) collected from 2003-2008 in San Diego Bay. Stable carbon and nitrogen values in skin of 87 green turtles ranged from –26.0‰ to −11.6‰ and 8.6‰ to 19.4‰, respectively, whereas the values for prey in the San Diego Bay ranged from −25.4‰ to −10.4‰ for δ13C and 8.4‰ to 15.3‰ for δ15N. SIAR and Isosource are conceptually similar but differentiate in source amount capabilities, output abilities and statistical approaches. Although SIAR and Isosource have differences, both mixing model distributions revealed an omnivorous diet, with invertebrates constituting up to 65% (Isosource) and 80% (SIAR) of the green turtle diet. Historical paradigms suggest that, adult green turtles are obligate herbivores with diets largely consisting of various sea grasses and/or marine algae. Recent studies have presented growing evidence suggesting that in some locals adult green turtles exhibit omnivorous foraging strategies. Our data clearly indicate omnivory in green turtles, suggesting the highest level of invertebrate consumption yet reported for this species. These results also highlight the importance of eelgrass beds in San Diego Bay as critical habitat for a main forage item as well as a food source.

COMPARATIVE EFFECTS OF ANTICOAGULANTS ON STABLE CARBON AND NITROGEN ISOTOPE VALUES OF GREEN TURTLE BLOOD TISSUE

Garrett Lemons[1], Tomoharu Eguchi[1], Boyd N. Lyon[2], and Jeffrey A. Seminoff[1]

[1] NOAA/NMFS Southwest Fisheries Science Center
[2] deceased

The foraging ecology and movements of vertebrate species have been increasingly studied via stable isotope analyses (SIA) using small quantities of body tissues. While whole blood and blood fractions (e.g. red blood cells, blood plasma) have been used for SIA, the properties of sea turtle blood have generally required the use of anticoagulants immediately upon collection, so as to prevent coagulation which would otherwise occur rapidly and prevent adequate blood fraction separation. Although use of anticoagulants is a common practice for sea turtle blood destined for SIA, their impacts on stable isotope signatures of blood tissue have not been established. In this study, we determined the effects of three widely used anticoagulants (acid citrate dextrose [ACD], sodium heparin and ethylenediaminetetraacetic acid [EDTA]) on stable-carbon and stable-nitrogen signatures in whole blood, red blood cells, and blood plasma of green sea turtles (*Chelonia mydas*). During 2004-2005, blood samples were collected from 11 green turtles captured in San Diego Bay, California USA. Vacutainers containing each of three blood preservatives were used, as was fourth vacutainer with no additive (i.e. control) that was immediately centrifuged to separate blood fractions. We found no significant difference in control and treatments for both red blood cells and whole blood. However, there was a significant effect on the δ13C values of blood plasma that had been preserved using treatments. Understanding the effects of preservatives on blood tissue used in stable isotope studies of sea turtles will allow for more accurate interpretation of SIA results for studies in areas where tools for immediate blood separation are not readily available.

HARDWIRED FOR NAVIGATION: HOW AN INHERITED MAGNETIC MAP GUIDES YOUNG LOGGERHEADS ON THEIR FIRST TRANSOCEANIC MIGRATION*

Kenneth J. Lohmann, Nathan F. Putman, and Catherine M. F. Lohmann

University of North Carolina, Chapel Hill, North Carolina, USA

Young loggerhead sea turtles from eastern Florida undertake a transoceanic migration in which they gradually circle the north Atlantic Ocean before returning to the North American coast. Hatchlings begin the migration with a 'magnetic map' in which regional magnetic fields function as navigational markers and elicit changes in swimming direction at crucial geographic boundaries. The responses of hatchlings to regional fields appear to be inherited, inasmuch as the fields elicit orientation responses in turtles that have never migrated or even been in the ocean. Recent experiments have demonstrated that the magnetic navigational responses inherited by hatchlings are far more elaborate and detailed than previously recognized. Turtles respond to fields that exist at diverse locations along the migratory route, including areas that are well within the latitudinal extremes of the gyre. Thus, the responses do not function solely to help turtles remain within an appropriate range of latitudes. New findings show that turtles can also derive longitudinal information from the Earth's field and use this to determine which side of the Atlantic Ocean they are on. For young sea turtles, the coupling of oriented swimming to a regional magnetic field appears to provide the fundamental building blocks from which natural selection can sculpt a sequence of responses capable of guiding first-time ocean migrants along complex migratory routes. The results imply that hatchlings from different populations in different parts of the world are likely to have magnetic navigational responses uniquely suited for the migratory routes that each group follows. Thus, from a conservation perspective, turtles from different populations are not interchangeable. These findings raise doubts about the efficacy of conservation practices that involve moving eggs or hatchlings long distances from their natural locations, including the mass relocation of eggs from the Gulf of Mexico to east Florida beaches following the 2010 Gulf oil spill.

USE OF TRACE ELEMENTS TO INFER POPULATION CONNECTIVITY IN MARINE ENVIRONMENTS: GETTING THE GOOD FROM THE BAD*

Melania C. Lopez-Castro[1], Karen A. Bjorndal[1], Alan B. Bolten[1], and George Kamenov[2]

[1] Department of Biology and Archie Carr Center for Sea Turtle Research. University of Florida, Gainesville, Florida, USA
[2] Department of Geological Sciences. University of Florida, Gainesville, Florida, USA

Traditionally trace elements, and in particular heavy metals, have been used to infer levels of pollution and ecosystem health by measuring the concentration of these elements in tissues of an array of organisms as well as in water samples of bays and estuaries around the world. Therefore, the words "heavy metals" have a negative connotation for people. However, there is another aspect of trace elements and heavy metals that in the past decade has proven useful in ecological research. In marine environments, these elements have been used to determine population connectivity in a variety of marine organisms such as fish, octopuses, cetaceans, and pinnipeds by analyzing the elemental composition of inert tissues with continuous growth such as calcium based structures like otoliths and stylets, as well as keratin based structures like baleen and hair. The principle behind this technique is that the elemental signature of a tissue reflects that of the environment in which the animal feeds and grows, making it possible to infer different developmental areas by analyzing different growth layers of the tissue. This principle may be useful in cases where marine organisms have cryptic developmental stages like the oceanic stage of green turtles (*Chelonia mydas*) in the Atlantic. We are using this technique to identify the site(s) where green turtles spend their first years of life by collecting scute samples from turtles that have recently recruited to neritic habitats (smaller than 45 cm straight carapace length). We have collected scute samples from a total of 103 green turtles in the following regions of the Atlantic: East and West Florida, central and southern Bahamas, and Nicaragua. Scute, the keratinized epidermal covering of the bony shell of sea turtles, is inert after deposition and, like baleen and hair, it also has continuous growth. Thus, scute records a "history" of where the turtle has been. By analyzing the elemental composition of the

different layers of scute, it is possible to identify oceanic foraging grounds of green turtles in the Atlantic. We present the results of the trace elements analysis of oceanic scute layers of green turtles from different regions in the Atlantic. This research was funded in part by a Boyd Lyon Sea Turtle Fund Scholarship, the Florida Sea Turtle License Plate Grants Program, the PADI Foundation, The Explorers Club Exploration fund, and Sigma Xi Grant.

SPATIAL AND TEMPORAL HABITAT USE BY EAST PACIFIC GREEN TURTLES, *CHELONIA MYDAS*, IN SAN DIEGO BAY, CA, A HIGHLY URBANIZED FORAGING GROUND*

Bradley D. MacDonald[1], Sheila V. Madrak[1], Rebecca L. Lewison[1], Jeffrey A. Seminoff[2], and Tomo Eguchi[2]

[1] San Diego State University, San Diego, CA, USA
[2] National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, CA, USA

San Diego Bay, CA, an ecosystem heavily impacted by human activities, is one of the northernmost year-round foraging grounds for East Pacific green turtles. While it is known that the bay is home to as many as 60 resident green turtles and that new turtles come in every year, little is known about their spatial ecology. Effective management of turtles in the bay is highly contingent upon knowing where and when turtle activity overlaps with human activities – boat strikes caused by industrial, military, and recreational boating are a known source of mortality for this population. The majority of these activities take place in the central and northern portions of San Diego Bay, but it has long been thought that green turtles almost exclusively use the southern portion of the bay, concentrated around the area's extensive eelgrass pastures and associated with the warm water effluent emitted by the South Bay Power Plant (SBPP). To date, however, no study has been conducted to assess their habitat usage or degree of fidelity to different areas within the bay. We tracked 16 green turtles tagged with acoustic transmitters using manual acoustic telemetry from December 2009 – October 2010. We also deployed automated acoustic receivers to monitor continuously for turtle presence in two areas: along the warm-water effluent outfall of the SBPP (an area of relatively low boat presence), and along the Sweetwater Marine Terminal (a shipping dock, boating channel, and area of relatively high boat presence). Manual telemetry of turtles showed a distinct clustering of turtle activity near the SBPP during winter months, followed by a gradual shift towards the south bay's eelgrass pastures in spring (possibly as those areas became more thermally suitable). Manual telemetry also revealed that turtles rarely venture out of the south bay. Initial data from automated receivers support this pattern: turtles averaged far more visits per day to the power plant compared to the marine terminal, especially in winter months. Turtle visitation to the SBPP appears to occur largely during dusk and nighttime hours, with 75% of visitation occurring during these time periods. While turtle visitation to the marine terminal was low overall, over 80% of those visits occurred during daylight, when the bulk of boating occurs in this area and therefore when the threat of boat strikes is highest. Monitoring of green turtle habitat usage in San Diego Bay will continue through 2011, including an expanded array of automated receivers along marinas, boating channels, and eelgrass foraging pastures. The results of manual telemetry will be used to construct fixed kernel density home range estimates. Those analyses will be complemented by a between and among site comparison of turtle site visitation based on results from our automated receivers. Our results will address the data gap of how green turtles utilize an "urban" foraging ground, providing a more robust understanding of their spatial ecology for management of green turtles both in San Diego Bay as well as other human-impacted foraging grounds.

SATELLITE TRACKING THE SEA TURTLE "LOST YEARS"*

Kate L. Mansfield[1] and Jeanette Wyneken[2]

[1] NOAA Fisheries, Southeast Fisheries Science Center, Miami, Florida, USA
[2] Florida Atlantic University, Boca Raton, Florida, USA

Using small, solar-powered satellite tags and novel tag attachment methods, we satellite tracked 17 neonate loggerhead sea turtles (12 to 18 cm straight carapace length) in 2009 and 2010. Sea turtles were lab-reared, weighed between 314-

692 g and ranged in age from 113 to 281 days post-hatching. All turtles were released off the southeast Florida (USA) coast in the Gulf Stream in proximity to their natal beaches. Releases of two to three turtles at a time were staggered throughout 2009 and fall of 2010. Tags transmitted for an average of two to three months (range: 38-172 d). All turtles remained in or within close proximity to the Gulf Stream immediately post-release. Turtles traveled north with the Gulf Stream, off the eastern coast of the US. Several turtles continued within the Gulf Stream, past Cape Hatteras, North Carolina, then eastward into the northwestern Atlantic. Turtles associated with frontal systems including the Gulf Stream's western and eastern boundaries; they also were found in association with meso-scale eddies. One turtle deviated from the Gulf Stream, traveling southeast from Cape Hatteras. This turtle skirted the edges of two large eddies, passed Bermuda and remained approximately 100-200 km southeast of the Island for two months. During the final month of this turtle's 172 day track, it traveled north towards the northwestern Atlantic and warmer waters of the Gulf Stream. Turtles remained within average sea surface temperatures (SST) of 18-27° C. Internal temperature sensors on the tags were consistently 4-6° C higher than SST data derived from satellite imagery. This disparity may reflect, in part, the surface-based 'basking' niche occupied by these turtles. Our data represent the first successful satellite tracks of any posthatchling sea turtle and provide the first *in situ*, empirical evidence of the movements and habitat use of neonate loggerheads in the Atlantic. Funding and support for this project was provided by the Large Pelagics Research Center Extramural Grants Program, National Marine Fisheries Service Southeast Fisheries Science Center and the National Academies Research Associateship program, the Florida Sea Turtle Grants Program, Ashwanden Family fund, Nelligan Sea Turtle Fund, Save Our Seas Foundation, and J. Abernethy.

CERRO VERDE, URUGUAY, CAN BE A YEAR-ROUND FEEDING AREA FOR JUVENILE GREEN TURTLES?

Gustavo Martinez-Souza[1,2], Gabriela Velez Rubio[1], Bruno N. Techera[1], Mauro Russomagno[1], Laura Berrondo[1], Andrés Estrades[1,3], and Paul G. Kinas[4]

[1] KARUMBE, Biodiversidad y Conservación, Montevideo, Uruguay
[2] Programa de Pós-graduação em Oceanografia Biológica - FURG, Rio Grande do Sul, Brasil
[3] Museo Nacional de Historia Natural, Montevideo, Uruguay
[4] Laboratório de Estatística Ambiental, Universidade Federal do Rio Grande - FURG, Rio Grande do Sul, Brasil

Since 2000, Karumbé, a Uruguayan NGO, has been working during all summer in Cerro Verde, Uruguay, known as the main feeding area for juvenile green turtles in the country. To discover what is happening with the green turtles in Cerro Verde during the other seasons of the year is the main objective of this study. A set net with 50 m in length, 3 m in depth and with a mesh size of 30 cm (bar) was used to capture turtles in Cerro Verde from November 2009 through October 2010. For analysis of population structure, only first captures were used. Curved carapace length (CCL) was measured using a flexible tape. Seawater temperature (ST) was measured in situ with thermometer. One effort unit was defined as deploying the standard set net for one hour. Catch per unit effort (CPUE) was calculated by dividing the total number of sea turtles catch by the number of effort units. CPUE values were compared among the seasons, ST values and effort per day using general linear model analysis. Seasonal size distributions were compared using a one-way ANOVA. CCL of captured turtles ranged from 26.6 cm to 71.0 cm (mean=39.1). In summer, we captured 111 green turtles in 22 sampling days (mean CPUE=1.08 turtle/hour), with mean of 322 minutes (or 5º22') of effort per day (range=46' to 707' or 11º47'), and mean ST of 24.4ºC (range=21.5ºC to 26ºC). In autumn, we captured 108 green turtles in 24 sampling days (mean CPUE=1.09 turtle/hour), with mean of 256 minutes (or 4º16') of effort per day (range=75'to 390' or 6º30'), and mean ST of 20.25ºC (range=15ºC to 23ºC). In winter, we captured 10 green turtles in 4 sampling days (mean CPUE=0.86 turtle/hour), with mean of 218 minutes (or 3º38') of effort per day (range=50'to 350' or 5º50'), and mean ST of 14.5ºC (range=13ºC to 15.5ºC). In spring, we captured 18 green turtles in 18 sampling days (mean CPUE=0.19 turtle/hour), with mean of 219 minutes (or 3º39') of effort per day (range=76' to 345' or 5º45'), and mean ST of 16.7ºC (range=14ºC to 19ºC). We observe green turtles feeding at temperatures below 15ºC. In contrast to other regions, where green turtles are dormant, quiescent, do not feed and appear to hibernating, at those temperatures. Size distributions did not differ significantly among the seasons (p=0.104). Different size distributions can suggest size segregation in a possible seasonal migrations. GLMs suggested that ST and time of effort per day influence the CPUE (AIC=147.6). There was a significant negative relationship between time of effort per day and CPUE (p=0.172) and a significant positive relationship between ST and CPUE (p=0.011), which was probably due to (1) green turtles´ migration when the ST decreased; and/or (2) reduction of the activity during low ST. To test these hypotheses, further studies involving tag recovery data and the connectivity between diverse foraging areas in a regional scale are critical. Our data suggests that Cerro Verde, Uruguay, can be a feeding area for juvenile green turtles among the four seasons.

IMPORTANCE OF WRIST ROTATION FOR HIGH PERFORMANCE TERRESTRIAL LOCOMOTION OF A SEA TURTLE INSPIRED PHYSICAL MODEL

Nicole Mazouchova[1], Paul Umbanhower[2], and Daniel I. Goldman[1]

[1] Georgia Institute of Technology, Atlanta, GA, USA
[2] Northwestern University, Evanston, IL, USA

To reach the ocean after hatching, juvenile sea turtles use their flippers to traverse a beach environment typically composed of granular media (sand), which can exhibit both solid and fluid-like response to stress. Previously we found that during rapid (3 BL/sec) locomotion on loosely packed sand, the fore-limbs did not slip during ground contact, resulting in speed on sand comparable to that on hard ground. We hypothesized that judicious control of limb penetration and wrist bending allows the hatchlings to maintain propulsive forces below the sand's yield force during stance phase. To explore this hypothesis, we use a turtle-inspired physical model to test the influence of wrist bending on locomotor performance on granular media. The device propels itself with either a symmetric or diagonal gait on sand using two servo-motor driven limbs consisting of flat-plate flippers and passively flexible or rigid wrists. We use high speed video to record kinematics in a trackway filled with a granular medium (poppy seeds). With flexible wrists and a symmetric gait there was no visible limb slip, and average forward speed increased with limb frequency f (t-test, p0.05) and observations revealed that the flipper slipped relative to the substrate during stance and body lift was smaller. A flexible wrist prevents slipping and enables the model to advance geometrically making use of granular induced constraint forces (yield force) instead of through slipping induced granular drag forces.

GREEN TURTLES OF CORISCO BAY

Catherine McClellan[1], Angela Formia[2], Armando Villarubia[3], Innocent Ikoubou[3], Severin Ikaka[3], Joan Ngossa[3], Paul Nguema[4], Jean-Jacques Tanga[4], Matthew Witt[1], Alan Rees[1], and Brendan Godley[1]

[1] Centre for Ecology and Conservation, University of Exeter, Penryn, Cornwall TR10 9EZ UK
[2] Wildlife Conservation Society, Global Conservation Program, 2300 Southern Blvd., Bronx, NY 10460, USA
[3] Project Manga, Cap Esterias, Gabon
[4] Agence National des Parcs Nationaux, Libreville, Gabon

Corisco Bay is an equatorial foraging ground for green turtles spanning the borders of Gabon and Equatorial Guinea. One of the few shallow-water habitats along the West Central African coast, Corisco is rich in biodiversity. The 2,455 km2 bay features several small islands, rocky fringing reefs, trailing sand bars, and abundant algae. Green turtles (20 – 108 cm CCL; mean 76 cm CCL; N = 735), may be found year round and compose a mixed-stock foraging aggregation from over 10 different rookeries. While this habitat seems ideal, these turtles face a variety of threats to their survival, including incidental capture in illegal trawl fisheries, harvest by local communities, habitat degradation through coastal development and oil exploration, and disease (fibropapilloma). There is an urgent need to provide empirical data that can be used to guide local conservation management efforts. In March of 2010, we began the first in-water study of sea turtles in Gabon to characterize the movements and habitat use of green turtles using sightings and satellite tracking. Over 14 survey days we recorded 96 green turtles (approx. 30 – 100 cm CCL) and deployed 6 satellite transmitters (40 – 85 cm CCL). Turtles were captured by hand or net, measured and weighed, tagged, and released near their capture site. Most turtles (62%) were discovered along the edges of rocky reefs covered with leafy algae. Tracking durations were relatively short (mean 116 days, range 45 – 230+) and varied due to transmitter size (limited battery life), tag loss, and tag damage. Turtles showed strong site fidelity (95% kernel UD mean 25 km2, range 11 – 41 km2), particularly to

shallow waters (< 5 m) near the small islands of Cocotier and Mbanye. Although our sample size is limited, we found no evidence for size-related depth preference among small (30-50 cm CCL), medium (50-70), and large (70-90) turtles (sightings data: REML Wald = 4.44, $F = 2.22$, $p = 0.116$; tracking data: GLMM Wald = 2.08, $F = 1.04$, $p = 0.454$). As we continue our work in Corisco Bay, we hope to elucidate these and other patterns further. Although sea turtles have long been part of the traditions of the local Benga people, awareness of their conservation need is low. National laws to protect sea turtles exist in both Gabon and Equatorial Guinea, but they are not always known, followed, or enforced. Since a ban on sea turtle harvest was enacted in Cap Esterias (Gabon) in November 2009, intentional captures have dramatically decreased. Satellite tracking green turtles has great potential for their conservation through raising awareness and through progressing our understanding scientifically. This research project has begun in Cap Esterias, on the southern shore of Corisco Bay, where community members are being integrated into conservation and research work.

WEST KIMBERLEY WANDERINGS – A FLATBACK'S JOURNEY

Glenn McFarlane

Conservation Volunteers Australia, Darwin, Australia

This presentation follows the year long Platform Terminal Transmitter tracking of one of two Australian flatback (*Natator depressus*) marine turtles from the far Northwest coast of Western Australia. As part of an annual 40-night tagging program in a newly monitored region of the West Kimberleys, the featured turtle was successfully tracked from nesting to foraging grounds and then return travelling more than 5,000 kilometres having even navigated her way through a cyclone. High nest temperatures, annual remigrants and now an identifiable foraging ground north of Australia, are just some of the results from this flatback program where further PTTs have since been deployed. The marine turtle research division of not-for-profit Conservation Volunteers Australia delivers this annual program.

MOVEMENTS OF JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) IN NEARSHORE WATERS OF THE NORTHWESTERN GULF OF MEXICO

Tasha L. Metz , André M. Landry, Jr., Amanda L. Moss, and Katie I. St. Clair

Sea Turtle and Fisheries Ecology Research Lab, Texas A&M University at Galveston, Galveston, TX 77553

Satellite telemetry is a valuable tool for identifying critical habitat and habitat use patterns essential to assessing potential fisheries and non-fisheries threats to sea turtle survival and revising out-dated recovery plans. Radio, sonic and satellite tracking of sea turtles in nearshore waters of the northwestern Gulf of Mexico (Renaud *et al*. 1995; Landry and Costa 1999; Seney and Landry 2008; Shaver and Rubio 2008; Seney and Landry In Press) has largely been devoted to movements of the critically-endangered Kemp's ridley (*Lepidochelys kempii*). Movements of the green turtle (*Chelonia mydas*), despite it being a year-round resident of bay waters along the middle and lower Texas coast, are not well known. To this end, the Sea Turtle and Fisheries Ecology Research Lab (STFERL) at Texas A&M University at Galveston conducted entanglement netting and satellite tracking surveys to assess green turtle habitat use patterns in five Texas estuaries - 1) Upper coast: Sabine Lake and Galveston Bay; 2) Mid-coast: Lavaca/Matagorda Bay; and 3) Lower coast: Aransas Bay Complex and Lower Laguna Madre - during 2006-2010. These netting efforts yielded 182 green turtle captures, all of which occurred in mid and lower coast estuaries. Juvenile/subadult life history stages (mean: 41.3 cm straight carapace length, range: 27.4-71.2 cm) dominated these captures. Sirtrack KiwiSat 202 satellite transmitters were attached to 15 greens comprised of 9 wild cohorts in the Lower Laguna Madre, 3 wild and 1 rehabilitated green in the Aransas Bay Complex, and 1 wild and 1 rehabilitated green in Lavaca/Matagorda Bay. Core activity areas were generated using home range tools for satellite tracks during warm (April-October) vs. cold months (November-December) to assess seasonal differences in green turtle movements. During warm months, all turtles exhibited fidelity to seagrass beds in which they were captured and released. Conversely, four greens moved from the lower Laguna Madre to shallow, offshore waters along the Mexican coast following passage of strong cold fronts in

December and January. Overall, green turtles exhibited a mean track duration of 123 days (as of November 2010; range: 16-327 days) and traveled a mean total distance of 665 km. Additional track parameters examined include mean depth and distance from shore, as well as the threshold temperature for seasonal migration. Habitat use and movement data presented herein mandate continued bi-national cooperation between the US and Mexico to protect critical habitat and enhance the recovery of this endangered and threatened species.

SUN COMPASS ORIENTATION BY JUVENILE GREEN SEA TURTLES (*CHELONIA MYDAS*)*

Cody R. Mott[1] and Michael Salmon[2]

[1] Gumbo Limbo Nature Center, Boca Raton, Florida, USA
[2] Florida Atlantic University, Boca Raton, Florida, USA

Juvenile green turtles occupy home ranges on shallow reefs that parallel the southeastern coast of Florida. When disturbed, the turtles often flee eastward toward deeper water. We captured turtles at night and recorded their orientation over the next two days while they swam tethered within a large circular outdoor pool. Inside the pool, they had no view of the sea but were exposed to the sun. The turtles from two reef sites (one ~ 40 km to the north; the other, ~ 4 km to the south) oriented generally eastward. The two distributions did not differ statistically. After 7-10 d of exposure to a laboratory photocycle advanced by 7 h, turtles tested in the same pool oriented generally westward, as predicted if they used the sun for orientation. Westward orientation was unaffected by placing either disc magnets or non-magnetic (brass) discs on the turtles' head. These results are consistent with the hypothesis that orientation under clear skies is based upon solar cues. However, control turtles exposed for 7-10 d to a photocycle advanced by only 1 h were also expected to swim generally eastward but for unknown reasons, failed to show significant orientation. Our results therefore support the hypothesis that the sun is used as a compass but do not constitute definitive evidence.

SATELLITE TRACKING GREEN TURTLES OF THE PALMYRA ATOLL NATIONAL WILDLIFE REFUGE, CENTRAL PACIFIC

Eugenia Naro-Maciel[1], Eleanor J. Sterling[2], Felicity Arengo[2], George Balazs[3], Andrés Gómez[2], Katherine Holmes[4], Katherine McFadden[5], and Erin Vintinner[2]

[1] College of Staten Island, Staten Island, New York, USA
[2] American Museum of Natural History, New York, New York, USA
[3] NOAA, Pacific Islands Fisheries Science Center, Honolulu, Hawaii, USA
[4] Wildlife Conservation Society, Kavieng, New Ireland Province, Papua New Guinea
[5] Columbia University, New York, New York, USA

The Palmyra Atoll National Wildlife Refuge (PANWR), a remote North Pacific Atoll (Longitude: 162° 04' 59.05" W; Latitude: 005° 52' 55.54" N), is a foraging ground for green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles whose population biology is still largely unknown. As part of a comprehensive research program aimed at addressing this problem, satellite tracking of green turtles was carried out from 2008-2010 (n = 14). The objectives were to investigate movements to and from, and residency at, the atoll. Due to restricted access to this Wildlife Refuge, field seasons were limited to two or three weeks a year, underscoring the importance of gathering movement data remotely using satellite telemetry. To provide a general baseline on green turtle movements, juveniles and adults were tracked in 2008 (n = 7). Of these, four were males. From 2009-2010 the focus of the study shifted entirely to males (n = 7), since comparatively little is known about their movements, with nesting females being tracked in most studies. Tracking duration for all turtles (n = 14) and for males only (n = 11) ranged from 42 – 616 days. The average track duration for all turtles was 231 days, while for males only it was 264 days. Of the 14 turtles tracked, all but one remained on the atoll. This included four males that stayed at Palmyra for over a year (396 - 616 days), indicating they were not annual breeders. One of these males departed Palmyra in September 2010 on a near circular loop through oceanic waters, passing by Teraina (Republic of Kiribati) for a total distance traveled of over 2000 km. The research is

providing the first information on green turtle residency and movement patterns at Palmyra, with applications for regional and local conservation and management.

POST BREEDING MIGRATORY TRACKS OF THREE SPECIES OF MARINE TURTLES FROM BONAIRE AND KLEIN BONAIRE, DUTCH CARIBBEAN

Mabel Nava[1] and Robert van Dam[2]

[1] Sea Turtle Conservation Bonaire
[2] Chelonia Inc

Of the four species of marine turtles commonly observed breeding in the Caribbean, three species, the loggerhead (*Caretta caretta*), the green turtle (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata*) reproduce on the beaches of Bonaire and Klein Bonaire, Dutch Caribbean. Marine turtles have been legally protected on and around the islands since 1991, while Klein Bonaire, the most important nesting area, was purchased by the government in 1999 and incorporated in its entirety into the Bonaire National Marine Park. Despite such legal protections, some illegal take of marine turtles, mostly juveniles, is known to occur, albeit at sharply reduced levels in recent years (G. Egbreghts, pers. comm.). Whereas juvenile green and hawksbill turtles can be observed year-round in the neritic waters surrounding Bonaire and Klein Bonaire, adult marine turtles are only very rarely seen outside of the breeding season, which combined for the three species lasts from May to December. In-water surveys of marine turtles conducted in all potential foraging habitats around the islands indicate that adult marine turtles are seasonal visitors and do not reside permanently in the islands' waters (Sea Turtle Conservation Bonaire, unpub. data). We used satellite telemetry to address the question of where the foraging grounds are located of the turtles breeding at Bonaire and Klein Bonaire. Our principal objectives were to identify the migratory pathways and the foraging ground locations of post-reproductive marine turtles, in order to deepen our understanding of the potential threats facing these animals. To elucidate the geographic scope of the populations of marine turtles breeding at Bonaire and Klein Bonaire (Netherlands Antilles), we examine the post-breeding migratory behavior of 20 marine turtles. Four female loggerheads (*Caretta caretta*), 3 female green turtles (*Chelonia mydas*), and 2 male and 11 female hawksbill turtles (*Eretmochelys imbricata*) were tracked by satellite telemetry while returning to their foraging grounds. Transmissions ceased for three turtles for unknown reasons while still underway, but all had departed Bonaire and at their latest position were 595-2221 km away from the island. The other 14 turtles swam 10-48 d (mean: 27.2 d) covering distances 241-2026 km (mean: 1330 km) at mean speeds of 24.1-68.4 km/d (mean: 48.4 km/d) with navigational efficiencies of 0.53-0.95 (mean: 0.80) to reach their foraging grounds. Benthic foraging area of particular importance to marine turtles breeding on Bonaire are located off Nicaragua and Honduras (n=7 turtles), Puerto Rico (n=3) and Venezuela (n=4). The wide migratory range of the breeding turtles examined further underscores the need for broad international cooperation in efforts aimed at protecting these endangered species. Satellite telemetry also is a highly effective method for enhancing local community awareness of marine turtle biology and relevant conservation issues. None of the 20 tracked turtles remained in the waters around Bonaire and Klein Bonaire beyond the breeding season. Turtles moved 241-2930 km to reach foraging areas encompassing multiple jurisdictions and therefore highlighting the need for concerted international efforts in the management and conservation of marine turtle stocks.

A COMPARISON OF HAWKSBILL TURTLE SITE OCCUPANCY BETWEEN NATURAL AND ARTIFICIAL REEFS IN PALM BEACH COUNTY, FL, USA

Suzanne M. Nuttall[1] and Larry D. Wood[2]

[1] Green Mountain College, Poultney, VT, USA
[2] Zoological Society of the Palm Beaches, West Palm Beach, FL, USA

Submerged debris of anthropogenic origin (a.k.a. "artificial reefs") often create suitable habitat for benthic marine organisms, particularly in shallow tropical waters. To that end, coastal managers in Florida (USA) have systematically placed structures such as ships, concrete pilings, culverts, and even automobiles in the nearshore marine environment to

enhance fisheries, tourism, and recreational activities. Juvenile through adult hawksbill turtles (*E. imbricata*) closely associate with coral reef habitats, and are found with regularity in the waters of Palm Beach County, Florida. In this study, multi-year SCUBA surveys and GPS-linked satellite telemetry were used to calculate the detection probabilities of hawksbill turtles in both natural and man-made reef locations, resulting in site occupancy estimates for both habitat types. The preliminary results confirm the persistent presence of hawksbill turtles at artificial reef sites and support the responsible deployment of structural debris for coastal environmental enhancement.

QUANTIFYING LARGE-SCALE MOVEMENT PATTERNS OF MALE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN THE EASTERN INDIAN OCEAN

E. Olson[1], A. Salomon[1], A. Wirsing[2], and M. Heithaus[3]

[1] Simon Fraser University
[2] University of Washington
[3] Florida International University

Understanding the distribution and movement patterns of endangered species is vital for developing effective conservation strategies. Loggerhead sea turtles are listed "Endangered" by The World Conservation Union. The Shark Bay World Heritage Property is home to the largest breeding population of loggerhead turtles in Australia and the third largest in the world. With little known about the movements of males in this population, our objective is to monitor and quantify the large-scale movement patterns of adult male loggerhead turtles to inform conservation strategies. In February 2009, we tagged 9 male loggerhead turtles with SPOT5 satellite tags. Data collection through March 2010 revealed all 9 individuals stayed within the protection of the World Heritage Property, exhibiting home ranges considerably smaller than previously thought. To complement the quantitative tracking data, we interviewed 6 locals and recorded their traditional ecological knowledge concerning loggerhead turtle movement, habitat use and species interactions. The unique combination of natural science and social science in this research will result in the most comprehensive investigation of male loggerhead sea turtle movement behavior and habitat use to date. Furthermore, it is cultivating relationships between North American researchers, local fishermen, and local Aboriginals, forming a basis for collaborative conservation management.

FORAGING HABITAT USE BY MALE LOGGERHEAD TURTLES AS REVEALED BY STABLE ISOTOPES*

Mariela Pajuelo[1], Karen A. Bjorndal[1], Alan B. Bolten[1], Kimberly J. Reich[2], Michael D. Arendt[3], and Al Segars[3]

[1] Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, Gainesville, Florida
[2] Sea Turtle and Fisheries Ecology Research Lab & Department of Marine Biology, Texas A&M University at Galveston, Texas
[3] South Carolina Department of Natural Resources, Marine Resources Division, Charleston, South Carolina

In coastal and oceanic areas, loggerhead turtles, *Caretta caretta*, forage opportunistically on a diverse array of prey items. While a variety of studies have addressed various aspects of the foraging ecology of adult female and juvenile loggerheads, little is known about where and on what adult male loggerhead turtles are foraging. We use stable isotope analysis of male loggerhead turtle tissue samples (n=45) collected from 2006 and 2007 off Cape Canaveral, Florida, to investigate the trophic ecology and habitat use of male loggerheads. A total of 29 of those individuals sampled was fitted with satellite transmitters and released after tissue collection to provide direct data on where males traveled after the mating season. Results show great variation in carbon and nitrogen isotope signatures ($\delta 13C$ and $\delta 15N$, respectively). Both $\delta 13C$ and $\delta 15N$ were significantly correlated with the latitude to which the loggerheads traveled. The high $\delta 15N$ variation may be explained by differences in $\delta 15N$ values at the base of the food chain, while carbon

signatures may reflect the differential uptake of carbon by primary producers due to latitudinal effects. Because isotopic signatures of male loggerhead tissues reflect integrated diet and habitat use before their capture, the agreement between isotopic signatures and migration patterns lends support to a high foraging site fidelity also observed in adult female loggerheads. Our results emphasize the need for knowledge of community $\delta15N$ and $\delta13C$ signatures when identifying trophic levels and foraging habitats in highly migratory organisms. We hope to incorporate isotopic signatures of food web organisms at the different foraging areas used by male loggerheads to corroborate our results. Additionally, the use of sulfur stable isotopes may help reveal definitive differences between neritic vs. oceanic or pelagic vs. benthic feeding strategies.

POST-NESTING BEHAVIOR OF LOGGERHEADS FROM CRETE REVEALED BY SATELLITE TELEMETRY

Samir H. Patel[1], Aliki Panagopoulou[2], Stephen J. Morreale[3], Dimitri Margaritoulis[2], and James R. Spotila[1]

[1] Drexel University, Philadelphia, Pennsylvania, USA
[2] ARCHELON, The Sea Turtle Protection Society of Greece, Athen, Greece
[3] Cornell University, Ithaca, New York, USA

Loggerhead turtles (*Caretta caretta*) are one of the most generalized species in terms of feeding, foraging and nesting locations. However, even though generalist behavior may contribute to resiliency, this species is endangered, and recent research indicates that a warming climate could dramatically affect them. While populations in the Atlantic and Pacific have a wider range of locations and environments for foraging and nesting, the Mediterranean subpopulation is confined to a very small and relatively homogenous basin. Movement of oceanic species to higher latitudes has occurred as global temperatures increased. However, that may not be possible in the Mediterranean. The purpose of this study is to determine what adaptations are occurring or are possible for loggerheads in the Mediterranean Sea. Greece contains the most important nesting beaches in the Mediterranean for loggerheads. Rethymno, Crete contains the third most populated nesting beaches averaging approximately 300 nests per season. In late July, during the 2010 nesting season in Rethymno, we attached satellite transmitters to five female loggerheads immediately after their final nesting event. Turtles varied in size from 75.5 – 81cm SCL. Four of the five transmitters functioned as expected and sent data for more than 60 days. Three loggerheads traveled to the north coast of Africa eventually settling near or within the Gulf of Gabes in Tunisia. These three took very similar routes from Crete to Tunisia, while the largest remained the furthest from the African coast. These turtles travelled approximately 1300km to their foraging site, taking only resting dives while migrating. The fourth remained very close to the nesting beach, travelling approximately 300km to a small island immediately south of Crete called Gavdos. Each turtle has taken resting dives to depths of over 100m and lasting over 90min. While foraging, these turtles have taken as many as 66 dives in 4h. Even with this small sample size, overall behavior has varied. For example, one individual foraged continuously once reaching her foraging site, while others spent time foraging as well as resting. By consolidating these data, an ecological niche can be determined for the loggerheads of the Mediterranean.

PREDICTING PELAGIC HABITAT WITH PRESENCE-ONLY DATA USING MAXIMUM ENTROPY FOR OLIVE RIDLEY SEA TURTLES IN THE EASTERN TROPICAL PACIFIC

Lindsey E. Peavey[1], Jeffrey A. Seminoff[2], Robert L. Pitman[2], Benjamin D. Best[3], and Larry B. Crowder[3]

[1] University of California, Santa Barbara, Bren School of Environmental Science & Management, Santa Barbara, California, USA
[2] Southwest Fisheries Science Center, NOAA Fisheries, La Jolla, California, USA
[3] Nicholas School of the Environment, Duke University Marine Laboratory, Beaufort, North Carolina, USA

Little is known about the oceanic distribution of olive ridley sea turtles (*Lepidochelys olivacea*) in the eastern tropical Pacific (ETP), or what governs their offshore movements. In this study we opportunistically sampled 350 olive ridley sea turtles in the ETP between August and December 2006, during a Stenella Abundance Research (STAR) Project cruise. Using these presence-only observations and remotely-sensed oceanographic data, we developed a maximum entropy habitat model using GIS and the Maxent software package to predict olive ridley habitat across the ETP seascape using seasonal averages (Aug-Nov 2006) of chlorophyll(a), sea surface temperature, and bathymetry as the final model parameters. Statistically, a simple generalized linear model (GLM) performed better (AUC > 0.78) than Maxent (AUC < 0.68). However, the Maxent results are more reasonable based on expert knowledge. For the scope of this study, Maxent was determined to produce a viable species distribution model, although model improvements are recommended. It produced useful results with conservation applications such as predicting distribution shifts as climate changes, and reducing fisheries interactions at sea. Maxent is a powerful distribution modeling tool that is appropriate for marine ecosystems¬, at minimum for comparison to more traditional techniques. Because it's a free, easy-to-use software package, Maxent is growing in popularity among terrestrial and marine habitat modelers. However, we caution against using the method for predictive habitat modeling with open-ocean, or rare species. Similar studies should be repeated for other oceanic species (e.g. migratory marine megafauna) and compared with richer datasets (e.g. line transect surveys and satellite telemetry) to gain a better understanding of Maxent's ability to accurately predict oceanic habitat.

GEOGRAPHY AND SYSTEMATICS OF PLANES CRABS – AN APPEAL TO THE FIELD

Joseph B. Pfaller[1], Michael G. Frick[2], and Karen A. Bjorndal[1]

[1] Archie Carr Center for Sea Turtle Research, University of Florida, Gainesville, Florida, USA
[2] Friends of the National Zoo, Smithsonian National Zoological Park, Washington, D.C., USA

Crabs of the genus *Planes* are small, pelagic crabs that live upon most floating objects in the open ocean – including pelagic marine animals such as sea turtles, sea snakes, jellyfish, siphonophores, and gastropods. There are currently three known species of *Planes*: ***P. minutus***, ***P. major*** (=cyaneus), and ***P. marinus***. All have been documented as epibionts of sea turtles. The distribution of ***P. minutus*** is thought to be restricted to the North Atlantic and Mediterranean Sea, where it has been found commonly on oceanic-stage loggerhead turtles (*Caretta Caretta*) and sporadically on hawksbill turtles (*Eretmochelys imbricata*). *Planes major* is found throughout the rest of the temperate and tropical oceans, and has been found commonly on loggerheads from the South Pacific and on both loggerheads and olive ridley turtles (*Lepidochelys olivacea*) in Baja Mexico. This species has also been reported sporadically from hawksbill and green turtles (*Chelonia mydas*) in these areas. The distribution and habits of the third species, ***P. marinus***, are poorly understood. Nevertheless, this species has recently been found on olive ridleys in the Eastern Tropical Pacific and loggerheads from Japan. Morphologically, ***P. marinus*** can be distinguished from its two congeners by a striated, box-shaped carapace and the lack of natatory fringes on its walking limbs. However, differentiating ***P. minutus*** and ***P. major*** is more difficult and has lead many numerous misidentifications in the past. To date the best character for differentiating these two species is the relative lengths of the walking legs: ***P. minutus*** has slightly longer legs than ***P. major***. Because of their pelagic existence, worldwide distribution and subtle morphological differences, the phylogenetic relationships among the three species of *Planes* are poorly resolved. For my dissertation, I am studying the phylogeography of *Planes* crabs and their association with marine reptiles. Our goals are to decipher species and population boundaries, assess connectivity, and better understand the role of marine reptiles in the ecology and evolutionary history of these crabs. For this work, we are currently amassing a collection of crab specimens from a variety of regions, and from a variety of animals and floating objects. Thus, we would like to issue an appeal to the sea turtle community to help augment our collection with *Planes* specimens from gaps in the worldwide distribution, such as the Eastern South Atlantic, Indian Ocean, and South Pacific.

AMPHIBIOUS HEARING IN HATCHLING HAWKSBILL SEA TURTLES (*ERETMOCHELYS IMBRICATA*)

Wendy E. Dow Piniak[1], Scott A. Eckert[2], David A. Mann[3], and Julia A. Horrocks[4]

[1] Nicholas School of the Environment, Duke University Marine Lab, Beaufort, NC 28516 USA
[2] Wider Caribbean Sea Turtle Conservation Network, Ballwin, MO 63011 USA and Principia College, Elsah, IL 62028 USA
[3] College of Marine Science, University of South Florida, St. Petersburg, FL 33701 USA
[4] University of the West Indies, Cave Hill, Bridgetown, Barbados, BB11000

Despite the rising concern of increasing levels of anthropogenic sound throughout the oceans, we know very little about the hearing capabilities of sea turtles or how they may be impacted by potentially harmful sources of anthropogenic sound. Hatchling sea turtles exist in both aerial and aquatic habitats, exposing them to sounds in both media, and making the comparison of in-water and in-air hearing particularly important. We measured the hearing thresholds of five hatchling hawksbill sea turtles (*Eretmochelys imbricata*) in water and in air by recording auditory evoked potentials (AEPs). AEPs are produced by the central nervous system in response to acoustic stimuli. This technique has historically been used as a non-invasive, quick method for determining hearing in non-communicative species. Before testing, we isolated hatchlings from noise and vibrations and lightly restrained them to prevent movement that would mask AEP signals. For underwater measurements, we completely submerged hatchlings at least 10 cm (measured at the location of the ear) below the surface of the water and presented stimuli with an underwater speaker (Clark Synthesis AC339), calibrated with a hydrophone (High Tech, Inc. HTI-96-MIN). For aerial measurements we suspended hatchlings in air to isolate them from vibrations and presented stimuli with similarly suspended aerial speaker (Sony) calibrated with a microphone (LinearX Systems, Inc. M31). We recorded responses to click and tonal stimuli from 50 - 3200 Hz using three subdermal electrodes. A Tucker-Davis Technologies Auditory Evoked Potential Workstation with SigGen and BioSig software generated click and tonal stimuli and recorded AEP responses. Results showed that hatchling hawksbill sea turtles are able to detect sounds in both air and water, however ranges of maximum sensitivity and thresholds differed between the two media. Hatchling hawksbills, like other species of sea turtle tested, appear to have a narrow, low frequency range of hearing sensitivity. They hear well in air and water, particularly at frequencies below 1000 Hz. These represent the first measurements of hawksbill sea turtle hearing sensitivity. Hawksbills are critically endangered, and much of their important nesting and foraging habitat overlaps with areas with prevalent anthropogenic sound sources such as seismic exploration for oil and gas, oil and gas drilling, pile driving, and shipping. When our resulting audiograms are compared with the frequencies and source levels (dB) produced by these anthropogenic sources it is clear that hawksbill hatchlings are able to detect these sounds in their environment, suggesting the need to further investigate into the potential behavioral and physiological impacts of these sounds. We would like to thank the SeaWorld & Busch Gardens Conservation Fund for supporting this research and the International Sea Turtle Symposium, International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service for travel support.

SURVEY OF BASKING GREEN TURTLES AT MIDWAY ATOLL

Marc Rice[1] and George Balazs[2]

[1] Hawaii Preparatory Academy, 65-1692 Kohala Mr. Rd., Kamuela, Hawaii, USA 96743
[2] Pacific Islands Fisheries Science Center, NOAA Fisheries, 2570 Dole St., Honolulu, Hawaii, USA 96822

Midway Atoll (280 N, 1770 W) is ~9 km in diameter with 234,876 ha of submerged reef and three coral islands (Eastern, Sand and Spit) totaling ~626 ha. Work done by Balazs in the 1970s and 1980s and by Balazs and Rice in 1998 to 2001 showed that there was a significant population of green turtles (*Chelonia mydas*) at Midway Atoll. This population is part of the Hawaiian stock of green turtles. The main aggregation was around Sand Island with the inner harbor and the cargo and fuel piers acting as underwater resting/sleeping locations for juvenile, sub-adult and adult turtles. In the 1970's and 1980's, most of the population was composed of juvenile turtles with a slow somatic growth rate. By the late 1990's, the population had matured such that 40% of the animals were sub-adults or adults. Several cases of fibropapillomatosis were observed in the 1990's, whereas no cases had been observed in the 1970's. In April of 2010, Rice went to Midway Atoll with the Oceanic Society to conduct a survey of the green turtles that bask on Midway Atoll, particularly on "Turtle Beach" (28.2160 N, 177.3660 W), Sand Island. Green turtles generally began basking at 0700 h with increased numbers coming out throughout the morning reaching a peak between 1200 and 1400 h. The counts tapered off toward the evening hours. By 2100 h, there were very few turtles on the beach. In some cases, turtles remained out into the night and, on at least one occasion; a turtle remained out the entire night and into the next day. The sex ratio of basking turtles was 31% males, 36% female and 33% sub-adults/undetermined. The number of basking turtles was influenced by tidal fluctuation (range ~0.64 m) and whenever the tide was rising and near its high point many of the basking turtles would be washed over by the incoming waves and return to the water. Although it did not rain during this trip, observations made during our work from 1998 to 2001 found that basking turtles will return to the water if there is significant rainfall. The largest number of basking turtles counted at any one time from 4/17 to 4/27/2010 was 17. Other counts in 2010 have been higher, ranging up to 35 individuals. Twenty-five basking turtles were scanned/observed for tags during the 9-day observation period. There were 8 tag recoveries out of the 25 scanned. These turtles had been originally tagged at Midway Atoll or at French Frigate Shoals during nesting migrations. There were no fibropapilloma tumors observed on any basking turtles. This was particularly good news because of the presence of tumored animals discovered during our work from 1998 - 2001. It appears that the disease may have run a course similar to that in the population in Pala'au, Molokai, Hawaii where the disease has gone from a high of nearly 60% incidence rate in 1996 to approximately 11% in 2010.

DISTRIBUTION OF HAWKSBILL SEA TURTLES (*ERETMOCHELYS IMBRICATA*) THROUGH SEASCAPE FEATURES IN CARIBBEAN CORAL REEFS

Martha P. Rincon-Diaz[1], Carlos E. Diez[2], Robert P. van Dam[3], and Alberto M. Sabat[1]

[1] Department of Biology, University of Puerto Rico-Rio Piedras Campus, PO Box 23360 San Juan 00931-3360, Puerto Rico, USA
[2] Department of Natural Resources and Environment, PO Box 9066600, San Juan 00906-6600, Puerto Rico, USA
[3] Chelonia Inc., PO Box 9020708, San Juan 00902-0708, Puerto Rico, USA

Seascape features influence the distribution and abundance of marine animals, and are used to identify critical areas to protect marine species. In this study we related the relative distribution of juvenile hawksbill turtles in five localities at the west side of the Culebra Archipelago, Puerto Rico, with seascape variables that could explain turtle distribution in reef areas. Main goals of the study were to identify habitat affinities of hawksbills in reef areas, and predict the potential distribution of the species in study sites to identify important areas not protected within local the Marine Reserve of Luis Peña Canal. We tested the hypothesis that distribution of juvenile hawksbills (presence) is positively related to areas that could be used for sheltering such as high rugosity and hard bottom areas. To accomplish the first goal, daytime snorkeling censuses were conducted by 2-5 observers at study sites during April 2008-June 2009 to capture turtles, obtain the CPUE (catch per unit effort) as index of relative abundance, and record capture locations by using a GPS. A total of 15 one-hr surveys were conducted at each site during the 14 months of this study, and a total of 80 captures plus 39 sightings of hawksbill turtles were recorded for all study sites. We used available geospatial layers to extract seascape variables such as depth, rugosity, slope, number and proportion of reef zones and benthic bottom types for study sites within grids of 0.01 km2 for which presence of turtles was recorded. To accomplish the second goal we built a distribution map of turtles of 10 m2 resolution by using 70% of capture locations and raster maps of seascape features using the GARP Program. The remaining locations were used for testing the model. A Kruskal-Wallis one-way analysis of variance was used to test for differences in the relative abundance of hawksbills among study sites. The relationship between presence of turtles and all seascape variables independent of each other was evaluated with a Spearman rank correlation analysis. Results showed that there are differences in abundance of juvenile hawksbill turtles among study sites, and turtles had a high affinity for areas with depths of 2 to 15 m, high rugosity indices and high cover of colonized pavements or linear reefs. Turtles were absent from areas of high cover of colonized bedrock. Colonized pavements are defined as hard bottoms covered by sessile invertebrates such as sponges that could serve as feeding areas by juvenile hawksbills. Linear reefs, due to their high rugosity, are areas of high shelter availability including small caves or spaces under coral heads. Map of predicted distribution suggested the site with the highest turtle abundance, Carlos Rosario reef, had presence of hawksbills at its north side, which is outside of the marine protected area. This study demonstrates the importance of using seascape features to understand the distribution of sea turtles in their developmental habitats, and also as a tool to identify potential areas for protection.

UNDERSTANDING THE ECOLOGICAL ROLE OF JUVENILE GREEN TURTLES IN A COASTAL LAGOON ECOSYSTEM*

Juan M. Rodriguez-Baron[1], Victor H. Cruz-Escalona[2], Rafael Riosmena-Rodriguez[3], Jaime Camalich[2], Andres F. Navia[2], and Jeffrey A. Seminoff[5]

[1] Universidad Autónoma de Baja California Sur, (UABCS) Apartado postal 23080, km. 5.5 Carretera al Sur La Paz B.C.S. México.
[2] Centro Interdisciplinario de Ciencias Marinas (CICIMAR-IPN), Av. Instituto Politécnico Nacional s/n Col. Playa Palo de Santa Rita, Código Postal 23096 La Paz, B.C.S. México
[3] Fundación colombiana para la investigación y conservación de tiburones y rayas Carrera 79 No 6 - 37, Cali. Colombia
[4] NOAA - National Marine Fisheries Service, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, California 92037, USA

Bahia Magdalena is a Pacific-coast lagoon along the Baja California Peninsula of Mexico, considered as a center of biological productivity and the most important foraging and developmental habitat for green sea turtles (*Chelonia mydas*) in the area. From 2008-2009 we studied 23 juvenile turtles (SCL= 50.9 ± 3.6 cm, range= 46.6 - 58.2 cm); our main goal was to establish the ecological role of green turtles within this coastal ecosystem. We used the mass-balance model energy flow program Ecopath with Ecosim and determined the structural importance of the groups by applying topological indices the local and intermediate scales, with 24 input groups of soft-bottom community members, including marine mammals, sea birds, and fishes, several invertebrate groups, benthic primary producers, detritus and green turtles. To support this exercise we used traditional tools and isotopic analysis that elucidate diet composition and trophic status of green turtles. Esophageal lavage was used to recover recently consumed food items from all turtles; skin samples were collected from 10 of these animals and analyzed for stable carbon, nitrogen, and sulfur isotope signatures. Isotope values from skin were then compared to those for 50 potential prey samples to determine trophic linkages. In lavage samples, we identified 14 dietary components; red algae were the most prevalent, with a relative volume (% V) of 86.66 %, followed by seagrass *Ruppia maritima* (5.16 %), green algae (3.80%), mangrove *Rizophora mangle* (1.93 %) and animal matter (1.61 %). The isotope mixing model SISUS was used to calculate the range of possible contributions of each source to green turtle diet. Results showed that green algae and seagrasses were the major contributors to green turtle diet (60.43±3.44 % and 26.77±0.43 %), followed by brown algae (5.21±4.05 %) and red algae (4.58 ±3.53 %). Sponges and mangrove had the least contribution (1.92±1.49 % and 1.09±0.84 %). Ecopath modeling established the trophic level (TL) of green turtles, estimated the biomass distribution between trophic levels, and calculated transfer efficiencies of all groups. Green turtles had a TL of 2.12, omnivory index of 0.16 and the proportion of energy paths that participated in the ecosystem was 8.1, thus indicating that green turtles (with dolphins and suprabenthic organisms) are the three most important components in the local marine ecosystem with high connectivity and important dispersal of indirect effects through it. The marine algae and seagrasses apparently have the

highest energy transfer efficiency (24.2 %), a result that underscores the role of juvenile of green turtles in the nutrient balance within coastal lagoons. We want to acknowledge to The International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and the International Sea Turtle Symposium for its economic support.

SOUTHERMOST RECORD OF POST-HATCHLING *CARETTA CARETTA* IN THE ATLANTIC OCEAN

Gabriela Velez Rubio[1], Maria Noel Caraccio[1,2], Gustavo Martinez-Souza[1,3], and Andres Estrades[1]

[1] KARUMBE, Biodiversidad y Conservación. Av. Rivera 3245, Montevideo CP 11400, Uruguay
[2] Laboratorio de Bioquímica de Organismos Acuáticos. Dirección Nacional de Recursos Acuáticos (DINARA)
[3] Programa de Pós-Graduação em Oceanografia Biológica – Universidade Federal de Rio Grande (FURG), Rio Grande do Sul, Brazil

Loggerhead turtle (*Caretta caretta*) is distributed globally in temperate, subtropical and tropical waters. The principal nesting populations along the Western Atlantic Ocean are located in the northeast of Brazil (Bahia, Espirito Santo and Sergipe states). Adults migrate seasonally to the feedings grounds of the Southwestern Atlantic (SWA) region, including the Rio de la Plata estuary. In Uruguay, is frequent found immature and adults from 51 to 112 cm curved carapace length (CCL) in coastal waters and continental shelf, respectively. The area is under influence of the southern branch of the South Brazilian Current. Mean water temperature in autumn is around 14ºC, and mean salinity is 35‰. The post-hatchling stage of a sea turtle's life history has often been referred to as the 'lost years', reflecting the lack of understanding about this phase in their life. Obtaining information on where post-hatchlings go, or for how long is significantly hindered by the elusiveness of a post-hatchling in its natural environment. Previous sighting of *C. caretta* post-hatchlings in the SWA corresponds to the coast of Sao Paulo, Brazil. But knowledge of the distribution of the early juvenile stage for this species is limited. On 14 June 2010, a post-hatchling loggerhead turtle was stranded on the south beach of Cerro Verde (33°56' 47"S, 53º 30' 27" W), located within the Coastal-Marine Protected Area of Cerro Verde and Islas de La Coronilla, Department of Rocha (Uruguay). The turtle was stranded alive and was moved to the Karumbé's Marine Turtle Center in Montevideo for rehabilitation. The physical condition was not optimal because it was thin (weight was 75 grams) and had a cut on his right front flipper. The turtle measured 8,43 cm SCLn-t; 8,35 cm SCLmin and 6,99 cm SCW. During the time spent in the rehabilitation center was offered different kind of food but did not eat regularly. After two month the turtle died. Necropsy was performed and shows that the digestive tract was completely filled with nematode worms, possible cause of death. To identify the natal origin of this post-hatchling loggerhead turtle, tissue sample was collected for genetic analysis. The sequence of 800 bp obtained from the mitochondrial DNA control region revealed a haplotype previously described. The specimen exhibits the loggerhead CC-A4.2 haplotype registered in the Archie Carr Center for Sea Turtle Research database. Nonetheless, this sequence has also been reported in the GenBank database as BR3 haplotype (accession number DQ177336.1) associated to a Brazilian hawksbill x loggerhead hybrids nesting population. According with the geographic localization where the turtle was found, and the morphologic and genetic analysis accomplished in this study, this turtle corresponds a loggerhead CC-A4.2 haplotype. This stranded turtle seems to be the southernmost record for the Western Atlantic Ocean. There is a big gap in the knowledge of the post-hatchling ecology of the Southwest Atlantic loggerheads. These kinds of reports contribute to clarify the post-hatching stages of this species.

DIET OF *CHELONIA MYDAS* IN GORGONA NATIONAL PARK (COLOMBIAN PACIFIC) DETERMINED THROUGH ESOPHAGEAL LAVAGE AND STABLE ISOTOPE ANALYSIS

Laura Sampson[1], Diego Amorocho[2], and Alan Giraldo[1]

[1] Universidad del Valle, Cali, Colombia
[2] CIMAD, Cali, Colombia

Gorgona National Park (GNP) is the most important foraging area of the Colombian Pacific for green sea turtles *Chelonia mydas*. *C. mydas* are known to be herbivorous as adults, and it has been thought that when juveniles enter the neritic phase, they switch from a carnivorous to a mainly herbivorous diet. However, several recent studies in the Eastern Pacific have found that juveniles also include animal protein in their diet, tending towards an omnivorous diet. The *C. mydas* juveniles that forage in GNP seem to feed on a mostly carnivorous diet of invertebrates, with a much lower amount of vegetable material in the diet than that found for juveniles foraging in other areas. It is therefore important to determine the diet of *C. mydas* in a potentially important foraging area of the Eastern Pacific, and the timing of the switch from a pelagic to a neritic diet. Knowing the variability in the feeding strategies of *C. mydas* juveniles in GNP, as well as determining their position in the food chain of this area, is important for establishing their role in the local ecosystem, and could be of use in the long-term assessment of ecological integrity of the protected marine area of GNP. The objectives of the present study are 1) to confirm the diet and trophic position of green turtle juveniles while they forage at GNP, 2) to establish whether diet previous to the arrival at GNP (presumably pelagic carnivory) differs significantly from diet while in the park. Diet will be determined through stable isotope analysis of skin and scutes and compared with results of eosophageal lavage. Skin tissue has a stable isotope turnover rate of a few months and will be indicative of diet while in the park, while keratin tissue, which is inert, will be indicative of the diet at the time of tissue formation. Keratin from the anterior edge of marginal scutes represents recent diet and keratin from the posterior edge represents older diet. The isotopic signal of *C. mydas* skin after spending several months feeding in the area should reflect the isotopic signal of their food in the neritic zone of GNP. The $\delta^{13}C$ values will allow us to infer the origins of nutrients and timing of the switch from pelagic to neritic feeding, while $\delta^{15}N$ isotopes are indicative of trophic level and will allow us to infer a switch in diet from carnivory to herbivory. Previous studies have shown that *C. mydas* diet can be opportunistic. We will therefore sample potential prey over one year in order to get an estimate of isotopic signals of available prey seasonally.

TRAS LA RUTA DE LAS TORTUGAS GOLFINAS…!!!!. LOS CABOS, B.C.S. MEXICO SATLELLITE TRACKING PROGRAM OF THE OLIVE RIDLEY SEA TURTLES IN A CONSORTED EFFORT WITH THE GOVERNMENT, PRIVITE SECTOR, THE LOCAL COMMUNITY, AND NON PROFIT ORGANIZATIONS

Phil R. Sanders[1], Graciela Tiburcio Pintos[2], and Jeffrey A. Seminoff[3]

[1] Hotel Hilton Los Cabos miembro de la Red para Protección de la Tortuga Marina en el Municipio de Los Cabos, Baja California Sur, México
[2] H. X Ayuntamiento de Los Cabos, Baja California Sur, México
[3] NOAA - National Marine Fisheries Services, Southwest Fisheries Science Center, La Jolla, California

The administrators of this project will convey that Satellite tracking of the Olive Ridley Sea turtles captured within the Los Cabos Baja California Sur with the proper application of transmitters, providing invaluable knowledge about the behavior of the animals during their inter-nesting, Sea turtle rookery, distance and possible routes in the post displacement nesting season and how it contributes to the study of their behavior at sea, This project provides invaluable knowledge to define the different migratory routes or groups estimate the components of the breeding population. The Satellite tracking project was started in 2009 and since that time we have tracked four turtles of this species with the combined effort and contributions from sponsors who include both local and international Hotels, municipal government, federal government, and nonprofit organizations. We will also present the results of these four projects (Azteca, Camilla, Terramar, Renata) and their outcome. We will present a recommendation for the secure

attachment of transmitters (TAGS) to help reduce the premature and costly loss of tags. In conclusion we will present the important benefits of involving the local community, local and federal government and local businesses. We will discuss the joint campaign with the Hilton hotel and their promotion of the project and the amount of public awareness and education gained from their involvement as well as other hotels in the area. We will also describe the transition from the early work of conservation and research on marine turtles. From both a local and regional perspective that has led to a successful and integrated conservation program within the community. The organization recently celebrated its first decade in 2010 and is also promoted by the local municipal government. For this project of recovery in order for the sea turtles to mitigate, current threats to nesting habitat in the region of Los Cabos, BCS must be protected and enforced as Los Cabos is a very important destination in Mexico for the Sea Turtles and other Marine life.

FINE SCALE DAILY MOVEMENTS AND HABITAT USE OF EAST PACIFIC GREEN TURTLES AT A SHALLOW COASTAL LAGOON IN BAJA CALIFORNIA SUR, MEXICO*

Jesse Senko[1], Volker Koch[2], William M. Megill[3], Raymond R. Carthy[1], Robert P. Templeton[3], and Wallace J. Nichols[4]

[1] Florida Cooperative Fish and Wildlife Research Unit, USGS Biological Resources Division, Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL 32611, USA
[2] Universidad Autónoma de Baja California Sur, Departmento de Biología Marina, Carretera al Sur km 5.5, 23080 La Paz, BCS, Mexico
[3] Department of Mechanical Engineering, Ocean Technologies Laboratory, University of Bath, Bath, BA2 7AY, UK
[4] Ocean Revolution and California Academy of Sciences, Davenport, CA 95017, USA

Green turtles spend most of their lives in coastal foraging areas where they face multiple anthropogenic impacts. Therefore, understanding their spatial use in this environment is a priority for conservation efforts. We studied the fine scale daily movements and habitat use of East Pacific green turtles (*Chelonia mydas*) at Laguna San Ignacio, a shallow coastal lagoon in Baja California Sur, Mexico where sea turtles are subject to high levels of gillnet bycatch and directed hunting. Six turtles ranging from 44.6 to 83.5 cm in straight carapace length were tracked for short deployments (1 to 6 d) with GPS-VHF telemetry. Turtles were active throughout diurnal, nocturnal, and crepuscular periods. Although they moved greater total distances during daytime, their speed of travel and net displacement remained consistent throughout 24-h periods. A positive selection for areas of seagrass and moderate water depth (5 to 10 m) was determined using Ivlev's electivity index, with neutral selection for shallow water (b5 m) and avoidance of deep water (N10 m). Turtles exhibited two distinct behavioral movement patterns: circular movements with high fidelity to the capture–release location and meandering movements with low fidelity to the capture–release location. Our results indicate that green turtles were active throughout the diel cycle while traveling large distances and traversing multiple habitats over short temporal scales.

VERTICAL AND HORIZONTAL HABITAT PREFERENCES OF POST-NESTING LEATHERBACK TURTLES IN THE SOUTH PACIFIC OCEAN*

George L. Shillinger[1], Alan M. Swithenbank[2], Helen Bailey[3], Steven J. Bograd[4], Michael R. Castelton[2], Bryan P.Wallace[5], James R. Spotila[6], Frank V. Paladino[7], Rotney Piedra[8], and Barbara A. Block[2]

[1] Center for Ocean Solutions, 99 Pacific Street, Suite 155A, Monterey, CA 93940, USA
[2] Hopkins Marine Station, Stanford University, 120 Oceanview Boulevard, Pacific Grove, CA 93950, USA
[3] Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD 20688, USA
[4] NOAA/NMFS/SWFSC/Environmental Research Division, 1352 Lighthouse Avenue, Pacific Grove, CA 93950, USA

[5] Global Marine Division, Conservation International
[6] Department of Biology, Drexel University, Philadelphia, PA 19104, USA
[7] Department of Biology, Indiana-Purdue University, Fort Wayne, IN 46805, USA
[8] Parque Nacional Marino Las Baulas, Ministerio de Ambiente y Energía y Telecomunicaciones, Apartado 10104-1000, San José, Costa Rica

In this study, we analyzed the vertical and horizontal habitat preferences of 46 satellite-tagged female leatherback turtles (Playa Grande, Costa Rica; 2004-2007) in the South Pacific Ocean. Turtles exhibited short, shallow dives during their migration southward (mean depth = 45 m, mean duration = 23.6 min), followed by deeper, longer dives (mean depth = 56.7 m, mean duration 26.4 min) in the South Pacific Gyre that probably indicated searching for prey. We integrated the horizontal movements with remotely-sensed oceanographic data to determine the turtles' response to the environment, and applied this information to recommendations for conservation in the pelagic environment. A generalized additive mixed model applied to the daily turtle travel rates confirmed that slower travel rates occurred at cooler sea surface temperatures, higher chlorophyll-a concentration and stronger vertical Ekman upwelling, all of which are considered favorable foraging conditions. The southern terminus (35-37°S) of the leatherback tracks was also in an area of increased mesoscale activity that might act as a physical mechanism to aggregate their prey, gelatinous zooplankton. However this could also act as a thermal limit to their distribution. This characterization of leatherback habitat use could aid the development of management efforts within the South Pacific Ocean to reduce mortality of leatherback turtles from fisheries interactions.

POSSIBLE EVIDENCE FOR MALE-MEDIATED GENE FLOW IN GREEN TURTLES

Kimberley L. Stokes[1], Wayne J. Fuller[2,3], Brendan J. Godley[1], Robin T. Snape[1,3], and Annette C. Broderick[1]

[1] University of Exeter, Tremough, Cornwall, UK
[2] European University of Lefke, Lefke, Cyprus
[3] Society for the Protection of Turtles in Northern Cyprus, Girne, Turkey

The study of mating systems and their impact on effective population size is fundamental in the assessment of species of conservation concern, and is particularly challenging in the marine realm. A rare opportunity allowed us to deploy a satellite transmitter on an adult male green turtle (*Chelonia mydas*) from a major nesting site in Cyprus. Upon release, the male travelled to two further nesting sites in Cyprus, before making a 350 km diversion to Turkey. Here, he spent 12 days in the coastal waters offshore from three major nesting beaches, undertaking behaviour patterns consistent with mate-seeking, before travelling to the north African coast. This diversion extended the distance of his journey by 44% and took him within 20 km of six different rookeries, which together represent 58% of all conspecific nesting activity in the Mediterranean. Should this behaviour result in matings at multiple sites, it has considerable implications for the effective size of this population, representing a possible avenue for male-mediated gene flow and potentially ameliorating a significant sex ratio bias in the face of climate change.

STABLE ISOTOPE ANALYSIS OF LEATHERBACKS NESTING IN NORTHERN AND SOUTHERN GABON*

Manjula Tiwari[1], Eric Augowet Bonguno[2], Edgard Faure[2], Angela Formia[3], Gil Avery Mounguengui Mounguengui[2], Carine Moussounda[2], Monique NSafou[2], Solange Ngouessono[2], Richard J. Parnell[2], Guy-Philippe Sounguet[2], Jean Michel Megne[2], François Boussamba[2], Sebastian Verhage[2], Didier Pierre Agamboue[2], Floriane Cardiec[2], Sandrine Ricois[2], Alain Gibudi[2], and Jeffrey Seminoff[1]

[1] NOAA-National Marine Fisheries Service, Southwest Fisheries Science Center, 8604 La Jolla Shores Dr., La Jolla, CA 92037, USA
[2] The Gabon Sea Turtle Partnership, Libreville, Gabon
[3] Wildlife Conservation Society, Libreville, Gabon

Gabon supports one of the largest leatherback nesting populations in the world with the majority of nesting occurring in Pongara in the north and Mayumba in the south. Leatherbacks from this population have been reported from South African and South American waters suggesting that the population may have different foraging strategies. In this study, we collected tissue samples from leatherbacks nesting in Pongara and Mayumba and analyzed the stable isotope values of carbon and nitrogen to determine whether leatherbacks nesting in Pongara and Mayumba may have different foraging strategies. Differences were found in isotope values between leatherbacks nesting in northern and southern Gabon suggesting differences in diet and geographic range. Both northern and southern Gabon leatherbacks forage in oceanic and neritic waters, with a larger proportion of leatherbacks foraging in neritic waters. The implications of these findings are discussed in the context of the conservation and management of this population.

18 YEARS OF TAGGING AND RECAPTURE DATA ON JUVENILE LOGGERHEAD SEA TURTLES FROM THE WESTERN MEDITERRANEAN

Jesús Tomás[1], Patricia Gozalbes[2], Juan Eymar[2], Gabriela Vélez-Rubio[1], and Juan A. Raga[1]

[1] Cavanilles Institute of Biodiversity and Evolutionary Biology, Apdo. 22085, E-46071 Valencia, Spain
[2] Conselleria de Medio Ambiente Agua Urbanismo y Vivienda, Generalitat Valenciana & Cavanilles Institute of Biodiversity and Evolutionary Biology, Apdo. 22085, E-46071, Valencia, Spain

Sea turtle strandings and captures on the coasts and in coastal waters of the Valencia Community (VC, East Spain) have been recorded since 1989 as part of a stranding network. Since 1993, a total of 232 sea turtles stranded or captured alive have been recovered, flipper tagged (metal and/or plastic tags) and released within this network. Most of them (231) were juvenile loggerhead turtles (*Caretta caretta*, mean CCL= 45.3 ± 11.7 cm), but also a Kemp's ridley (*Lepidochelys kempii*) was tagged. In the recent years, turtles have been double-tagged with external tags and PIT tags. For the period 1993-2010, a total of 12 tagged loggerhead turtles (5.2%) have been recaptured either in the VC (7) or in other locations of the western Mediterranean (5), including South France, the Tyrrhenian Sea (Italy) and the Balearic Archipelago (Spain). Some of these turtles where included in a collaborative study that gathered data of different stranding networks from different regions of the Spanish Mediterranean. However, recent recaptures and the recaptures in the VC waters of loggerheads turtles tagged elsewhere, including Italy (2), France (2), Malta (1) and the east coast of USA (1) call for a new data analysis to answer emerging questions. Average minimum distance travelled (i.e., straight distance between release and recapture locations but surrounding land) of recaptured turtles released by the VC network was 310.1 km (N= 12), but for the 5 recaptured out of VC waters was 699.1 ± 300.1 km. The other 7 stayed in a range under 200 km from release point (range: 24.7-187 km). Mean time between release and last recapture was 447 days (range: 17-2533 days), being the one that lasted more the turtle recaptured in the Tyrrhenian Sea, which retained a metal tag for 7 years. Main cause of entry of these turtles into rescue centers of the VC network was incidental capture by fisheries 38.2%, mainly by trawler. Three of the recaptures were also due to fisheries interaction. Since only 6 out of 12 turtles were recaptured dead, we cannot calculate survival rates, although relative long recapture periods of most of the turtles indicate good rehabilitation. The fact that some turtles stayed in a limited range for long periods (one turtle was recaptured just 187 km from release point after 1252 days) may indicate that some loggerheads remain using the

central westernmost part of the Mediterranean as feeding and development ground. In fact, one of the turtles was recaptured three times between 2002 and 2005 within a range of 100 km. Nonetheless, the recaptures out of VC waters, including movements against main surface currents, and the recaptures of turtles tagged elsewhere are indicative of complex dispersal movements, including transatlantic migrations, of juvenile loggerheads during development stages. Our results show the importance and need of international cooperation and coordination between networks and institutions to increase data collection that contributes to unlock habitat use and dispersal movements of juvenile sea turtles.

TURNING OFF THE HEAT: IMPACTS OF ONCE-THROUGH-COOLING (OTC) POWER PLANT DECOMMISSIONING ON GREEN TURTLE RESEARCH IN SAN DIEGO BAY, CALIFORNIA, USA

Cali Turner Tomaszewicz[1] and Jeffrey Seminoff[2]

[1] University California San Diego, Scripps Institution of Oceanography – Center for Marine Biodiversity and Conservation, La Jolla, California, USA; Current: Ocean Discovery Institute, San Diego, California, USA
[2] NOAA National Marine Fisheries Service – Southwest Fisheries Science Center, La Jolla, California, USA

Green turtles (*Chelonia mydas*) are among the most high profile species in San Diego Bay, California, and understanding impacts of coastal development and industry is essential to the management and conservation of this local population. Here we describe power plant changing energy production and its impact on turtle habitat use and our ability to research and manage this population. For over 20 years, green sea turtles have been captured, assessed and tagged near the South Bay Power Plant (SBPP) in the San Diego Bay; from 2002-2009, 73 turtles were captured on 173 occasions. As the 50-yrs old SBPP generates less energy, effluent patterns change and water temperatures decrease, presumably to more natural conditions. There has been a concurrent decrease in turtle-capture success, perhaps due to lesser visitation to the effluent site where nets are tended. Seasonal catch-per-unit-effort declined from a high of 4.14 turtles per monitoring day, to a seven-year low of 1.45 during the 2008-2009 season. It is already apparent that management decisions related to energy policy are affecting the habitat and behavior of this stock of endangered turtles. Green turtles are expected to remain in the San Diego Bay after the SBPP becomes inoperative and continuing research will monitor future impacts and distribution shifts resulting from the expected changes in thermal pattern within south San Diego Bay. Research efforts to study this population (i.e. capture methods and locations) will require modification in response to these changes. Lessons learned here are applicable to the immediate coastal development of San Diego, as well as at similar interactions between marine turtles and industrial thermal effluent discharge throughout Southern California, the United States and beyond.

OBSERVATION AND ANALYSIS OF INSECTS AS A PELAGIC JUVENILE SEA TURTLE PREY ITEM DURING THE DEEPWATER HORIZON OIL SPILL EVENT

Christina M. Trapani[1], Craig A. Harms[2], Lydia A. Staggs[3], Melanie S. Holmes-Douglas[3], and David L. Stephan[2]

[1] Virginia Aquarium Stranding Response Program, Virginia Beach, Virginia, USA
[2] North Carolina State University, Raleigh, North Carolina, USA
[3] Gulf World Marine Park, Panama City Beach, Florida, USA

On April 20, 2010, an oil rig off the coast of Louisiana exploded, causing what would become the worst oil spill in United States history. As a result, NOAA (National Oceanic and Atmospheric Administration) initiated sea turtle rescue efforts off the coasts of Louisiana, Alabama and Florida. Audubon Nature Institute (ANI) in New Orleans, Louisiana and Gulf World Marine Park (GWMP) in Panama City Beach, Florida, admitted most of the rescued turtles

during this event. Species admitted to both facilities included Kemp's ridley (*Lepidochelys kempii*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*) sea turtles. During this event, GWMP admitted 149 sea turtles for de-oiling and rehabilitation. Veterinarians and staff maintained daily feed and defecation records for each turtle. Defecation observations included shells (sp. unknown), anthropogenic debris and insect parts. As prevalence of insect parts became apparent, staff began to note more specifically the insect parts and collect samples. From July 31 through August 4, GWMP admitted 72 turtles including 40 Kemp's ridley (avg 1.8 kg, 22.49 cm SCL), 30 green (avg. 1.24 kg, 21.16 cm SCL) and two loggerhead (avg. 1.15 kg, 19.3 cm SCL) sea turtles. An initial analysis of up to 11 days of post-capture fecal observations for the above turtles indicated that minimally, 42% of these turtles defecated insect parts: 55% of Kemp's ridleys (n=22), 50% of loggerheads (n=1) and 23% of greens (n=7). During the above mentioned time frame, turtles were rescued within a 14,500 square km (5600 square mile) area. Rescue locations were mapped and the locations of animals that defecated insect parts compared to those that did not defecate insect parts showed no obvious geographic pattern. Apparent non-insectivores were found up to 97 km (60 miles) from shore. Nine samples of insects from two species of sea turtle (Kemp's ridley and green) were collected for identification. Initial identification of some of the samples includes the *Schistocerca* (Katydids) and *Neoconocephalus* (Grasshoppers) genera, the *Chlaenius* and *Calosoma* genera (Ground Beetles), the *Aeschnidae* and *Libellulidae* families (Dragonflies), and undetermined *Odonata* (Dragonflies or Damselflies). The composition of insect species represented in these fecal samples may result from some combination of differential aerial and debris-rafting dispersal capacity by insects, selective feeding by sea turtles, or durability of exoskeleton parts through the digestive process. There have been previous reports of insect consumption by both post-hatchling and pelagic juvenile sea turtles. This unusual circumstance of elevated sea turtle rescues provided the opportunity to record insectivory by multiple species. The high prevalence of insect parts in fecal samples from turtles rescued over a broad area of the Gulf of Mexico, suggests that terrestrial food sources may, at least occasionally, make a substantial contribution to the diet of juvenile pelagic sea turtles.

PRELIMINARY TESTS OF SOLAR-POWERED GEO-POSITIONAL ARCHIVAL TAGS WITH LOGGERHEADS

Tony Tucker[1], Thomas Gray[2], and Marco Flagg[2]

[1] Mote Marine Laboratory, Sarasota, Florida, USA
[2] Desert Star Systems, Marina, California, USA

We field tested a solar-powered geo-positional archival tag based on the Earth's magnetic field for comparisons with standard tracking methods by ARGOS transmitters. The measurement of properties of the earth's magnetic field to augment light readings as a means to improve latitude estimates was first proposed in 1994. The approach is now implemented in SeaTag-GEO, an archival tag introduced in 2010 by Desert Star Systems that relies on measurements of the total intensity of the magnetic field. The development of novel tags holds promise to revolutionize the accessibility of marine vertebrate tracking, but has received limited evaluation in tracking sea turtles. A concurrent satellite tracking program for loggerheads in the Gulf of Mexico enabled an accessible suite of animals with known histories for a test-bed. These preliminary results establish a baseline for future broad scale assessments of geospatial activities by marine vertebrates. The results evaluate a potential tool to cost-effectively document sea turtle nesting, internesting movements, post-nesting migrations, and foraging residency. A large suite of animals were tracked simultaneously with geo-positioning tags and satellite transmitters. Should the geo-positioning tags work as well as expected, a necessary premise is fulfilled in validating and verifying their accuracy. If a geo-positioning and satellite telemetry match of locations is consistent among individuals, there is an encouraging possibility that SeaTags can be used in lieu of the much more expensive satellite telemetry approach. These are the first results from the devices on sea turtles, although the instruments have been tested for other marine vertebrates (seals, sharks, penguins). We explore several practical tagging issues and questions related to magnetic field sensing tags, including the magnetic influence of related tagging hardware and the opportunity for obtaining limited position estimates based on magnetic data only, such as in the absence of light in deep or turbid waters.

MECHANISMS OF MAGNETIC ORIENTATION AND EFFECTS ON NEST SITE FIDELITY IN LOGGERHEAD TURTLES WITHIN THE GULF OF MEXICO

Christina Vilmar[1] and Tony Tucker[2]

[1] University of Texas, Austin, Texas, USA
[2] Mote Marine Laboratory, Sarasota, Florida, USA

In the world of long distance migration typified by butterflies, birds, salmon, and sea turtles, there are competing hypotheses about mechanisms underlying migration which include celestial, magnetic, olfactory, celestial, and geospatial cues. To successfully navigate by a mechanism or combinations of mechanisms, organisms must determine relative position and direction to a selected destination. Sea turtles use magnetic orientation as a guidance system by at all life history stages from developmental migrations through to reproductive migrations. Long distance migrations from foraging sites to natal beaches may be explained because sea turtles can perceive magnetic inclination and field intensity. Every spatial location has a specific angle of inclination and intensity. Inclination is the angular difference between the magnetic vector and the horizon and shifts from 90 degrees at the magnetic poles to 0 degrees at the magnetic equator. Total intensity is the strength of the magnetic field ranges from about 65,000 nanoTesla (nT) at the magnetic poles to about 25,000 nT at the magnetic equator and is made up of horizontal and vertical components. Sea turtles possess an inclination compass similar to birds' magnetic compasses, but can also orient in complete darkness unlike birds. A magnetic inclination gradient from foraging ground to nesting coastlines might potentially aid in nesting migrations. We tested the premise about loggerheads' mechanisms of magnetic orientation and potential influences on nest site fidelity by contrasting the geomagnetic values of nest and foraging locations around the Gulf of Mexico to understand potential effects of magnetic orientation on site fidelity. Site fidelity is a distance between a female's two furthest nests in a season. A loggerhead rookery at Casey Key, Florida, was patrolled on ATVs from mid May through July at night to intercept nesting females and apply ARGOS transmitters to the carapace. We evaluated a subset of 43 female loggerheads (2006-2009) tagged on their first nest of the season to encompass all nests of the season. Females were subsequently tracked in their internesting areas and finally to a foraging grounds. We calculated nest fidelity both including and excluding the first nest because of a skewed distribution relating to navigational correction. Geomagnetic field values for latitude and longitude at the foraging grounds and nesting rookery were derived in NOAA's National Geomagnetic Calculator. We compared site fidelity (km between furthest nests) for all nests and excluding first nest to the differences in geomagnetic components of their foraging and nesting grounds. The study furnishes empirical data that address several questions: 1-Is distance between foraging and nesting grounds a determinant of site fidelity? 2-Does a migration across changes of vertical or horizontal intensity in the geomagnetic field affect nest site fidelity? 3-Does female reproductive status affect nest site fidelity?

INTERNESTING, POST-NESTING AND FORAGING MOVEMENTS OF FLATBACK TURTLES (*NATATOR DEPRESSUS*) IN THE KIMBERLEY REGION, WESTERN AUSTRALIA*

David Waayers, Jeremy Fitzpatrick, and Leanne Smith

RPS Planning and Environment, Australia

Despite the abundance of satellite transmitters released in northern Western Australia (a total of 66 transmitters on www.seaturtle.org), little information relating to internesting, post-nesting and foraging movements of flatback turtles (*Natator depressus*) has been published. The few published studies from rookeries in Western Australia have provided some preliminary data on the post-nesting migration movements of flatback turtles, which show migration pathways along the Kimberley coast to waters in the Northern Territory. However, there continues to be a paucity of literature on the internesting movements and foraging areas of flatback turtles in Western Australia. This paper presents satellite tracking data on the internesting and post-nesting migratory pathways of flatback turtles in Western Australia nesting at the Maret and Lacepede Islands and identifies probable foraging areas in the Kimberley region. Eighteen Fastloc™ satellite transmitters were attached to flatback turtles nesting at South Maret Island (Bonaparte Archipelago) and West Island (Lacepede Islands). The acquisition of GPS positions were recorded for up to 12 months. A total of seven F4G-

291A (Sirtrack Pty Ltd, New Zealand) transmitters were harnessed to flatback turtles on South Maret Island during the interesting period (December) in 2006 and 2007. Eleven F4G-291A and Mk10-AF (Wildlife Computers Inc., Redmond USA) were harnessed to flatback turtles on West Island in December 2009 and February 2010. Unlike most hard-shelled Cheloniids, the study found that flatback turtles at both locations had broad interesting distributions with all turtles immediately departing the nesting area and continuously travelling during the re-nesting period for up to 60 km visiting the inshore waters of nearby islands and mainland coastal areas. Of the transmitters released at South Maret Island, five provided post-nesting data while eight transmitters provided post-nesting data from West Island. Key findings from the post-nesting data showed that the majority (8/13) of the flatback turtles travelled to the same end point between Gale Banks, Penguin Shoal and Eugene McDormett Shoal in the Timor Sea, suggesting this area is a probable foraging ground for flatback turtles. The other turtles remained within the internesting area with the exception of one flatback turtle that travelled 2,700 km to Thursday Island via the coast of Papua New Guinea. This paper investigates the temporal and spatial movements of flatback turtles and identifies a potentially significant foraging area for flatback turtles in Western Australia.

CONTRASTING THE ROLE OF GREEN SEA TURTLES (*CHELONIA MYDAS*) IN CARIBBEAN AND HAWAIIAN REEF ECOSYSTEMS*

Colette C.C. Wabnitz[1], George Balazs[2], Sallie Beavers[3], Karen A. Bjorndal[4], Alan B. Bolten[4], Villy Christensen[1], Marta Coll[5], and Daniel Pauly[1]

[1] Fisheries Centre, AERL, University of British Columbia, 2202 Main Mall, Vancouver V6T 1Z4, Canada
[2] Marine Turtle Research Program NOAA, National Marine Fisheries Service Pacific Islands Fisheries Science Center 2570 Dole Street Honolulu, HI 96822-2396, USA
[3] National Park Service, Kaloko-Honokohau National Historical Park, 73-4786 Kanalani St., #14, Kailua Kona, HI 96740, USA
[4] Archie Carr Center for Sea Turtle Research, Department of Zoology, PO Box 118525, University of Florida, Gainesville, FL 32611, USA
[5] Institut de Ciències del Mar, Scientific Spanish Council (ICM-CSIC), Barcelona, Spain

Grazing by macroherbivores is one of the major processes structuring benthic coral reef communities. In Hawai'i, green sea turtles (*Chelonia mydas*) feed primarily on algal species that commonly occur on the reef. Recovery of the species' populations throughout the Hawaiian Archipelago since their formal protection in the 1970s has meant that green turtles have been playing an increasingly important role in maintaining reef resilience. However, reduced growth rates and poor body condition at a number of foraging sites, including Kaloko-Honokōhau National Historical Park (Kaloko), suggests that some populations have reached carrying capacity. In contrast to Hawai'i, green turtles in the Caribbean predominantly forage on seagrass and, thus, may only have an indirect impact on the trophodynamics of reef systems. Moreover, a long history of human exploitation means that green turtle numbers have been so dramatically reduced that they probably no longer perform their functional role within seagrass-reef systems. To better understand and contrast the ecological structure and ecosystem processes of the ecosystems at 'carrying capacity' levels of green turtles at both locations, two ecopath ecosystem models were developed, which synthesized available data on the trophic web: (i) at Kaloko for the year 2005, representing 26 groups; and (ii) in the coastal waters around the USVI and Puerto Rico, for an average mid-1990s situation, representing 36 groups (17 fish and 19 non-fish). Restoration of green turtle abundance was simulated through hypothetical bio-accumulation. Non-trophic interactions to simulate the loss of protective cover afforded to juvenile fishes and other prey by shorter seagrass blades (due to increased grazing) were implemented through 3 alternative functions derived from the literature. Model results for Kaloko showed that the combined grazing pressure of the different herbivorous functional groups (i.e., fish, urchins and turtles) matched total algal production. Overall, urchins exerted the strongest control over algae - partly owing to their large biomass in park waters. Model results confirmed that the Kaloko green turtle population, which feeds almost exclusively on algal turfs that grow on a shallow near-shore lava bench, has reached carrying capacity. Analyses highlighted the important role (and complementary to other herbivores) Hawaiian green turtles play in maintaining low algal cover and, thus, resilience of reefs in the face of disturbance, and the need to explicitly include green turtles in studies seeking to describe ecosystem dynamics on reefs. Caribbean model results showed that green turtles indirectly influenced reef dynamics via their grazing impact on the nursery function of seagrass for the juveniles of certain species. Findings demonstrated that these changes are more complex than suggested by published simple predator-prey experiments conducted under different seagrass densities. We discuss (i) implications of diet and fish behaviour on current findings; (ii) the role of ecological models to help translate predictions made at experimental scales to the level of the ecosystem,

and to highlight existing gaps in our current understanding of Caribbean ecosystem processes; and (iii) the need for conservation measures that target sea turtle population recovery to consider ecosystem-level processes, and develop such recovery initiatives within an ecosystem-based management framework.

TIMING AND PATHWAYS OF FALL MIGRATION FOR JUVENILE GREEN SEA TURTLES IN BACK AND CORE SOUNDS, NORTH CAROLINA

Amanda Southwood Williard[1], Joanne Braun McNeill[2], and April Goodman[2]

[1] University of North Carolina Wilmington
[2] NOAA Beaufort Laboratory

Interactions with gillnet fisheries targeting southern flounder (Paralichthys lethostigma) have been implicated as a significant source of mortality for juvenile green sea turtles (*Chelonia mydas*) in coastal North Carolina. Green turtles are particularly vulnerable to gillnet encounters in the fall not only because of increased fishing effort, but also because of increased movement rates associated with the onset of their migration. More data regarding the timing and pathways of green turtle migrations are necessary in order to fully assess the potential for overlap with gillnet fishing operations and options for avoiding sea turtle interactions during the fall flounder fishery. We deployed 14 satellite transmitters on juvenile green turtles in Back Sound, North Carolina during September/October 2010 to document movements and migratory behavior during the period when the fall flounder fishery is in operation in this region. Preliminary data show that turtles have limited home range while resident in Back Sound and Core Sound. Initiation of migration out of the Sounds occurred as early as mid-October for some turtles, but other turtles remained resident in the Sounds through November. An analysis of green turtle movements with regards to environmental conditions and distribution of gillnet fishing effort within Back and Core Sounds will be presented. Spatial and temporal information on green turtle migrations may be useful in guiding future management decisions for the coastal gillnet fishery in this region.

GPS-LINKED SATELLITE TELEMETRY OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN PALM BEACH COUNTY, FLORIDA, USA

Lawrence D. Wood

Zoological Society of the Palm Beaches

Recent increases in the accuracy of satellite telemetry allow for the study of marine animal movements on a much finer scale than was previously possible. Though sea turtles are often associated with long-distance migration, many appear to remain in relatively small areas for extended periods of time, particularly during their juvenile and sub-adult life stages. Mark-recapture studies have suggested that young hawksbill turtles often exhibit highly restricted movement patterns upon recruitment to coral reef habitats. To better understand the foraging ecology of hawksbill turtles, GPS-linked satellite transmitters were deployed on three previously-documented sub-adult hawksbills in Palm Beach County, Florida, USA. Environmental and behavioral data were collected along with both ARGOS and GPS- generated location coordinates. Preliminary results confirm that the satellite-tagged hawksbills restrict their movements to relatively small areas within the reef environment, and that these ranges are likely shaped by resource availability.

VISUAL WAVELENGTH DISCRIMINATION BY THE LOGGERHEAD TURTLE, *CARETTA CARETTA*

Morgan Young[1], Michael Salmon[1], and Richard Forward[2]

[1] Biological Sciences, Florida Atlantic University, Boca Raton, Florida, USA
[2] Marine Science and Conservation, Duke University Marine Laboratory, Beaufort, North Carolina, USA

Very little is known about the visual capabilities of marine turtles. Studies have explored temporal resolution and spectral sensitivity differences among species but the ability to discriminate between colors has not been adequately demonstrated on the basis of behavioral criteria. In our study, we used a three-part methodology to determine if color discrimination occurred. First, we exposed naïve, light-adapted hatchlings to either a blue, green or yellow light presented in one arm of a Y-maze. These induced the hatchlings to crawl toward the light source. We manipulated light intensity to obtain a behavioral phototaxis threshold to each color. These responses provided us with a range of intensities for each wavelength that we knew the turtles could detect. Second, and using the same light sources, we used food to train the turtles to swim in a seawater-filled Y-maze toward one light color, and then to discriminate between the rewarded light and another light color that was not rewarded with food. Both lights were presented to the turtles at an intensity that was equally (usually, 1 log unit) above the phototaxis threshold. In the third part of the experiment, we will expose the trained turtles to paired lights of different colors in which intensity of the rewarded, and then the unrewarded, light is varied so that brightness can not be used as a discrimination cue. To date, one turtle has completed this task and shown a clear ability to select a rewarded color over a non-rewarded color, regardless of stimulus intensity. We are in the process of training additional turtles.

UNDERSTANDING MIGRATORY AND FORAGING BEHAVIOR OF GREEN TURTLES *CHELONIA MYDAS* IN THE GALAPAGOS ISLANDS THROUGH STABLE ISOTOPES

Patricia M. Zárate[1,2], Karen A. Bjorndal[1], Jeffrey A. Seminoff[3], and Alan B. Bolten[1]

[1] Archie Carr Center for Sea Turtle Research and Department of Biology, PO Box 118525, University of Florida, Gainesville, FL 32611, USA,
[2] Native Vertebrates Monitoring Program, Charles Darwin Foundation, Santa Cruz Island, Galapagos Islands, Ecuador
[3] National Marine Fisheries Service, Southwest Fisheries Science Center 8694, La Jolla, CA 92037, USA

Fundamental aspects of the ecology of populations and individuals are their temporal and spatial distribution, migratory patterns, and habitat utilization. These studies can be difficult for marine turtles because most of their lives are spent at sea and their migrations involve long distance travel among separate breeding and foraging habitats. Stable isotope analysis has proved to be successful in providing information regarding trophic status, foraging ecology, migratory behavior and for the identification of sea turtle critical habitats. The Galapagos Archipelago, Ecuador, is one of the very few places in the world where green turtles (*Chelonia mydas*) both feed and reproduce. Stomach content analysis revealed that green turtles at local foraging grounds feed mainly on algae and to some extent on mangroves. Tag and recapture studies and satellite telemetry have provided information regarding the extent of migration of post-nesting females. Although these results provide information about green turtle foraging and migratory behavior, sample size is small. Our study here is the first to examine migratory and foraging behavior of Galapagos green turtles with stable isotope analysis. The impetus for this research is the lack of knowledge regarding the ecological role of green turtles in Galapagos, and the growing concern about appropriate protection of critical habitats for sea turtles in the Archipelago. Green turtles were examined at four key nesting beaches and four foraging grounds in the Galapagos Islands from 2003 to 2008. For each foraging site mean and standard deviations were calculated for $\delta 13C$ and $\delta 15N$ and related to body size and to individual morphological characteristics. Mean values of isotopic ratios of females nesting in Galapagos were related to body size and compared to foraging ground isotopic signatures in areas within Galapagos and throughout the southeast Pacific region. Oceanographic conditions and climatic factors were also examined. Galapagos foraging aggregations had a wide range of individual values for carbon and nitrogen suggesting differences among sites

and individuals. Stable isotope signatures for black and yellow morphs were different at particular foraging grounds suggesting different trophic status. Nesting females showed wider ranges for δ13C and δ15N compared to local foraging ground signatures, suggesting Galapagos green turtle visit other foraging grounds different than the ones examined here.

LOGGERHEAD SPECIALIZATION REVEALED BY STABLE ISOTOPE ANALYSIS*

Hannah B. Vander Zanden[1], Karen A. Bjorndal[1], Kimberly J. Reich[2], and Alan B. Bolten[1]

[1] Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, Gainesville, FL, USA
[2] Department of Marine Biology, Texas A&M University at Galveston, Galveston, TX, USA

Examination of individual resource use may reveal intrapopulational differences that are overlooked with population-level measures. Adult loggerhead sea turtles (*Caretta caretta*) are generalist carnivores with a broad isotopic niche. We used scute, an inert but continuously growing tissue, to examine variation in long-term resource use (diet, habitat, and location) in a population of nesting loggerhead turtles from Florida. Samples were microlayered in 50μm intervals and analyzed for stable isotopes of nitrogen and carbon. We estimate that scute records retain up to 12 years of resource use history and reveal that individual loggerheads are long-term specialists within a generalist population. We present our results in the context of a conceptual model comparing isotopic niches in specialist and generalist populations. Revealing patterns of individual consistency in resource use may have important ecological, evolutionary, and conservation consequences.

Health and Rehabilitation

BASELINE HEALTH PARAMETERS OF CLINICALLY HEALTHY AND PATHOLOGICAL EVALUATION OF STRANDED PACIFIC LOGGERHEAD TURTLES (*CARETTA CARETTA*) IMPACTED BY SMALL-SCALE FISHERIES IN BAJA CALIFORNIA SUR, MEXICO*

A. Alonso Aguirre[1], Hoyt Peckham[2], Iga Stasiak[3], Susan Hayhurst[4], Victor de la Toba[5], Alan Zavala-Norzagaray[6], Natalia Rossi[7], Carmen Valle[8], and Terry R. Spraker[9]

[1] EcoHealth Alliance, 460 West 34th Street, 17th Floor, New York, NY, USA
[2] Proyecto Caguama/Grupo Tortuguero de las Californias, AC, La Paz, Baja California Sur, Mexico
[3] Zoo Medicine and Pathology, University of Guelph-Toronto Zoo, Toronto, Canada
[4] Tufts University, Cummings School of Veterinary Medicine, Grafton, Massachusetts, USA
[5] Grupo Tortuguero de las Californias, AC, Puerto Lopez Mateos, Baja California Sur, Mexico
[6] IPN-CIIDIR-Sinaloa, Programa de Proteccion y Conservacion de Vida Silvestre, Guasave, Sinaloa, Mexico
[7] Department of Ecology, Evolution and Environmental Biology, Columbia University, New York, USA
[8] EcoHealth Alliance, New Yotk, New York, USA
[9] Colorado State University Veterinary Diagnostic Laboratory, Fort Collins, Colorado, USA

At Baja California Sur, México (BCS), the overlap of an important juvenile loggerhead foraging area with intense, local small-scale fisheries results in among the highest sea turtle bycatch rates documented globally, which in turn fuels equally high stranding rates. Additional factors may also contribute to regional loggerhead mortality including bycatch in undocumented fisheries, directed hunting for the illegal trade and consumption, and natural factors including predation and disease. To assess baseline health parameters of loggerheads in the region we have established comprehensive strandings and intensive live-capture programs during summer fishing seasons since 2007. Over 60 apparently healthy turtles captured alive were evaluated and their hematological and biochemistry values have been recorded. In addition, normal skin biopsies for herpesvirus and papilloma virus PCR screening and histopathology; and nasopharyngeal and cloacal swabs have been collected for microbiological analysis. Of 1121 loggerheads stranded at the 43km Playa San Lázaro BCS since 2007, very few stranded in fresh condition. Fully trained veterinarians performed full necropsies and histopathological analyses were performed by a board-certified pathologist on 12 turtles that were stranded in relatively fresh condition. The health of live turtles appears to have been excellent and we provide for the first time baseline hematological and biochemistry values for Pacific loggerhead turtles. A subset of the 12 turtles stranded in fresh condition that were subjected to full histopathological examination revealed liver, renal and lung lesions compatible to biotoxin poisoning and/or red algal bloom. Further testing is required to determine if domoic acid or a similar biotoxin is involved in exacerbating loggerhead strandings related to bycatch fisheries. Multifactorial etiologies have been identified as a cause of mortality of the endangered loggerheads suggesting that disease may result in morbidity and or mortality that could increase exceedingly high local mortality due to fisheries bycatch. Further research is needed to elucidate the relative importance of these disease and environmental factors in high regional stranding levels.

HAEMATOLOGY OF FREE-LIVING BLACK SEA TURTLES (*CHELONIA MYDAS AGASSIZII*) AND RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*) FROM THE PACIFIC COAST OF COSTA RICA

Ana Meneses[1], Andread Chaves[2], Kinndle Blanco[2], Mauricio Jiménez[1], Didiher Chacón[3], and Randall Aráuz[4]

[1] Escuela de Medicina Veterinaria, Universidad Nacional, Costa Rica
[2] Escuela de Ciencias Biológica, Universidad Nacional
[3] WIDECAST, Costa Rica
[4] PRETOMA, Costa Rica

This study reports the haematology values for free-living individuals of the species *Chelonia mydas agassizii* and *Lepidochelys olivacea* for the Pacific Coast of Costa Rica. A comprehensive health study will be conducted from October 2010 through October 2012 on free-living black sea turtles (*Chelonia mydas agassizii*) and ridley turtle (*Lepidochelys olivacea*) occurring off the Pacific coast of (Jiménez Port and Ostional Beach) Costa Rica. As a preliminary part of this study, blood samples were obtained from a total of 40 clinically normal individuals of each species, to establish normal haematology reference values for free-living green sea turtles. These results are the first data ranges of blood values available in individuals of this species of free-living turtles in Costa Rica and therefore will be very useful as a complementary diagnostic tool in the veterinary care of individual turtles.

FIRST CASE OF GREEN TURTLE FIBROPAPILLOMATOSIS IN COMOROS ARCHIPELAGO

Katia Ballorain and Stéphane Ciccione

Kelonia, l'Observatoire des tortues marines, Saint Leu, La Réunion, France

Fibropapillomatosis (FP) was first reported over 70 years ago in green turtles (*Chelonia mydas*) from Florida. Today, this epizootic disease is a growing threat to the survival of green turtle populations worldwide. The South West Indian Ocean is an important world area for the breeding and foraging green turtles, particularly in the small islands in the Mozambique Channel. However, little is known about the prevalence of the disease in the region: previous reports of green turtles affected by cutaneous fibropapillomatis concern only individuals of the Barren Archipelago on the west coast of Madagascar, Seychelles and Aldabra Island. Fibropapillomatosis is a neoplastic disease characterized by single to multiple external and internal fibroepithelial tumors. Between 2005 and 2007, a first case of FP has been suspected in a female green turtle foraging in a seagrass meadow at Mayotte Island. Tumors have not been confirmed as fibropapillomas on histology, but photographed epithelial lesions were compatible in morphology with the green turtle FP and affected eyes, neck, and shoulder areas. Tumors developed and multiplied in 2006, and then we observed a regression of the external tumors in 2007. Cases of tumor regression have been also observed in green turtles of the Barren Archipelago. Such observations need to be communicated to help better understand the geographical distribution of the disease, its origin, and its evolution.

THE USE OF OESOPHAGOSTOMY TUBE FOR THE FORCE-FEEDING IN SEA TURTLES

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

[1] Division of Veterinary Surgery, Faculty of Veterinary Medicine, University of Bari, Italy
[2] WWF Sea Turtle Rescue Centre, Lampedusa (Ag), Italy
[3] Department of Veterinary Public Health, Faculty of Veterinary Medicine, University of Bari, Italy

Severely debilitated or post-surgical sea turtles often suffer from anorexia, making their management very challenging. In cases like these, a nutritional support is mandatory. Common practice in rescue centres is assisted feeding, daily administered via a soft tube passed by mouth to stomach. This procedure is relatively easy in most reptile species, but it results very difficult in chelonians, and particularly in large sea turtles, as access to mouth and oesophagus can become impossible if the animal withdraw the head. Furthermore, this practice can result a source of considerable stress in wild animals, and in sea turtles it becomes very messy because of the particularly narrow gastroesophageal sphincter. The placement of a permanent oesophagostomy tube can considerably simplify the daily administration of assisted nutrition. Drugs (antibiotics, vitamins, etc.) and fluids, essential in the clinical management, are as well easily administered through the permanent oesophagostomy. This procedure was performed in 5 severely ill Loggerhead sea turtles (*Caretta caretta*) in order to assure a correct assisted feeding. All patients were anaesthetized with 4-5 mg/kg intravenous propofol. Before placement, the tube length was pre-measured from the lateral side of the neck to the left pectoral scute, then permanently marked. With the extended neck, a curved hemostat was introduced through the mouth into the esophagus and laterally displaced. This caused the skin to tent and the carotid and jugular veins to slip dorsally or ventrally to avoid them to be incised. A small incision was made trough the skin and the wall of the esophagus with a scalpel blade at the tip of the hemostat, that has been forced outside by blunt. The incision has to be as caudal as possible in the neck to avoid the turtle to entangle a limb and extract the tube. The tip of the tube was grasped with the clamp, pulled through the incision and withdrawn trough the mouth to the marked point. Then, the tube was redirected into the oesophagus and pushed up to the stomach. Levin’s tubes 4-5 mm diameter with radiopaque guide were used, to verify the correct placement by x-ray examination. After placement the tube was sutured to the skin just next to the incision with nonabsorbable sutures; the extended length of the tube was secured to the edge of the nucal scute with a suture and to the carapace with cyanoacrylic glue. Broad spectrum antibiotics were administered after the surgical procedure. Patients were fed daily through the tube with homogenized fish and shellfish, supplemented with vitamins. After food administration, the tube was washed with few millilitres of saline solution to avoid its obstruction. The tube was well tolerated, and the turtles were able to eat normally in 2-3 weeks while it was still in place. The tube was kept in place for two more weeks after appetite had returned to normal. If the tube has to be held in place for several weeks, it is possible that reparative reactions expel stitches and the tube needs to be sutured again.

THE TURTLE BAY – REHABILITATION OF RESCUED MARINE TURTLES IN A NATURAL ENVIRONMENT*

Flegra Bentivegna, Raffaella Bova, Fulvio Maffucci, Giovanni De Martino, and Sandra Hochscheid

Stazione Zoologica Anton Dohrn, Villa Comunale 1, 80121 Naples, Italy

The rescue and medical treatment of injured or otherwise impaired marine turtles has long been recognised as a measure to reduce turtle mortality. With the aim to re-introduce healthy specimens back into the sea the Stazione Zoologica Anton Dohrn of Naples (SZN), Italy, has been rescuing marine turtles for over 20 years. With increasing numbers of recovered turtles the SZN centre was in need of an extension facility to guarantee an appropriate rehabilitation of the treated turtles. In 2004, the “Turtle Point” was inaugurated, equipped with large square tanks (LxWxH = 2 m x 2 m x 0.5 m) and an oval tank (6 m x 3 m x 0.5 m), where turtles had more space to move. The experiences gained in running the “Turtle Point” stressed the importance of the rehabilitation phase in large tanks where the turtles’ capability to swim, feed and maintain buoyancy could be ascertained. However, the water depth was still limited and for some specimens which had suffered severe injuries and long treatment periods, the rehabilitation in shallow tanks could not reveal their diving ability. For this reason, the "Turtle Bay" project was initiated in 2007: a rehabilitation area inside an old submerged volcanic crater, which had open access to the surrounding sea. A 900 m2 area with a maximum depth of 5 m within the bay was enclosed with a 130 m long aquaculture net. During the summer months of 2007 – 2009 a total of 20 loggerhead turtles (maximum 5 at a time) were observed in the Turtle Bay. The overall results were both unexpected and encouraging: some turtles which had previously floated in the tanks, were perfectly capable of diving, feeding and resting on the bottom of the sea, while others showed swimming difficulties that could formerly not be observed in the tanks. In 2008, time-depth recorders were attached to 4 turtles at the Turtle Point and 4 in the Turtle Bay to record differences in their behaviour over a period of 3 to 13 days. While turtles at the centre spent most of their time inactive on the bottom of the tank irrespective of day or night, turtles in the bay rarely came to rest in the first three days, indicating the turtle's need to acclimate and familiarise with the new environment. After that they developed diurnal activity patterns with most of the swimming, exploring and feeding occurring during the day and resting bouts during the night. In conclusion, the Turtle Bay has proven to be a valuable rehabilitation tool, particularly for turtles with a long treatment history which may not have been found ready for re-introduction otherwise. Moreover, the initial 3 days "swimming frenzy" of released turtles highlights the importance of choosing an appropriate release area where turtles can acclimate undisturbed.

INITIAL INVESTIGATIONS OF VITAMIN D3 IN DISPLAY AND REHABILITATION SEA TURTLES*

Shane Boylan

South Carolina Aquarium, Charleston, South Carolina, USA

Biologists and veterinarians use a variety of clinical parameters to evaluate aspects of sea turtle health and biology. A small number of blood analytes from wild sea turtles have been thoroughly evaluated in the scientific literature to generate reference ranges ("normals") that help guide husbandry and medicine. In many circumstances, clinicians must evaluate an animal's status in the absence of published reference ranges for comparison. In these circumstances, a subset of available animals that are considered healthy for the parameter in question are used to generate reference ranges to guide the clinician. Calcium phosphorus ratio of at least 1:1 is considered a minimal release criterion by the South Carolina Aquarium (SCA) Sea Turtle Rescue Program for loggerhead (*Caretta caretta*) sea turtles. As part of the dietary evaluation, vitamin D3 is examined due to its role in calcium absorption and secretion. Current theories suggest reptile vitamin D3 precursors are converted to previtamin D3 in UVB (280 - 315 nm) exposed epidermis. The previtamin D3 is then converted in the liver to the blood circulating metabolite 25-hydroxyvitamin D3 which is the metabolite evaluated in blood chemistry profiles. Given the numerous organs involved in vitamin D3 metabolism and its crucial role in calcium homeostasis, SCA is examining vitamin D3 as a potential parameter to help evaluate sea turtle health and husbandry. Vitamin D3 synthesis is dependent on UVB light exposure. Nocturnal and crepuscular reptiles appear to synthesize vitamin D3 with lower UVB exposure or acquire it through dietary means. Sea turtles have a life history similar to diurnal, basking reptiles that require more UVB exposure. However, data interpretation is complicated by etiologies of stranding, durations of illness/display, individual metabolisms, and differences among species and life stages. As the first part of a study evaluating artificial UVB, natural UVB, and oral supplementation, samples of 25 hydroxyvitamin D3 were collected from 17 rehabilitation animals from 2007-2010. Preliminary results suggest adult *C. caretta* females have 50 - 100% more circulating 25 hydroxyvitamin D3 (30 - 60 nmol/L; 12 - 25 ng/ml) than juveniles. In one case, a long term captive *C. caretta* which was lacking appropriate UVB supplementation did not experience the expected slow decline of 25 hydroxyvitamin D3 serum levels. Additionally, two *C. caretta* strandings in 2010 possessed 25 hydroxyvitamin D3 levels of zero at admission. In one of these cases, the serum levels has increased to 16 nmol/L in a four month period without any significant UVB exposure. Vitamin D3 is an important component to health that needs further examination.

SOLAR POWERED TURTLE REVIVAL DEVICE IS SUCCESSFUL AT REVIVING STRANDED AND POORLY RESPONDING SEA TURTLES

Steve Canion

Energetic Health and Research Center, Port Aransas, Texas, USA

The Sea Turtle Acupuncture Resuscitation protocol (STAR) is continuing to work in reviving stranded, comatose, and drowned sea turtles. Developed by Steve Canion Chiropractic Acupuncturist, Biologist, and Phil Rogers, MRCVS, Veterinary Acupuncturist, the STAR protocol is based on the acupuncture revival points used on humans and animals over thousands of years. We have proven that acupuncture needles placed at the sea turtle emergency point GV26 (center of the horizontal line joining the lower edge of the nostrils) will revive a sea turtle as it does in humans and animals. (see STAR Pilot Results 30th ISTS). Following the introduction of the acupuncture protocol and incorporating the feedback received at the 28th ISTS Conference in Loreto Mexico, work has continued to develop another way to use the STAR technique without needles or sharp implements. The new device was first introduced to the sea turtle community at the 30th ISTS in Goa, India. This new medical device was developed so that the turtle emergency point GV26 could be stimulated safely. It is taped in place at the center of the horizontal line below the nostrils (nasal philtrum). The turtle should respond within 2 - 30 minutes.. The beta version, which will be ready in late December 2010, is waterproof and is 3x stronger than the prototype introduced in Goa. This beta version of the Solar-powered Tortuga Revival device speeds response times and is ocean worthy. In July 2010, Veterinarian Ana Negrete revived a stranded loggerhead at La Playa (Xcaret) Mexico using the prototype of the Solar-powered Tortuga Revival device. She had previously revived 2 semi-comatose turtles using acupuncture needles at GV26. This was the first test of the new solar-powered device to revive a sea turtle. It is a small microcurrent stimulator measuring 1 inch across that uses a specific ultra low frequency direct current (10hz,20-50Ua,12V). It requires no batteries. In November 2010, the World Wildlife Fund will begin using the Solar-powered Tortuga Revival device in sea trials to revive sea turtles caught on shrimp trawlers in Orissa, India.

SPIRORCHIIDAE FLUKE INFECTION IN STRANDED SEA TURTLES OF TAIWAN : PREVALENCE AND PATHOLOGY STUDY

Hochang Chen[1], R.J. Kuo[2], and I.J. Cheng[1]

[1] Institute of Marine Biology, Nation Taiwan Ocean University
[2] Penghu County Livestock Disease Control Center

The prevalence of spirorchiidae trematodes infections were always high and may leads to death in sea turtles worldwide. However, very few studies discussed about the spirorchiides infection in sea turtles of Taiwan. We examined spirorchid infection status in 30 stranded green turtles and 3 stranded loggerhead turtles from 2007~2010. Most stranded green turtle were juvenile, and all three stranded loggerhead turtles were subadult. 70%(21/30) stranded green turtles were infected with spirorchid eggs, but fail to detected in stranded loggerhead turtles. Type I eggs can be found in every infected cases. Among spirorchiidae trematodes, Leardius learedi、Hapalotrema postorchis, H. mehrai and Carettacola hawaiiensis were identified, mainly in the heart. In juvenile green turtles, the BCIs of infected turtles were lower than wild turtles. Despite the high prevalence and lower BCIs, most infections were not the principal cause of death in green turtles. Results of this study provide the status of spirorchids infection in stranded green turtles of Taiwan. However, more studies are needed to understand the infections status of loggerhead turtles.

EPIBIONTS OF LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN THE CENTRAL MEDITERRANEAN

Maristella D'Addario[1], Paolo Casale[1], and Daniela Freggi[2]

[1] Dept. of Biology and Biotechnologies "Charles Darwin", Univ. of Rome "La Sapienza", Roma, Italy
[2] WWF Italy Turtle Center, Lampedusa, Italy

The central Mediterranean hosts both neritic and oceanic foraging grounds for loggerhead turtles and the occurrence of epibionts on turtles frequenting these habitats was investigated in summer 2008 and 2009. Among loggerhead turtles with epibionts observed at the WWF Italy turtle centre in Lampedusa (Italy) located in the middle of the study area, 117 turtles ranging 21 to 78,6 curved carapace length (mean: 51,09, SD: 12,98) were randomly included in this study. Turtles were either incidentally captured by drifting longline, bottom longline, bottom trawling, and set net or gathered while floating at sea. The epibionts were photographed, counted, identified, removed and preserved. We analyzed the species composition, the distribution of each species on the body surface and the relationships between number of epibionts and type of turtle finding. We observed algae, amphipods and 3268 individuals belonging to eight species of barnacles and to the Columbus crab *Planes minutus*. Most epibionts were distributed dorsally on the posterior scutes of the carapace except *Chelonibia* sp. that was found frequently on the anterior scutes. Five species (*Chelonibia testudinaria*, *Chelonibia caretta*, *Stomatolepas elegans*, *Stomatolepas praegustator*, *Lepas anatifera*) showed a different number of individuals in relation to the type of turtle finding. Ecological implications of different occurrence of epibionts according to turtle size class and habitat are discussed.

A CASE STUDY: THE CHALLENGES ASSOCIATED WITH REHABILITATION OF A LOGGERHEAD SEA TURTLE BY-CAUGHT IN A SEA SCALLOP DREDGE

Shannon J. Davis, Christina M. Trapani, Margaret C. Lynott, Wendy J. Walton, and Linda R. D'Eri

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

On 28 August 2009, the Northeast Fisheries Observer Program recovered a juvenile loggerhead (*Caretta caretta*) sea turtle with severe crushing injuries (MMSC-09-123) following an interaction with a sea scallop dredge. This turtle was one of 20 scallop dredge interactions recovered by the observer program from 2000-2010. MMSC-09-123 was stabilized at the Marine Mammal Stranding Center in Brigantine, New Jersey, and immediately transferred to the Virginia Aquarium Stranding Response Program (VAQS) for rehabilitation. Gross injuries to the turtle included multiple fractures to the left lateral region of the carapace that appeared to be caused by blunt force trauma. Radiographs revealed MMSC-09-123 also sustained left medial longitudinal fractures to the carapace involving two rib fractures and luxations. The plastron sustained unstable curvilinear fractures penetrating into the coelomic cavity. These irregular and penetrating injuries involving longitudinal fractures of the carapace and plastron are commonly associated with scallop dredge interactions (Haas *et al*., 2008). Other commonly documented injuries include: head and neck trauma, severe flipper injuries, cracked and chipped carapace and plastron, and comatose animals (Haas *et al*., 2008). From 1989 to 2005, an estimated 619 loggerhead sea turtles were taken per year in the US Atlantic sea scallop fishery (Merrick and Haas, 2008). In a 2003 study involving 749 by-caught loggerhead sea turtles from the Mid-Atlantic sea scallop dredge fishery, Murray (2004) estimated only a 22.7% survival rate. MMSC-09-123 was the second known live scallop dredge take admitted into rehabilitation at VAQS. The first live scallop dredge take (NMFS2009-June-04-01) died as a result of similar injuries within three days of the interaction. NMFS2009-June-04-01 had a similar longitudinal fracture extending the length of the carapace, small elliptical cuts, and bilateral fractures involving the scapulas. As part of the treatment protocol for this animal, VAQS incorporated conventional veterinary medicine in conjunction with non-traditional practices. On 27 September 2010, 394 days after admission for rehabilitation, VAQS outfitted MMSC-09-123 with a satellite transmitter and released the turtle off the coast of Virginia. Based on the satellite transmissions, MMSC-09-123 is currently following documented patterns associated with juvenile loggerhead sea turtle fall migration out of the Chesapeake Bay and into North Carolina. The severity of the injuries presented by this scallop dredge take created a challenging and lengthy rehabilitation. Although we have

only encountered two live by-caught scallop take turtles, we believe it is unlikely this turtle would have survived if released immediately following capture. This case proves that rehabilitation is possible despite severe injury and observers and fishers should consider rehabilitation of injured by-caught turtles.

ARE DISEASES INCREASING IN FREQUENCY AND COMPLEXITY IN INDO-PACIFIC GREEN SEA TURTLES OF EASTERN AUSTRALIA?*

Mark Flint[1], Colin J. Limpus[2], Janet C. Patterson-Kane[3], and Paul C. Mills[4]

[1] Aquatic Animal Health, College of Veterinary Medicine, University of Florida, Gainesville, Florida, USA
[2] Queensland Department of Environment, Resources and Management, Brisbane, Queensland, Australia
[3] School of Veterinary Medicine, University of Glasgow, Bearsden Road, Glasgow, UK
[4] Veterinary- Marine Animal Research, Teaching and Investigation unit, School of Veterinary Science, The University of Queensland, Gatton, Queensland, Australia

Comparing periodic health assessments conducted in southern Queensland on the Indo-Pacific green sea turtle (*Chelonia mydas*) in the 1980s and 1990s with those undertaken since 2007 suggest a shift of diseases and their prevalence during this time. In the 1980s and 1990s in eastern Australia, direct anthropogenic factors and the risks of fibropapillomatosis and coccidiosis were the primary known considerations influencing free-ranging sea turtle survivorship. For captive (e.g. the "head start" programs) populations, concerns included bacterial and viral complications suspected to be caused by high-density housing and rudimentary water filtration systems. Management strategies were implemented to reduce these impacts. By 2007, a growing concern that localised sea turtle populations were being subjected to new direct and indirect environmental stressors coinciding with alteration of coastal habitats by increased human populations led to a new wave of intensive disease investigations across eastern Australia. Integrating biological surveillance programs with veterinary health assessments, baseline parameters were established for ante and post mortem examination of healthy green turtles which were used to identify clinically significant disease i.e the unhealthy cohorts. Prevalent disease syndromes within the population were identified as spirorchiidiasis (42%), gastrointestinal disorders (12%), microbiological infectious diseases (5%) and traumatic injuries (5%). Further, syndromes previously unrecorded for the region were identified at low prevalence. For example, a single case of cerebral apicomplexan protozoal parasitism, strongly indicative of toxoplasmosis, was discovered in a large immature male green turtle. While this diagnosis could not be fully confirmed, the potential occurrence of a toxoplasma-like disease is significant in a reptilian species, particularly one proposed as a sentinel indicator of environmental health. Other species, such as a bottle-nosed dolphin (*Tursiops truncatus*), have been recorded with this disease in this area. A further newly described disease is corneal fibropapillomatosis in small (immature) green turtles. Common in parts of the United States, this syndrome is novel to Australian waters but is now being increasingly reported during population surveys. Reproductive anomalies were recorded in several animals including ectopic uteri, cloacal deformities, and a true hermaphrodite found on a nesting beach. Causes for these novel syndromes are unknown, therefore on-going disease surveillance programs need to be continued and refined as knowledge of specific regional diseases grow. Further, it needs to be determined if improved surveillance has resulted in increased disease discovery or if novel diseases are truly emerging as a consequence of environmental change.

COMPARISONS OF PLASMA BIOCHEMISTRIES OF NESTING AND CAPTIVE GREEN TURTLES WITH THE BASELINE DATA IN TAIWAN

Chia Ling Fong[1], Fu Kuo[1], Jin Feng Huang[2], Chung Kang Hus[2], Wan She Tsai[2], and I Jiunn Cheng[1]

[1] National Taiwan Ocean University, Institute of Marine Biology, Keelung, Taiwan
[2] Fisheries Research Institute, Penghu Marine Biology Research Center, Taiwan

Plasma biochemistries are commonly used to assess the health condition of animals, including sea turtle. However, these values can be influenced by both physiology and environmental factors, and affect the accuracy of health assessments. Therefore, a reliable and sizable database of plasma biochemistries for the clinically normal turtle is

essential. We have established the baseline plasma biochemistries for the free-ranging green turtles in Taiwan. This provides us a better tool to evaluate the health conditions of rehabilitated turtles. Yet, there are several questions remained unanswered. Is the triglyceride concentration the only plasma biochemistries that fluctuate during the nesting activities of gravid turtles? Can the rehabilitated turtles release back to the wild based on the plasma biochemistry evaluation? How long should they be kept in the rehabilitation center? In this study, the plasma biochemistries of nesting females and long-term captive green turtles are compared with the baseline values. We also try to identify the key parameters to assess the health condition of sea turtles, both in the wild and in captivity.

EPIBIONT COMMUNITY COMPOSITION IN GREEN TURTLES IN PALMYRA ATOLL NATIONAL WILDLIFE REFUGE

Andrés Gómez[1], Eleanor J. Sterling[1], Eric A. Lazo-Wasem[2], Felicity Arengo[1], Katherine McFadden[3], and Erin Vintinner[1]

[1] Center for Biodiversity and Conservation, American Museum of Natural History
[2] Yale University Peabody Museum of Natural History
[3] Columbia University

Little is known about the epibiont species identity, community composition, and incidence in sea turtles in the Central Pacific. Since 2009 we have studied the epibiont communities of green sea turtles (*Chelonia mydas*) in Palmyra Atoll, as part of a broad sea turtle research and conservation program in this National Wildlife Refuge. Notably, we collect epibionts from turtles in all age classes and both sexes, and each animal is given a thorough physical examination; therefore we are able to collect samples representative of the epibiont community in this turtle population. The most common epibiont species collected in Palmyra Atoll are typically, if not exclusively associated with turtles: i) an embedded Platylepus? barnacle; ii) an amphipod in the genus *Hyachelia*; and iii) a tanaid in the genus *Zeuxo*. These species form the overwhelming majority of specimens collected in two field seasons at Palmyra Atoll, suggesting that epibiont diversity in Palmyra Atoll is lower than in other *C. mydas* populations. Our preliminary observations also suggest that there are temporal differences in epibiont loads in this population. Further research is needed to understand patterns of epibiont diversity in this region, as well as any conservation implications of the turtle-epibiont relationship.

REHABILITATION: IS IT ONLY FOR THE RICH AND FAMOUS?

Jennie Gilbert

Cairns Turtle Rehabilitation Centre, crn Aropa street and Cook Hwy, Trinity Beach. Qld Australia

All six species of marine turtles living in the Great Barrier Reef region are listed as vulnerable, endangered, or critically endangered both in Queensland and Australian federal legislation. Injury or death from entanglement in discarded fishing nets, ingestion of marine debris, and accidental capture and drowning during commercial fishing activities are believed to be amongst the major causes of decline in marine turtle populations worldwide. Ingestion of anthropogenic debris by marine turtles has been frequently documented, however few studies have attempted to quantify the sublethal effects produced by debris ingestion. Current research indicates the consumption of marine debris causes a reduction in nutrient assimilation from the diet due to the presence of inert diluents. Diminished nutrient intake can have significant consequences, including reduced growth and development rates, increased vulnerability to predation, depleted energy resources, reduced reproductive output and decreased lifespan. Turtles may also suffer a blockage in the gut due to the ingestion of marine debris, causing the turtle to float due to a build up of gas in the gastrointestinal tract. This is termed 'floaters disease'. Many of these animals perish at sea, as they are unable to dive to feed. Derelict fishing gear and abandoned nets are a serious problem contributing to accidental entanglement and/or capture of marine turtles. Injuries may be life threatening, and include limb amputation and subsequent infection, reduction in mobility and ability to flee from predators, prolonged periods of floating when entangled in nets and damage from boat strike. During the monsoon season when extreme north–west winds occur, discarded ghost nets are carried across the Gulf of Carpentaria. Entangled marine turtles and other fauna are carried to the beaches with the nets. Many of these turtles suffer severe

injuries and are flown from Weipa, in the Gulf of Carpentaria, to Cairns. After initial veterinary evaluation and emergency treatment, they are transferred to Cairns Turtle Rehabilitation Centre; a facility designed for the treatment of ill and injured turtles. The turtles are kept in this facility until they are healthy enough to be released. To date, three turtles that had been rescued from entanglement, after suffering horrendous injuries, have been released with satellite trackers. Two turtles; 'Princess' and 'Jewell,' were tracked after their release from rehabilitation in a joint project between the turtle group of Swansea University, Dhimarru indigenous turtle group, Cairns turtle rehabilitation centre, Charles Darwin University, James Cook University, Marlin Coast Veterinary Clinic and Carpentaria Ghost Net Program. A third turtle was released recently following rehabilitation for 11 months. She also has a satellite tracker attached. Two turtles have also been released with satellite trackers on the east coast of far northern Australia within the Great Barrier Reef lagoon. Both turtles recovered from floaters disease. One turtle, Matilda, had spent 20 months in rehabilitation, whilst the other turtle, 'Sammy', had spent only three months in rehabilitation. All five turtles released with satellite trackers have survived for long periods of time, demonstrating the successful outcome of rehabilitation.

EVIDENCE OF DIFFERENTIAL XENOBIOTICS INTAKE AND PHYSIOLOGICAL SENSITIVITY OF EAST PACIFIC GREEN SEA TURTLES (*CHELONIA MYDAS*) INHABITING TWO FORAGING COASTAL LAGOONS IN THE BAJA CALIFORNIA PENINSULA*

Vanessa Labrada-Martagón[1], Paola A. Tenorio Rodríguez[1], Melania López-Castro[2], Susan C. Gardner[3], Lia C. Méndez-Rodríguez[1], and Tania Zenteno-Savín[1]

[1] CIBNOR, Apdo. Postal. 128; La Paz, BCS C. P. 23090, México
[2] Department of Biology, University of Florida, Gainesville, FL, USA
[3] Office of Environmental Policy, U.S. Department of State, Washington, D.C., USA

The toxic levels of chemical contaminants and their adverse effects in the short term (physiology) and in the long term (population dynamics) are unknown for sea turtles. Exposure to xenobiotics generates a cascade of biochemical reactions in an attempt to rid the cell of the toxin or to defend it against adverse effects. Those biochemical responses could be used as biomarkers of exposure and effects of chemical pollution and may extend ultimately to the level of populations. In order to determine the potential effects of trace elements and organochlorinated pesticides (OC´s) in the health of East Pacific green see turtle, *Chelonia mydas*, the blood biochemistry parameters, hormone profile, concentration of vitellogenin (VTG), blood cell counts, the activity of antioxidant enzymes and lipid peroxidation (TBARS) levels were measure in individuals captured alive in the coastal lagoons of Punta Abreojos (PAO) and Bahía Magdalena (BMA) during 2005-2007. A relative index of body condition (Krel) was estimated using length and weight data. The predominant (90%) age class captured was juveniles (<77.3 cm straight carapace length, SCL). Principal component analyses (PCA) were used to assess relationships between trace elements and OCs concentrations and health indicators in the sea turtles. Sea turtles captured in 2005 with the higher body condition and higher concentrations of glucose, uric acid, VTG and thyroxine, were separated from those sampled in 2006 which had the higher concentration of Si and higher aspartate aminotransferase (AST) activity (PCA, 37.5% variance explained). The higher frequency of individuals with residuals of pesticides in plasma was found in PAO, where the highest concentration of heptachlor in plasma and highest Si and Cd in blood were registered. The concentrations of Cd and Si were positively correlated with AST activity, proportion of monocytes and TBARS levels, and negatively related to and thyroxine levels. In PAO, individuals having the higher concentration of chlordanes had also the higher TBARS levels and the higher glutathione-S-transferase (GST) activity. These correlations were not found in sea turtles from BMA. Sea turtles from BMA were characterized (PCA, 43% variance explained) by higher concentrations of α-BHC, lindane, aldrin and hexachlorobenzene in plasma and higher superoxide dismutase (SOD) activity. Neither TBARS levels nor the activity of the antioxidant enzymes analyzed were correlated with body condition. These results suggest that East Pacific green turtles are physiologically sensitive to chemicals and ambient perturbations; sea turtles from PAO appear to be more susceptible to habitat perturbations than those from BMA. We suggest that AST and GST activities may be used as biomarkers of chemical contaminants, while levels of glucose, uric acid, VTG and thyroxine are suggested to be good biomarkers of body condition and nutritional state in green turtles.

HOW DO CAPTIVE-RAISED HAWKSBILL TURTLES PERFORM WHEN RELEASED BACK INTO THE WILD?

Hock-Chark Liew[1], Juanita Joseph[1], Eng-Heng Chan[2], Siti Norazliyana Ali[1], and Lionel H. Sebastian[1]

[1] SEATRU, Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Malaysia
[2] Turtle Conservation Centre, 56-2/1, Jln Cerong , 20300 Kuala Terengganu, Malaysia

It is often said that only one in a thousand sea turtle hatchlings will ever survive to become adults largely due to high mortality rates in the early life stages. To increase the chances of survival for these threatened species, rearing them in captivity to a larger size before release has often been suggested and practiced. Counter arguments by conservationists to this practice is that little is known about whether these captive-reared turtles would be able to survive when released back into the wild. Moreover, sea turtle hatchlings, when first released into the sea, would undergo a pelagic phase during their early "lost years" before settling as juveniles in foraging habitats. Would they circumvent this pelagic phase when released into the wild after being raised in captivity for a few years? To give insight to these questions, two juvenile hawksbill turtles, named Duke Aziz and Myrtle Adi, were raised in captivity for four years in a public aquarium facility before release into the wild at the beach where they were born at Redang Island, Malaysia. Satellite transmitters fitted with GPS and pressure sensors were mounted on them to relay information about their location and diving activity. Both of the captive-reared juvenile hawksbills remained within the vicinity of Redang Island during the first three days. Subsequently, Myrtle Adi headed northeast towards the waters off Vietnam while Duke Aziz remained at Redang Island. During the journey towards Vietnam, Myrtle Adi did not just stayed close to the surface but made occasional dives. Duke Aziz however, appeared to have circumvented the pelagic phase and decided to remain within the vicinity of Redang Island. Myrtle Adi and Duke Aziz were tracked over a duration of 13 days and 49 days respectively before no further transmissions were received.

THE BEAUTY OF GREY, WHY RADIOGRAPHS ARE REALLY NEAT

Nancy S. Mettee

Loggerhead Marine Life Center, Juno Beach Florida

This presentation is primarily a graphic one, including numerous radiographic images to acquaint the viewer with positioning and clinical importance of radiographs. Accurate assessment of sea turtle disease requires the use of diagnostic testing. The minimum database is: physical exam (in and out of the water), a complete blood cell count (including white blood cell differential), chemistry panel, and full body radiographs. Many veterinary hospitals have x-ray machines and are willing to donate their use and assist with the taking of the films or digital images if approached. Once the images have been obtained, interpretation may be accomplished onsite by trained personnel or the images emailed to a veterinarian for evaluation. The benefits of radiographic imaging include: it is a non invasive, high yield diagnostic; physical or chemical restraint is not required; low cost per plate (once equipment is acquired or if donated from a local DVM or MD); can be used to evaluate: fractures, dislocations, GI obstructions, lung pathology, and foreign body ingestion; images can be photographed and emailed allowing diagnostic assistance. The drawbacks of radiographic imaging include: interpretation can be challenging; equipment is not portable; cost of X-Ray machine and developer is prohibitive; use of equipment requires radiation certification and monitoring; use of the x-ray machine requires training; anatomical differences make for poor image contrast in the coelom (lack of coelomic fat, no distinct thorax/abdomen, loss of detail as image is take thru the carapace and plastron). Radiographs provide a two dimensional image of a three dimensional structure, thus several views are required to evaluate cranial-caudal and left-right. Careful positioning is crucial to accurate interpretation. Radiographs provide information based on the variation of tissue density: gas or air will appear black, bone or metal (flipper and PIT tags) appears white, soft tissue or fluid appears grey. Three standard views are used, a dorso-ventral view (to include skull), an anterio-posterior view, and a right lateral view. In turtles, the last two require horizontal placement of the x-ray beam to avoid displacement of the lungs via the viscera. Technique will vary with size of the turtle, but is based on patient measurements and can be determined

with the help of experienced radiology technicians. Large turtles may require several plates to image completely. The dorso-ventral view allows visualization of the left and right sides of the turtle with the lungs superimposed over the viscera. The bones of the plastron and carapace, pelvic and pectoral girdles are clearly visible, along with the trachea and left and right lungs. Pathology in the gastrointestinal tract can include: shell impaction of the intestine, foreign body ingestion, and hook/line/sinker. This positioning is also good for diagnosis of bone infection, presence of eggs, and tissue necrosis. The anterior-posterior view is utilized for viewing intestinal gas, lung pathology, and carapace structure. The lateral view is effective for carapace structure and lung pathology. A dorso-ventral skull image can be used to evaluate for fractures and trauma.

LOW PRESSURE ASSISTED WOUND HEALING

Nancy S. Mettee[1], Melissa Ranly[1], Deborah Mauser[1], Letizia Shaffer[2], and Lauren Arango[3]

[1] Loggerhead Marinelife Center 14200 US Highway One Juno Beach Florida USA
[2] KCI USA, Inc San Antonio TX 78219 USA
[3] Martin Memorial Wound Care Center, Stuart Fl. USA

Low pressure vacuum pressure assisted wound healing is an advanced wound management system that has great application in sea turtles. Carapace and plastron fractures frequently have large defects, exposing the underlying soft tissue and are often grossly contaminated. The use of negative pressure with frequent bandage changes under the supervision of a veterinarian can result in successful treatment of major injuries, such as open body cavity wounds, that previously have been associated with high mortality. The negative pressure created by the vacuum results in accelerated wound healing and is an effective way to remove infectious material from a wound. Use of the vacuum system results in less soft tissue edema, promotion of granulation tissue, continuous exudation, and increased perfusion. The technique for application involves several steps: Ensure that the patient is a good candidate for the therapy. Ensure adequate analgesia and systemic antibiotic coverage. Wound hemostasis must be verified prior to application of the bandage. The wound must be cleaned and debrided prior to each application. This may sometimes require anesthesia, but most should be practical without. A moisture dressing placed over soft tissue, this dressing can be silver impregnated (ie, Silverlon) to increase antimicrobial benefit, but vaseline soaked gauze squares are effective. This dressing will prevent the delicate soft tissue from coming directly in contact with the successive layer. The next layer is open pore polyurethane cell foam cut to fit and then placed over the dressing. The open foam will ensure equal distribution of the negative pressure across the wound bed and allow for infectious debris to migrate out of the wound. The foam must not be placed directly over exposed organs, blood vessels, or nerves. If multiple pieces are used, all foam in the dressing must contact other segments to enable equal distribution. This foam is then draped with a water tight/air tight drape and secured to the patient. This seal must be 100% effective and when lost the bandage will need to be replaced. Use of adhesive drape material and silicone caulk is the most effective. Care must be taken to remove or cover over any sharp edges that would puncture the drape and result in loss of the seal. A suction unit can then be attached to the sealed bandage. Proprietary systems are available, but modifications can be made to standard suction units allowing them to be used successfully. Suction should be continuous at 120-150 mmHg. Portable suction units are available that can be used if the patient is to be returned to the water. Suction should be for 22 out of 24 hours per day for maximal results. If no loss of suction is noted the bandage can be left in place for 3-5 days. Once a strong granulation bed is present the vacuum can be discontinued and the wound allowed to heal by secondary or tertiary (delayed primary) intention.

PRELIMINARY OBSERVATION OF FIBROPAPILLOMA VIRUS IN GREEN TURTLES (*CHELONIA MYDAS*) CAPTURED FROM TEXAS' LOWER LAGUNA MADRE*

Tasha L. Metz and André M. Landry, Jr.

Sea Turtle and Fisheries Ecology Research Lab, Texas A&M University at Galveston, Galveston, TX 77553

Texas waters provide essential habitat to five protected sea turtle species, including the green turtle (*Chelonia mydas*). Entanglement netting surveys deployed by the Sea Turtle and Fisheries Ecology Research Lab (STFERL) since 1991 to assess abundance, distribution, and habitat use of greens within seagrass and jettied habitats of Texas' lower Laguna Madre (LLM) have yielded 273 conspecific captures and provided evidence for an exponentially increasing population that likely represents the largest northern Gulf concentration west of Florida. These captures also provide a long-term historical record and timeline of potential introduction of the fibropapilloma (FP) virus to Texas populations where there were no confirmed reports prior to May 2010 (including the aforementioned 242 greens captured by STFERL). A dead stranded green with tumors recovered on South Padre Island by Sea Turtle, Inc. personnel on 26 May 2010, as well as a live stranded green with tumors retrieved from the University of Texas Marine Science Institute boat basin in Port Aransas on 18 June 2010 were the first confirmed reports of FP in Texas (Dr. Donna Shaver, Texas Sea Turtle Stranding and Salvage Network Coordinator, pers. comm.). The STFERL's entanglement net capture of 31 greens from the LLM in August 2010 included 11 cohorts exhibiting tumors on the eyes and the ventral side near the flippers and cloaca. Statistics from these directed captures are a preliminary indication of a 33+% FP infection rate among the free-living green turtle assemblage within the LLM and raise concern as to the disease's impact on continued population growth and the ability to develop response initiatives to contain the spread of this infectious agent. Little is known about the geographic extent of this disease in Texas nor the degree of infection within constituent assemblages, including those in the lower Laguna Madre, Aransas and Matagorda Bay Systems where the STFERL has netted greens on a consistent basis. This need is particularly acute given the fact that the LLM serves as an important developmental foraging ground for Texas' green turtle assemblages, which are primarily composed of juveniles between 35 and 55 cm straight carapace length (Landry and Metz, unpublished manuscript), a life stage well within that (40-90 cm SCL) documented by Ehrhart (1991) and Herbst *et al*. (2004) as having the highest incidence of FP and most extensive lesions. Future research proposed by the STFERL, in collaboration with other entities, will assess impact of FP infection on recent increases in and continued growth of Texas' green turtle population, identify the source(s) of infection giving rise to FP in Texas' constituent assemblages, and characterize environmental factors that promote the spread of FP in these assemblages.

DETERMINATION OF EPIBIONTS OF THE MARINE TURTLE *LEPIDOCHELYS OLIVACEA* (ESCHSCHOLTZ 1829) THAT NESTS IN CEUTA BEACH, SINALOA, MEXICO

Dulce I. Montaño-Valdez[1], Ingmar Sosa-Cornejo[1], Michael G. Frick[2], Marcos Bucio-Pacheco[1], and Fernando Enciso-Saracho[3]

[1] Escuela de Biología de la Universidad Autónoma de Sinaloa, México
[2] Research Project, P.O. Box 9841, Savannah
[3] Facultad de Ciencias del Mar de la Universidad Autónoma de Sinaloa, México

Epibionts are bentonic floristic and faunistic organisms that live atached on the skin of another animal; this phenomenon is known as epibiosis and has been documented for all the species of marine turtles. The interactions between the turtle and epibiotic organisms is provide substrate for the epibionts communities, these presence are based mainly in the shell and with other anatomical structures in low intensity. It has been registered that some epibionts affect the growth, diverse damages in anatomical structures like the eyes, mouth, extremities and usually are vectors of diseases. By such reason the objective of the present work, was to determinate of epibionts species associated to the marine turtle *Lepidochelys olivacea* in Playa Ceuta, Sinaloa, Mexico. During the season nesting May-December of 2008-2009, the female turtles nesting and stranding were monitored themselves and epibionts were collected. Seven species distributed in following taxa were obtained: Fishes of the family Echeneidae, Hirudíneos (*Ozobranchus branchiatus*, *Ozobranchus margoi*), Arthropods (*Chelonibia testudinaria*, *Lepas* sp, *Conchoderma virgatum*) and the first registry of *Stephanolepas muricata* for *Lepidochelys olivacea*. According to previous registries of Ceuta beach, the species of epibiontes continued registering themselves with the exception of *Ozobranchus margoi*, and *Stephanolepas muricata,* which suggests to continue developing investigation lines with epibiontic organisms.

EPIFLORA ON GREEN TURTLES (*CHELONIA MYDAS*) CAPTURED IN THE GULF OF VENEZUELA: PRELIMINARY DATA

Beatriz A. Moran[1], Ninive E. Espinoza[2], and Hector A. Barrios Garrido[1]

[1] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV). Laboratorio de Ecologia General, Facultad Experimental de Ciencias, Universidad del Zulia, Venezuela
[2] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV). Maracaibo, Venezuela

The Gulf of Venezuela (GV) characterized by having a diversity of ecosystems, allows the development of many species among them Sea Turtles (ST). One of many roles of ST in the marine ecosystems is to provide as a substrate to several epibiontic communities, mainly their carapaces. Due to the importance of these relationships in the marine ecosystems, this study was undertaken in order to identify fouling organisms, specifically, algae over individuals of *Chelonia mydas* (Green Turtle), and thus, establish a list of predominantly families of marine microalgae that lives on these reptiles. Fourteen (N = 14) samples obtained from juveniles of *Chelonia mydas*, were taken by scraping randomly on the carapaces and head of each individual, then these samples were stored in proper containers, fixed and treated with ethanol and or iodine for subsequent laboratory analysis. The genus *Chaetomorpha* appeared in 70% of the samples, 20% central diatoms, and 10% represented by *Polysiphonia* and *Chlorela* genus. The predominance of *Chaetomorpha* colonies could be due to the frequency in which sea turtles recruit or establish in coral reef ecosystems, species of this genus of algae need an adequate substrate to their survival and development, generated in this case by the body or sea turtles carapace, without harming their host. Another aspect that can describe the occurrence of different genera of microalgae could be related to the difference of sea turtles habits which travel across the GV, previous studies claim that green turtles have pelagic life habits, and in most cases are active animals; the occurrence of these microalgae over these specimens may be a reflection of low metabolic rates or another factor that positively affects the colonization of their carapaces. It is necessary to increase research and studies about sea turtle epibionts to establish the incidence, prevalence and dominance of different genera of microalgae and its relationship with sea turtles in the GV.

MEDICAL AND SURGICAL MANAGEMENT OF WOUNDS IN MARINE TURTLES*

Terry M. Norton, Michelle Kaylor, Amy Hupp, Rachael Thomas, Erika Kemler, and Steven Nelsen

Georgia Sea Turtle Center, Jekyll Island, GA USA

Twenty to 30% of sea turtles stranding in coastal Georgia have some evidence of boat strike injuries. Many survive some very significant trauma and are presented to the Georgia Sea Turtle Center for rehabilitation. Innovative wound care techniques have been developed for these injuries. Attention must be paid to emergency care, development of a prognosis, diagnostic testing and supportive care for turtles presenting with significant wounds. Principles of wound care that are utilized on other species should be followed. Topical placement of bone cement with antibiotics and doxirobe gel (Pharmacia & Upjohn Company, Kalamazoo, MI 49001, USA), honey, honey comb, Medi-honey (Derma Sciences from New Zealand, Toronto, Ontario MIS 3S4) and a variety of silver based products have proven useful in managing these wounds. Petroleum impregnated gauze, Steristrips (3M, St. Paul, MN 55144 USA), Tegaderm dressing (3M, St Paul, MN 55144 USA), superglue, and water proof tape have all been used to cover and water proof various wounds. In areas that are difficult to bandage, suture loops and umbilical tape can be used to keep medication and packing material in place. A modified Vacuum Assisted Wound care protocol has been successfully used for some

wounds. The turtle must be out of the water during the treatment, thus a combination VAC therapy with other modalities are typically used.

RADIOGRAPHIC ANATOMY OF THE CERVICAL AND COELOMIC FEATURES OF THE AFRICAN SIDENECK TURTLE (PELUSIOS SINUATUS)*

Samuel Gbadebo Olukole[1], Adenike Olatunji-Akioye[2], Matthew Olugbenga Oyeyemi[2], and Bankole Olusiji Oke[1]

[1] Department of Veterinary Anatomy, Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria
[2] Department of Veterinary Surgery and Reproduction, Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria

Many research investigations involving radiological studies had been reported in several sea turtle species. However, there is a dearth of information on descriptive reports focusing on radiographic anatomy in fresh water turtles especially those species indigenous to Africa. Radiographic anatomy of the cervical and ceolomic features of the African sideneck turtle (Pelusios sinuatus) is a necessary tool in the gross overview of the musculo-skeletal system of the animal with respect to anatomical landmarks. This study was therefore designed to investigate into the gross and radio-anatomical features of the cervical and coelomic features of the African sideneck turtle with the view of providing information which could assist in the understanding of the external body anatomy of the animal in relation to the internal structures of its neck and body. Dorsoventral views and anatomical dissections of the neck and body of 20 African sideneck turtles of both sexes were used to correlate external anatomical landmarks to the various positions of internal anatomical structures. Important external landmarks included the vertebral, marginal, nuchal, lateral and supracaudal scutes while the internal landmarks were the pelvic and pectoral girdles, the bronchi, coracoids bones and the acetabulum. Superficial muscles of the pelvic and pectoral girdles were the supracoracoideus, pectoralis major, deltoideus and rectus abdominis muscles. In the mature gravid female animals were found eggs measuring between 3.0-3.5cm in length well distributed underneath the plastron laterally and medially. The information made available by this study, the first of its kind, will assist in a better understanding of the gross and radiological anatomy of the African sideneck turtle especially as it concerns anatomical relations of the internal structures of the neck and coelom. Findings from the study are expected to assist veterinary surgeons and clinicians in their professional skills of handling fresh water turtles and also be useful in the comparative gross anatomy of the neck and coelom of fresh and sea turtles.

ENDOCRINE BASED HEALTH AND REPRODUCTIVE DIAGNOSTIC PROTOCOLS

David Owens[1], Gaëlle Blanvillain[1], Jesse Alderson[1,2], and Al Segars[2]

[1] College of Charleston, Charleston, South Carolina, USA
[2] South Carolina Department of Natural Resources, Charleston, South Carolina, USA

In human and veterinary medicine the use of endocrine indicators in diagnosis of disease and reproductive condition has long been a standard practice. Similarly, several labs have documented the hormone variation that occurs during the normal reproduction and stress changes that sea turtles undergo during their life history. In particular, steroid hormones have been well studied both in juveniles and adults. In general, a two ml blood sample taken soon after capture and yielding one ml of serum is adequate to test for testosterone (T) and corticosterone (Cort). If the hormone titers are accompanied by basic physical observations of turtle size , tail length, time of year, water temperature and obvious external injuries, a useful understanding of reproductive and stress condition can be determined. We have developed multiple standardized sea turtle T curves for immature and adult male and female turtles that can be used to evaluate reproductive condition. Some model curves describing individual’s endocrine status have recently been summarized by Blanvillain, Owens and Kuchling (2010). Additionally, response curves for Cort have been developed and can assist in

predicting the overall health status of the individual. In "best practice" methodology, this stress test procedure requires a second blood sample taken one hour after the initial capture sample while the turtle is maintained out of water (e.g. in a mildly stressed situation). The use of these endocrine parameters is enhanced by additional data such as blood chemistries, ultrasound diagnoses as well as physical observations (e.g. mating scars, plastron softening, capture location and capture conditions). Newer hormone measurement technologies including enzyme-linked immunosorbent Assays (ELISA) or enzyme immunoassay (EIA) may make these diagnostic techniques more practical in the near future since they do not require the use of radiation as in a standard radioimmunoassay (RIA).

PHYSIOLOGICAL STATE AND CONDITION IN NESTING LEATHERBACK TURTLES IN FRENCH GUIANA

Virginie Plot[1,2], Jean-Patrice Robin[1,2], Thomas Jenkins[1,2], Sabrina Fossette[1,2,3], and Jean-Yves Georges[1,2]

[1] Université de Strasbourg, IPHC, 23 rue Becquerel 67087 Strasbourg, France
[2] CNRS, UMR7178, 67037 Strasbourg, France
[3] Present address: Institute of Environmental Sustainability, School of the Environment & Society, Swansea University, Swansea SA2 8PP, UK

Organisms compensate for reproduction expenditure by increasing trophic resources thanks to two major strategies: *capital breeders* store large quantities of body reserves prior to reproduction without feeding during the reproductive episode whereas *income breeders* adjust their food intake depending on reproduction needs without relying on large body reserves. Intermediate strategies have been reported in mammals and more recently in reptiles. Physiological mechanisms involved in body reserve mobilisation during fasting have been extensively studied in endotherms (e.g. birds and mammals), but only scarcely in ectotherms specially reptiles (mostly on snakes). Sea turtles however represent interesting models for investigating fasting physiology in ectotherms: they are commonly considered as capital breeders with highly energetically expensive reproduction; yet, they may adopt intermediate strategy, suggesting particular physiological mechanisms never investigated so far in these species. Here we present the first longitudinal monitoring of body condition and plasmatic metabolites in gravid leatherback turtles *Dermochelys coriacea* during the 2006 nesting season in French Guiana. There, leatherbacks have been suggested to adopt intermediate strategy since some individuals are likely to forage, or at least attempt to, during reproduction. We tested this hypothesis by measuring biometric parameters and plasmatic metabolites as indicators of body condition and nutritional state. A total of 35 turtles were individually monitored during their entire nesting period. On average, leatherbacks nested 8 times (up to 12 clutches) within 72 ± 2 days. At the population level, body mass and plasmatic concentrations of glucose, triglycerides, urea, and calcium were 409.0±9.8 kg and 9.43±0.55, 9.48±0.87, 0.81±0.05 and 2.64±0.12 mmol/l respectively. Plasmatic concentrations decreased significantly throughout the nesting season, either logarithmically for glucose, urea and Ca^{2+} with minimal thresholds of 8.70±0.30, 0.73±0.01 and 2.23±0.10 mmol/l respectively or linearly for triglycerides with minimal concentration of 5.85±0.63 mmol/l. There was however a high inter-individual variability in initial plasmatic concentrations (some individuals initiating reproduction with metabolite concentrations as high as 4 times as others), and in the changes in plasmatic concentration throughout their nesting season, with 13 turtles (37%) showing individual trends different to the population trends. We show that individual reproductive effort is mostly determined by individual plasmatic metabolites, rather than individual body condition. Based on biometric and physiological data, our results show that in French Guiana most leatherback turtles do not feed during reproduction: they mostly rely on lipid metabolism, yet do not undergo critical protein catabolism, showing that despite their 2-mo fast associated to reproduction, females do not jeopardize their own condition and survival. Yet, 1/3 of the individuals do not show a strict capital breeder pattern. This partially supports our hypothesis that in French Guiana leatherbacks adopt intermediate strategy. Further individual monitoring are required to better understand the cues of such inter-individual variability and mechanisms. We are grateful to the International Sea Turtle Society, the Western Pacific Regional Fishery Management Council, the U.S. Fish and Wildlife Service, the U.S. National Marine Fisheries Service and the International Sea Turtle Symposium for their support and for providing us a travel grant.

HEMATOLOGICAL VALUES OF THE NESTING POPULATION OF GREEN TURTLES (*CHELONIA MYDAS*) IN THE AVES ISLAND WILDLIFE REFUGE, VENEZUELA

David A. Prieto[1], Jim L. Hernández[1], Alfonso R. Bravo[2], Martín J. Dávila[1], Mary C. Alvarado[3], Nolberto Quiroz[1], Luz A. Sánchez[4], and Jesús G. Ortega[5]

[1] Laboratorio de Investigaciones Piscícolas Dr. Lino Hernández, Facultad Experimental de Ciencias. Universidad del Zulia. Venezuela
[2] Laboratorio de Investigación y Desarrollo en Nutrición de la Escuela de Nutrición y Dietética, Facultad de Medicina. Universidad del Zulia
[3] Laboratorio de Diagnóstico Clínico, Policlínica Veterinaria, Facultad de Ciencias Veterinarias. Universidad del Zulia
[4] Oficina Nacional de Diversidad Biológica, Ministerio del Poder Popular para el Ambiente
[5] Comandancia General de la Armada Bolivariana. Servicio de Hidrografía y navegación. Caracas, Venezuela

The present investigation was to determine the hematological values of the nesting population of green turtles in the Aves Island Wildlife Refuge, Venezuela, which is the main nesting area for the species in the country and the second largest breeding colony of relevant in the Caribbean. Were collected, between July and September 2010, sixty-four (64) blood samples by puncturing the dorsal cervical sinuses, corresponding to fifty-two (52) in the process of egg laying females and twelve (12) males captured manually by diving. Two female turtles had emerging fibropapillomas the front flippers and the cervical region. The complete blood count included the Red Blood Cell (RBC), White Blood Cell Count (WBC), hematocrit (Hct), Hemoglobin (Hb), Packed Cell Volume (PCV), Mean Concentration Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC) and the differential count of leukocytes. They were also measured curved carapace length (CCL), curved carapace width (CCW) and also the length of the tail (LT) in the case of males, to estimate the minimum size at sexual maturity of animals. The average values obtained were: RBC 0.46 ± 0.14×106µL; WBC 3.66 ± 0.24×103 µL; Hct 30.77 ± 4.1%; Hb 9.60±1.2 g/dl; VGM 727.83 ± 216.03fL; MCH 226.08 ± 66.77pg. and MCHC 31.21 ± 2.73 G/dl. The differential leukocyte count was: Heterophils 54.3% (1.990×103/µL), lymphocytes 36.0% (1.297×103/µL), Eosinophils 7.4% (0.234×103/µL), Monocytes 3.8% (0.123×103/µL) and Basophils 0.4% (0.0097×103/µL). The CCL and CCW for nesting females were 112.1 cm and 101.4 cm, respectively, and for males was obtained from 105.6 cm CCL, CCW of 96.2 cm and LT of 34.3 cm. These results are consistent with the reference ranges for the species recorded in the populations of Florida, Mexico, Bahamas, Hawaii and The High Guajira in Venezuela. The variability in the values of the parameters evaluated can be directly related to factors such as age, sex, height, reproductive status, stress, environmental temperature, capture techniques and methods of analysis used.

VOLUNTEERS REHABILITATING RESCUED SEA TURTLES

Claudio Quesada-Rodríguez[1], Karolina Solis-Alfaro[2], Geovanni Quesada-Rodríguez[1], Andrea Chaves-Ramirez[2], Kinndle Blanco-Peña[2], Mirja Ansorge[1], Didiher Chacon-Chaverri[1], and Heiner Barquero[3]

[1] WIDECAST, San Jose, Costa Rica
[2] UNA, Heredia, Costa Rica
[3] SINAC-ACOSA, Peninsula de OSA, Costa Rica

The sea turtle conservation program from WIDECAST has been ongoing in Osa Peninsula (8 32 25.45 N, 83 18 08.26) in Puntarenas Province, Costa Rica, from 2006 until the present. Osa Peninsula is a really important feeding area and has several nesting beaches for different species like Hawksbill turtle (*Eretmochelys imbricata*), Black turtle (*Chelonia mydas*), leatherback turtle (*Dermochelys coriacea*) and Olive turtle (Olive ridley), this one is the most abundant turtle in the area. In November 2010, MarViva Foundation in partnertship with MINAET, an organization in charge of the marine animals in the ocean, in the Pacific coast of Costa Rica, found 21 olive ridleys sick in the Central Pacific area (08.28449N, 083.13403 W), after this, several organizations (lead by WIDECAST), put in practice a response rescue initiative to rehab these animals and release as many as we could, but the most important outcomes of this event, are the alliance of partners, the communication channel between government and NGOs, the response of private donors, the application of the Marine Turtles Trauma Response Procedure manual of WIDECAST and the rescue of 84% of the turtles. Several hypotheses were developed about the cause of the stranding like incidental fishing, red tide and epidemic disease, in particular the sea turtles shows several sickness related to all of this causes. WIDECAST is working in partnership with the Veterinary School from Universidad Nacional (UNA) to make blood and tissues analysis of the alive turtles and the necropsies of the death ones to find what is going on with this population.

ORGANOHALOGEN CONTAMINANT CONCENTRATIONS VARY IN ADULT MALE LOGGERHEADS BASED ON MIGRATION PATTERNS*

Jared M. Ragland[1], Michael D. Arendt[2], and Jennifer M. Keller[3]

[1] College of Charleston, Charleston, South Carolina, USA
[2] South Carolina Department of Natural Resources, Charleston, South Carolina, USA
[3] National Institute of Standards and Technology, Charleston, South Carolina, USA

Risks from organohalogen contaminants remain largely a mystery for loggerhead sea turtles (*Caretta caretta*). This study examines regional-scale differences in blood plasma contaminant concentrations from adult male *C. caretta* based on movement patterns. Turtles were captured in Port Canaveral, FL, in April of 2006 and 2007 and fitted with satellite transmitters. Residents (n=9) remained near the capture site while transients (n=10) migrated northward, becoming established in areas between South Carolina and New Jersey. Blood was sampled from the dorsocervical sinus of each turtle and analyzed for polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs), polybrominated diphenyl ethers (PBDEs), hexabromocyclododecane (HBCD), and toxaphenes using gas chromatography mass spectrometry and liquid chromatography tandem mass spectrometry. Plasma concentrations of OCPs and total PBDEs were significantly greater in transients than residents (p*C. caretta*. Understanding patterns of contamination informs wildlife managers about possible health risks to certain subpopulations. This study is the first to examine organohalogen contaminants in the rarely studied adult male loggerhead and one of the first to couple contaminant measurements with satellite tracking.

A REPORT OF FIBROPAPILLOMATOSIS IN EAST PACIFIC GREEN TURTLE (*CHELONIA MYDAS*) FROM LAGUNA SAN IGNACIO, BAJA CALIFORNIA SUR, MEXICO

Eduardo Reséndiz[1], Volker Koch[1], and Amaury Cordero Tapia[2]

[1] Universidad Autónoma de Baja California Sur (UABCS) Depto. de Biología Marina, Carretera al Sur km 5.5, 23080 La Paz, Baja California Sur, México
[2] Centro de Investigaciones Biológicas del Noroeste (CIBNOR)

Fibropapilomatosis (FP) in sea turtles are characterized by multiple fibroepitelial tumors that are firm to the touch with a rugose surface. Color varies from grey to pinkish or white, and sizes of 2 to >15 cm have been reported. Tumors are prevalently found in the eye, at the base of the flippers, and also in internal organs, infected individuals are often emaciated and have anemia. FP is distributed worldwide in sea turtles, in some regions the infection rate reaches up to 90%. However, in Mexico, few records exist on the presence and epidemiology of FP. We studied Green turtles from Laguna San Ignacio, located in the state of Baja California Sur (BCS) on the Pacific coast within a collaborative project between the Earthwatch foundation, UABCS, and Grupo Tortuguero that studies Ecology, behavior and conservation of green turtles. Live captures provide detailed information on various ecological aspects, and also the opportunity to conduct health status exams. On the 5th of July 2010, we caught a green turtle (SCL 48.3 cm, weight 7.4 kg) that showed nodules with a granular surface, rugose texture, and greyish/pink/whitish colours on the external upper surface of the eyes covering an area of approximately 1x2 cm, At the base of the extremities multiple nodulations were found

up to a diameter of 2 cm. Biopsies of aprox. 1cm3 were taken from the extremities, preserved in 10 % buffered formaline and processed for histopathology and electron microscopy. Light microscopy revealed orthokeratotic hyperkeratosis, epidermal hyperplasia, dermal papillary projections, balloning degeneration, herpesvirus-like anfophilic intranuclear inclusions in basal cells; necrosis and degeneration of epidermal basal cells, and perivascular light focal mononuclear infiltrate. Electron microscopy revealed viral particles in the tumor cells, confirming the diagnostic of FP. This is the first report of FP in green turtles from Laguna San Ignacio and one of the first records from the peninsula of Baja California.

FIBROPAPILLOMATOSIS IN JUVENILE GREEN TURTLE (*CHELONIA MYDAS*) CAPTURED IN THE GULF OF VENEZUELA: FREQUENCY ASSOCIATED WITH ENVIRONMENTAL CONDITIONS?

Nínive Espinoza Rodríguez[1] and Héctor Barrios-Garrido[1,2]

[1] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV) Maracaibo, Venezuela
[2] Laboratorio de Ecología. General. Facultad Experimental de Ciencias. La Universidad del Zulia (LUZ). Maracaibo-Venezuela

Fibropapillomatosis (FP) on Sea Turtles (ST) is a disease characterized by multiple cutaneous masses. This disease was first reported in the late 1930's, primarily affecting green turtles (*Chelonia mydas*), depending on their size, location and number of tumors can contribute to the animal weakening and eventually death. Between 2000 and 2006, in the Gulf of Venezuela (GV) had been reported only 2 cases of FP in turtles (0.285 per year), indicating that the occurrence and frequency of this disease was very low. Subsequently, between 2007 and 2010, records of FP on ST increased significantly (1.2 per year). A total of 5 individuals of juvenile green turtles were reported showing large masses or skin tumors in various parts of the body, indicating an increase of 420% in the occurrence of this disease at the GV. Many studies have supported that the occurrence and prevalence of FP is associated with coastal areas highly or moderately polluted, with high human density, agricultural and urban runoff, sewage and/or high production of algal bio-toxins. Eighty percent of animals captured with FP came from coastal waters characterized by habitat degradation and pollution due to urban runoff that flows through streams adjacent to the coast, this fact was strongly increased by heavy precipitation recorded for the date. Also, the characteristics of the beach (low energy and shallow waters) support the idea that more than one conditions or a combination of these, may trigger a high prevalence of FP in ST. Thus, the use of ST as a sentinel species is quite clear: these animals have a high public profile and are particularly vulnerable to degradation of the environmental health of the ecosystem. However, it is necessary to monitor the number of changes or fluctuations in environmental factors that can negatively affect the survival of ST populations in the GV.

FIRST SEA TURTLE PHYSIOLOGICAL BLOOD PARAMETERS FROM TURKEY

Dogan Sözbilen[1], Yakup Kaska[1], and Hulya Aybek[2]

[1] Pamukkale University, Faculty of Arts and Sciences, Department of Biology, Denizli-Turkey
[2] Pamukkale University, Faculty of Medicine, Department of Biochemistry, Denizli-Turkey

Number of sea turtles in the Mediterranean is quite low in comparison with rest of the world’s sea turtle populations. As a result of various anthropogenic factors, Mediterranean sea turtle populations are facing of decline in the near future. Moreover, mitochondrial DNA analysis shows that Mediterranean sea turtles are isolated from Atlantic populations. Genetic isolation is more distinctive in Turkey’s nesting beaches. Thus, more effective protection and research studies are required. Our knowledge about blood physiology and blood chemistry of sea turtles in Turkey is none and is very limited for the rest of the Mediterranean. Physiologic and biochemical blood parameters can be affected by geographic location, habitat, genetic factors, maturity, sex, reproductive condition, migration and diet. When we consider all of these conditions, there is a large lack of information on this topic. Therefore, we aimed in this study to investigate some physiologic blood parameters of 25 sea turtles (23 loggerhead and 2 green turtles). Of these 25 turtles, blood samples were collected from 14 injured turtles which brought from western part of Turkish coastline

to the "Sea Turtle Research, Rescue and Rehabilitation Centre" (DEKAMER) in Dalyan. The rest of the samples were collected from nesting and foraging turtles in Dalyan region. Testosterone, estradiol, corticosterone and progesterone levels and 26 different biochemical blood parameters were measured and compared according to their health conditions, sex and nesting. We believe that these study and its findings are going to facilitate rehabilitation process of injured turtles and help to understand physiology of sea turtles in the Mediterranean.

PHARMACOKINETIC BEHAVIOUR OF MELOXICAM IN LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*)

Simona Soloperto[1], Antonio Di Bello[2], Olimpia R. Lai[1], Daniela Freggi[3], Antonella Tinelli[1], Vito Carofiglio[1], and Giuseppe Crescenzo[1]

[1] Department of Veterinary Public Health, Faculty of Veterinary Medicine, University of Bari, Valenzano, BA, Italy
[2] Department of Emergency and Organ Transplantation, Division of Veterinary Surgery, Faculty of Veterinary Medicine, University of Bari, Valenzano, BA, Italy
[3] WWF Sea Turtle Rescue Centre, Lampedusa, AG, Italy

In rehabilitative medicine of sea turtles, traumatic lesions and infectious diseases are the more frequently encountered reasons to provide veterinary care to these animals. Trauma related emergencies (boat strikes, ingestion of fish hooks, entrapment in fish wires, etc.) require a surgical approach, and consequently a correct pain management. Data on reptile analgesia and pain management are scarce, both with NSAIDs and opioids, and totally lacking in sea turtles, so dosage regimens are generally extrapolated from other animal species, with consequent risks of clinical failure and damage to the animal. In order to avoid circumstances like these, preliminary data on the pharmacokinetic behavior of meloxicam in loggerhead sea turtle (*Caretta caretta*) are presented, in order to assert the possibility of its clinical use to provide pre- and post-surgical analgesia. Meloxicam has been chosen in spite of other NSAIDs because of its more selective anti-COX2 activity, and consequently expected lesser adverse side effects. 6 clinically health loggerhead turtles (courtesy of Lampedusa WWF Sea Turtles Rescue Center), 9.6-27.1 kg weight, were used. The animals were individually maintained in outdoor pools with continuous marine water flow, at 25-27°C and 35‰ salinity. The dose of 0.1 mg/kg of meloxicam was decided, so reducing the recommended dose used for dog and cat as no data are reported on the capacity of turtles to tolerate NSAIDs. Nevertheless, no adverse reaction was observed after the administration of the drug. Blood samples were collected from alternated cervical sinuses in lithium heparinized tubes. Meloxicam plasma concentrations were determined by DAD-HPLC. After the administration of a single i.m. dose, a very quick absorption rate has been noted, with time to peak concentration 0.79±0.28 h (mean ± s.e.), and peak concentrations 0.03±0,01 mg/ml. As pharmacodynamic and efficacy studies of meloxicam in reptiles have not been published, the minimum efficace concentration cannot be predicted, so further studies are requested to define the optimal dosage. A very fast disappearance of drug from vascular compartment was observed, with concentrations of drug below the detection limit in 4.60±3.49 h, elimination half-life of 1.32±0.55 h, clearance of 4.32±1.19 L/h·kg, and apparent volume of distribution of 6.51±2.45 L/kg. These data are surprising enough, if compared with the ones reported in green iguana, where plasma concentrations resulted >0.1 mg/mL for up to 24 h, elimination half-life 9.93±4.92 h, clearance 0.037±0.016 L/h·kg, and apparent volume of distribution 0.46±0,12 L/kg following a single i.v. dose of 0.2 mg/kg. The large volume of distribution observed in loggerhead turtle suggests a wide tissue distribution, but nothing can be said on the persistence of drugs in tissues or real elimination of the drugs, so further studies are essential. SS gratefully acknowledges travel support from International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and the International Sea Turtle Symposium.

FIBROPAPILLOMATOSIS AND FISHER CHOICE IN THE HARVEST OF GREEN SEA TURTLES*

Thomas B. Stringell[1], Marta C. Calosso[2], John A.B. Claydon[2], Wesley Clerveaux[3], Brendan J. Godley[1], Quentin Phillips[4], Susan Ranger[5], Peter B. Richardson[5], Amdeep Sanghera[5], and Annette C. Broderick[1]

[1] Marine Turtle Research Group, University of Exeter, Penryn, Cornwall, UK
[2] The School for Field Studies, Center for Marine Resource Studies, South Caicos, Turks and Caicos Islands, BWI
[3] Department of Environment & Coastal Resources, Providenciales, Turks and Caicos Islands, BWI.
[4] Department of Environment & Coastal Resources, South Caicos, Turks and Caicos Islands, BWI.
[5] Marine Conservation Society, Ross on Wye, Herefordshire, UK

We describe the incidence of fibropapillomatosis (FP) in green turtles (*Chelonia mydas*) in the Turks and Caicos Islands (TCI), a UK overseas territory in the Caribbean, which has a legitimate fishery that annually harvests approximately 300 green turtles for local consumption. Of the turtles captured and released during our in-water surveys (November 2008 – December 2010), 13% showed externally visible signs of FP. Turtles with FP, were significantly larger (mean CCL=54.0cm, SD=10.2, n=32) than those without (mean CCL=42.7cm, SD=11.4 n=207). The fishery harvests turtles with an average CCL (52.6cm, SD=12.3 n=136) similar to turtles captured and released with FP and therefore we might expect to find about 13% of harvested turtles to have FP. However, none of the harvested turtles that we observed showed signs of the disease (n=162). We investigate the influence of fishing location and fisher behaviour on the paucity of FP in the harvest. FP occurs at specific geographic locations in the TCI, some of which are fisher "home-ranges". We interviewed 28 turtle fishermen and although most (n=16) had seen FP in turtles in the TCI, only 2 fishers reported having harvested turtles with FP; most (93%) would not take turtles with FP for food, preferring instead to return their catch. We suggest that this fisher choice may selectively increase the survivorship of turtles with FP and might lead to an increase in the incidence of the disease in green turtle foraging areas in TCI. Attendance was supported through generous donations by the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service.

TWO CASES OF REHABILITATED LOGGERHEAD (*CARETTA CARETTA*) SEA TURTLES SURVIVING IN THE WILD AFTER RELEASE

Kelly J. Thorvalson[1], Mike D. Arendt[2], and Julia I. Byrd[2]

[1] South Carolina Aquarium, Charleston, SC, USA
[2] South Carolina Department of Natural Resources, Charleston, SC, USA

In partnership with the South Carolina Department of Natural Resources (SCDNR), the South Carolina Aquarium uses its facilities to aid sick and injured sea turtles through its Sea Turtle Rescue Program. Live sea turtles that strand along the South Carolina coast are transported to the Aquarium's Sea Turtle Hospital for medical treatment. Once a sea turtle is medically cleared, it is released back into the ocean. It is rare for a rehabilitated sea turtle to be seen again after its release, which inhibits evaluation of short or long term rehabilitation success. Since 2000, 53 sea turtles (34 loggerhead, 12 Kemp's ridley, 7 green) have been released from the South Carolina Aquarium after being treated for a variety of conditions, both acute (injuries) and chronic (debilitation). Of 34 loggerheads, short and long term survival have been documented on eight individuals through two different methods of monitoring: in-water research (n=2) and satellite telemetry (n=6). In this presentation, post release data on two male loggerheads are reported. The very first sea turtle treated by the South Carolina Aquarium was a juvenile loggerhead sea turtle admitted on August 22, 2000. The turtle was a "floater" and was unable to dive. After six months of rehabilitation, the loggerhead was released at the Archie Carr National Wildlife Refuge in Melbourne, Florida. Ten years later in July of 2010, this turtle was recaptured near Altamaha reef off of the central coast of Georgia by the SCDNR in-water project. The loggerhead's weight had increased from 47 kg to 80 kg and the carapace had grown almost 13 cm. The 31 cm tail length indicated this turtle was

male and nearing maturity. The second case was a 127 kg adult male loggerhead that was entangled in a crab pot line that damaged the front left flipper so extensively it had to be amputated. The turtle recovered in the Sea Turtle Hospital for four months and was released with a satellite transmitter off the South Carolina coast in November 2007. The loggerhead took almost no time to get his bearings and headed north towards the Outer Banks of North Carolina where he spent the winter. The next spring, this male migrated farther north along the eastern coast of the United States into the Delaware Bay and spent the summer and fall in this foraging area. When waters began to cool, he returned to his previous foraging area along the Outer Banks where the transmitter signal was lost. In-water monitoring and satellite telemetry (in cases where the satellite transmitter functions for a significant period), can be beneficial for determining post-release survivability in sea turtles after being in a captive care rehabilitation facility.

HISTOLOGIC CHANGES OF GROSSLY NORMAL SKIN IN LOGGERHEAD TURTLES (*CARETTA CARETTA*) CAPTURED IN BAHIA MAGDALENA, BAJA CALIFORNIA SUR, MEXICO

Colby Wells[1], Colleen Duncan[2], Bruce Wobeser[3], Terry R. Spraker[2], Hoyt Peckham[4], and A. Alonso Aguirre[5]

[1] College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, Colorado, USA
[2] Colorado State University Veterinary Diagnostic Laboratory, Fort Collins, Colorado, USA
[3] Western College of Veterinary Medicine, Department of Veterinary Pathology, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
[4] Proyecto Caguama/Grupo Tortuguero de las Californias, AC, La Paz, Baja California Sur, Mexico
[5] EcoHealth Alliance, New Yotk, New York, USA

Since the 1980's, sea turtle fibropapillomas have emerged as a significant cause of morbidity and mortality of sea turtles worldwide. Fibropapillomatosis is considered a visible marker of sea turtle health and is associated with damaged marine ecosystems. While late stage disease is well described, there is controversy in the literature regarding causative agents and early skin changes are poorly understood. The objective of this study was to histologically examine grossly normal skin biopsies of loggerhead sea turtles off Bahia Magdalena, Baja California Sur, Mexico for changes suggestive of early cutaneous lesions. Biopsies were collected from live caught loggerhead turtles. Fifty-eight biopsies were reviewed. Histologic changes were restricted to the epidermis. Mild histologic changes were observed in 38 (62%) of the biopsies. The most common histologic change observed within examined sections was a variable amount of cytoplasmic vacuolation. Vacuolation was most common in areas of acanthosis or papillary projections. Epidermal thickness was variable both within and between samples. Acanthosis, up to 20 cell layers thick, was observed in 29 biopsies. Animals with cytoplasmic vacuolation were nine times more likely to also have areas of hyperplasia than those without. Of these sections in which epidermal hyperplasia was present, the number of papillary projections appeared increased in 11 animals, however this was not statistically associated with cytoplasmic vacuolation. Keratin was mildly thickened in 29 animals. Hyperkeratosis was 15 times more likely to be present in animals with cytoplasmic vacuolation than animals without. Other histologic changes identified included aggregates of superficial bacteria and fungi devoid of associated inflammatory response and one animal with superficial, heterophilic pustules. Rare apoptotic keratinocytes were occasionally observed. In many species, preneoplastic epidermal and dermal changes have been identified as skin neoplasia tends to develop in a characteristic sequence. Acanthosis, orthokeratotic or parakeratotic hyperkeratosis, and dysplasia are precancerous transformations that can be seen histologically. As fibropapillomas are considered to be a type of neoplasm, it is vital to have an understanding of the neoplastic transformation that skin goes through to form fibropapillomas. Histologic changes identified in the present study were subtle and the significance of these changes is difficult to interpret. Molecular testing for infectious viruses is underway and will be reported. Given the ecological significance of sea turtle fibropapillomatosis, further investigation of the early dermal changes may elucidate important information regarding the pathogenesis of the disease.

HEAVY METAL VALUES IN BLOOD OF THREE SPECIES OF SEA TURTLES FROM GULF OF CALIFORNIA, MEXICO

Alan Zavala-Norzagaray[1,2], Cesar Ley-Quiñónez[1,2], T. Leticia Espinosa-Carreón[1], Hoyt Peckham[3], Ciro Marquez-Herrera[4], Lorena Campos-Villegas[5], and Alonso Aguirre[6]

[1] INSTITUTO POLITÉCNICO NACIONAL, CIIDIR-SINALOA, Guasave, Sinaloa, México
[2] Regional en Biotecnología, Universidad Autónoma de Sinaloa
[3] GRUPO TORTUGUERO DE LA CALIFORNIAS A.C., La Paz, B.C.S., México
[4] Facultad de Química, Universidad Nacional Autónoma de México, México, D. F.
[5] CIIEMAD, Instituto Politécnico Nacional. La Paz, Baja California Sur, México
[6] Ecohealth Alliance, New York, USA

Five species of sea turtles, *Dermochelys coriacea*, *Caretta caretta*, *Lepidochelys olivacea*, *Eretmochelys imbricata* and *Chelonia mydas agasiizi* have been documented in the Gulf of California. This region has been recognized as priority for the protection of nesting and developmental habitats for these species. The major threats for sea turtles include direct fishing and consumption by local communities, fisheries bycatch, egg harvest from nests and habitat destruction. Pollution of the oceanic environments induced by humans represents a further threat to sea turtles and other species through bioaccumulation, bioconcentration and biomagnification of contaminants. Bacterial metabolic pathways in a short time cannot degrade heavy metals persisting in the environment for long periods of time potentially harming the health of organisms and ecosystems. Sea turtles may provide an early warning system or be sentinel species with specific biological characteristics that provide information about the health of marine ecosystems. The purpose of this study is to determine the reference levels of heavy metals (Zn, Ni, Mn, Cu, Se, Pb, Cd and Hg) in three species of sea turtles from Northwest Mexico. We collected blood from June to December 2008 in different foraging areas of Northwest Mexico with the support of GRUPO TORTUGUERO for validation and analysis based on earlier studies. Heavy metal concentration analysis in blood was performed with a Plasma Atomic Emission Spectrophotometer (ICP-OES). We collected specimens from 37 sea turtles distributed as follows: ***L. olivacea*** (17), ***C. m. agassizii*** (15), ***E. imbricata*** (n=5). Straight carapace lengths averaged (64.02) as this was not statistically significant (P = 0,30) among species. Turtle tissues that presented major average concentration of As (5,014 µg g-1) were detected in ***E. imbricata***, and Cd (1,336 µg g-1) in ***L. olivacea***. Pb and Hg were below limit of detection. Essential heavy metals (Zn, Cu, Ni and Mn), Zn was found in major average concentrations in ***E. imbricata*** (66,609 mg Kg-1). Ni (2,176 µg g-1) and the Mn (2,478 µg g-1) in ***L. olivacea***. The average concentrations followed this order: Zn > Se>Ni> As> Cu> Mn> Cd.

Population Assessment

GREEN TURTLE NESTING ON TRINDADE ISLAND, BRAZIL

Antonio P. Almeida[1], Luciana M.P. Moreira[1], Soraya C. Bruno[2], Maria A. Marcovaldi[3], Agnaldo S. Martins[4], Alan B. Bolten[5], and Karen A. Bjorndal[5]

[1] Projeto TAMAR-ICMBio, Linhares, Espírito Santo, Brasil
[2] Projeto TAMAR-ICMBio, Vitória, Espírito Santo, Brasil
[3] Projeto TAMAR-ICMBio, Praia do Forte, Bahia, Brasil
[4] Universidade Federal do Espírito Santo, Vitória, Espírito Santo, Brasil
[5] Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, Gainesville, Florida, USA

Trindade Island is on the eastern end of the Vitória-Trindade submarine Ridge (20°30'S, 29°20'W), 1140 km off the coast of the state of Espírito Santo, southeastern Brazil. Green turtle (*Chelonia mydas*) nesting was monitored intermittently during 17 seasons, from 1982 to 2009. Different expeditions had distinct goals such as tagging females, assessing hatching success, mapping emergences both spatially and temporally, or estimating the proportion of nests in relation to the total tracks. Consequently, there is a large variation in data collection during the 17-year span. The nesting period was completely surveyed in six seasons (1994/95, 1995/96, 1999/00, 2006/07, 2007/08 and 2008/09). The nesting period is from December to April (more than 95% of records), with a peak between January and March. The number of nests was estimated from direct observations on the proportion of nests to total track counts in the four main nesting beaches, which comprise more than 90% of records, during four different seasons (99/00, 06/07, 07/08 and 08/09). These estimates were then used to estimate the total number of nests from track counts in other nesting seasons. Estimates varied from 1113 nests (for only 2 beaches sampled) to 5176 nests (9 beaches sampled) per year. The number of nests makes the Trindade nesting population among the most important known Atlantic nesting sites. Although available information suggests a stable population, tag recoveries from different points along the Brazilian coast highlight the need for conservation measures, which must be applied thousands of kilometers away from the nesting beaches to maintain the green turtle nesting population in Trindade.

MACHALILLA NATIONAL PARK, A CRITICAL NESTING SITE FOR HAWKSBILL (*ERETMOCHELYS IMBRICATA*) AND GREEN (*CHELONIA MYDAS*) SEA TURTLES IN THE EASTERN PACIFIC

Gabriela Anhalzer[1], Jose Luis Ferrin[1], Andres Baquero[2], Felipe Vallejo[1], Juan Pablo Muñoz[1], Fernando Vera[3], and Xavier Chalen[4]

[1] Equilibrio Azul, Quito, Ecuador
[2] Equilibrio Azul/Universidad San Francisco de Quito, Ecuador
[3] Machalilla National Park, Ecuador
[4] Conservation International, Quito, Ecuador

All sea turtle species are endangered to some degree globally. Therefore, it is critical to understand the dynamic of the populations during the different stages of their life cycles. Equilibrio Azul, in coordination with the Ministry of the Environment of Ecuador started a sea turtle monitoring program in the beaches of the Machalilla National Park (MNP) in 2007. The purpose of this program is to understand the status of the population of sea turtles in this protected area and to establish and protect the main nesting grounds. After selecting the two most important sites in the National Park an intensive night patrolling program was begun at La Playita beach and Drake Bay. The results of this three year program showed La Playita as the only nesting beach identified for the critically endangered hawksbill (*Eretmochelys imbricata*) in South America. In the 2009-2010 season we confirmed a total of 10 nesting females and protected 28 nests, along with seven nests of green sea turtles (*Chelonia mydas*) and one nest of olive ridley (*Lepidochelys olivacea*).

On the other hand, Drake Bay at La Plata Island was confirmend as the most important nesting beach of the coast of Ecuador for *C. mydas*. A total of 41 nesting females, 58 confirmed nests, and 33 non confirmed nests were recorded during the last season. As a management measure against the effect of high tides a total of 16 nests were relocated to the first sea turtle hatchery of the country built at La Plata Island. More than 300 neonates were released at this facility. This information indicates that Machalilla National Park is the main sea turtle nesting area in continental Ecuador and the only identified nesting site for *E. Imbricata* in the Pacific coast of South America.

RECORD YEAR FOR GREEN SEA TURTLE NESTING IN VIEQUES

Mike Barandiaran[1] and Mitsuka Bermudez[2]

[1] USFWS - Vieques NWR, Vieques, PR, USA
[2] TICATOVE - Vieques, PR, USA

Vieques plays an important role in the conservation of the natural treasures of Puerto Rico. It is so, that is the second largest territory of all the island of PR dedicated for the conservation with approximately 20,000 acres of land. This is between the lands administered by the Vieques National Wildlife Refuge (Vieques NWR-USFWS), the Department of Natural and Environmental Resources of PR (DNER) and the Puerto Rico Conservation Trust (PRCT). Another important fact that confirms our importance in the conservation is, the green sea turtles (*Chelonia mydas*) nesting. Vieques is between the five most preferred nesting sites within the Caribbean Islands. We have evidence of nesting from three species of endangered sea turtles. The green sea turtle is one of them. Vieques NWR-USFWS is working together with TICATOVE, Inc. (non profit community based Conservation Group from Vieques), in the Monitoring Project of this species. The collected data of 2010, has demonstrated that we are in a nesting record year for the green sea turtle in our island. We have made a comparison with the evidence that DNER collected for the NAVY from 1991 to 2003, and the one collected by Vieques NWR-USFWS with TICATOVE from 2004 to present. Given the fact that the nesting numbers for the main island of PR are so low, and ours are record numbers, we want to share and disclose this valuable information.

A COMPARISON OF METHODOLOGIES FOR ESTIMATING THE NEST DENSITY OF OLIVE RIDLEY ARRIBADAS AT OSTIONAL, COSTA RICA

Vanessa S. Bezy[1] and Roldán A. Valverde[2]

[1] University of North Carolina Wilmington, Wilmington, North Carolina, USA
[2] Southeastern Louisiana University, Hammond, Louisiana, USA

An alternative methodology was used to provide a comparison to the transect methodology for estimating the population size of Olive Ridley (*Lepidochelys olivacea*) arribadas at Ostional, Costa Rica. This study was performed to gain a better understanding of the nest density of arribadas and to verify the population estimates resulting from the transect methodology that is currently applied. Immediately following the conclusion of each arribada, fifty 1x1 meter quadrats were randomly placed along the same section of the beach where transects were performed. Each quadrat was dug out to 60 cm in depth to count the number of nests within the quadrat that were laid during the arribada. Results were then extrapolated to the entire beach to estimate the total number of nests remaining on the beach following each arribada. The estimates resulting from the quadrats were then compared to estimates from the transect methodology. Results show that quadrat and transect estimates are similar, the difference between them varying from 0.04% to 52.6%, with quadrat estimates being always lower, as expected. Because the quadrat methodology was carried out following the arribada, it offered a different measure of the reproductive potential at Ostional. Although the transect method provided an estimate of the number of nests laid, it did not take into consideration the amount of nests harvested and those destroyed by other nesting turtles, predators, and tidal levels. The destruction of nests by these other factors had not been previously quantified, although the amount of nests harvested is reported each arribada. It is important to take into consideration these other factors to understand the magnitude of threats to the nests deposited each arribada. It is expected that, over time, this new tool will offer us a new way to evaluate the true potential of

Ostional beach to produce hatchlings, along with the changes in the threats that control the success of this threatened population. By furthering our understanding of nesting population abundance and assessing the current methodology used in estimating it, we can determine the health of the population and accordingly implement or adjust appropriate conservation measures and management guidelines. Funds to support field research of this study came from USFWS Marine Turtle Conservation Act (96200-0-G037). A grant to support the presentation of this research was provided by the International Sea Turtle Symposium. Support for this grant was made available through generous donations provided by the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service.

HIDDEN CONNECTIONS: THE HAWKSBILL TURTLES OF GRENADA AND THE SOUTHERN GRENADINE ISLANDS

Darren C. Browne[1], Carl Lloyd[2], Crafton A. Isaac[3], and Julia A. Horrocks[1]

[1] Department of Biological and Chemical Sciences, University of the West Indies, Cave Hill Campus, Barbados
[2] Ocean Spirits, Bathway, Grenada
[3] Ministry of Agriculture, Lands, Forestry and Fisheries, St. Georges, Grenada

Although protection from harvest in a growing number of Eastern Caribbean territories has led to localized increases in hawksbill turtles (*Eretmochelys imbricata*) in recent years (e.g. in Barbados), numbers have been significantly reduced from former levels by over-exploitation for meat, eggs and shell. Investigations of the mitochondrial DNA control region have been used to reveal the linkages between regional nesting rookeries and foraging aggregations, but have largely focused on territories with full protection for sea turtles which often have larger nesting aggregations. Grenada and the southern Grenadine islands, where sea turtles are legally harvested, have recently initiated nesting beach and in-water monitoring, thus providing new opportunities for accessing tissue samples from tagged individuals. Mitochondrial DNA control region analysis of sampled individuals from this much reduced population has enabled an investigation of the linkages between these animals and those of previously studied territories. Mixed stock assessment was used to estimate the relationships between the small Grenada rookery and regional foraging aggregations, as well as between the Grenada foraging aggregation and other regional rookeries. Despite its small size, the Grenada rookery is genetically diverse, with some haplotypes confined to offshore islets. The Grenada foraging aggregation also shows a high level of diversity, indicating contributions from numerous regional sources. Mixed stock assessment revealed not only that distant foraging aggregations are important to recruitment at the Grenada rookery, but also that the coral reefs associated with Grenada and the southern Grenadine Islands may represent important developmental and foraging habitats for hawksbill turtles from several territories throughout the Wider Caribbean region.

THE ANALYSIS OF LONG FRAGMENTS OF MITOCHONDRIAL DNA IMPROVES THE UNDERSTANDING OF THE GENETIC STRUCTURE OF LOGGERHEAD SEA TURTLE'S (*CARETTA CARETTA*) IN THE MEDITERRANEAN SEA

Marcel Clusa[1], Carles Carreras[1], Marta Pascual[2], Andreas Demetropoulos[3], Dimitris Margaritoulis[4], Abdulmaula A. Hamza[5], Mona Khalil[6], Monica Aureggi[7], Yaniv Levy[8], Oguz Türkozan[9], Alex Aguilar[1], and Luis Cardona[1]

[1] Department of Animal Biology, Faculty of Biology, University of Barcelona, Av.Diagonal 645, E-08028 Barcelona, Spain
[2] Department of Genetics, Faculty of Biology, University of Barcelona, Av.Diagonal 645, E-08028 Barcelona, Spain
[3] Cyprus Wildlife Society, Emmanuel Xanthou 11, P.O. Box 24281, 1703 Nicosia, Cyprus
[4] ARCHELON, The Sea Turtle Protection Society of Greece, Solómou 57, GR-10432 Athens, Greece
[5] Marinelife Conservation Unit, Environment General Authority, Alfateh University Post, P.O. Box 13793,

Tripoli, Libya
[6] MEDASSET, P.O. Box 19, Tyre, Lebanon
[7] Naucrates, Via Corbetta 11, 22063 Cantù , CO, Italy
[8] The Israel Sea Turtle Rescue Centre, Nature Parks Authority, Mevoot Yam, Mikhmoret 40297, Israel
[9] Adnan Menderes University, Faculty of Science and Arts, Department of Biology, Aydin, Turkey

Traditionally, a short fragment (380 bp) of the D-loop of the mitochondrial control region has been used for genetic studies for sea turtles like the loggerhead (*Caretta caretta*). However, the recent development of new primers for amplifying a longer fragment (815 bp) offers the possibility of a better resolution for genetic studies of this species. Samples from 243 different nests from the main nesting beaches in the Mediterranean, including published data, were genotyped and analysed for both short and long fragments in order to compare the performance of the two markers. Long mtDNA fragments revealed the existence of 12 different haplotypes present in the region, whereas only nine haplotypes were revealed by short fragments, and some common haplotypes were split in several new haplotypes. This resulted in a slight improvement for individual assignments to natal nesting grounds (11.52% vs. 13.58% of unique haplotypes with short and long fragments, respectively). However, the most important benefit in using the long fragment is a much better understanding of the genetic structure of the area. Long fragments allowed a major differentiation between populations and a major definition of haplotype structure with network trees revealing a new group of haplotypes. Relationships between haplotypes can be used to infer studies on historical processes leading to their current genetic and geographic distribution. Benefits also emerged when analysing the relationship between pairwise genetic (Fst) and geographic distances. Principal Component Analysis (PCA) based on long fragments increased the number of genetic groups observed and improved the accuracy of geographical differenciation of such groups. The genetic variability explained by the short fragment resulted in only two clearly differentiated groups of nesting grounds (Calabria and the other locations), whereas the analysis of the longer fragment unveiled a higher degree of hidden genetic variability, with Libya as a prominent third differentiated unit. Overall, the use of long fragments of mtDNA increased the capability to detect new haplotypes, improved the efficiency in detecting unique haplotypes hence facilitating individual assignation to the natal region and increased the resolution when defining genetic units related to certain geographic locations. These results underline the necessity to work with long fragments in the future, becoming a potential tool for the study of genetic structuring and for the implementation of management and conservation plans worldwide.

ULITHI MARINE TURTLE PROGRAM: MONITORING NESTING GREEN TURTLES IN ULITHI ATOLL, YAP, FEDERATED STATES OF MICRONESIA

Jennifer A. Cruce[1], John Rulmal Jr.[2], Michael Lingelmar[2], Juanito Mangirechog[2], and Alexander Sau[2]

[1] Oceanic Society, Ulithi Marine Turtle Program, Ulithi Atoll, Yap State, Federated States of Micronesia
[2] Ulithi Marine Turtle Program, Ulithi Atoll, Yap State, Federated States of Micronesia

Yap is the most westerly state within the Federated States of Micronesia located in the Caroline Islands of the western Pacific Ocean. Yap State encompasses approximately 134 islands and 11 atolls extending nearly 800 km east and south. Of these islands (from the main island of Yap Proper to the neighboring island atolls), 22 are inhabited by the Yapese people who continue to closely follow the traditional culture. Marine turtles are a significant part of many aspects of Yapese life, predominantly in the outer islands where resources are limited. Four species of marine turtle are known to nest and forage within Yap State. Rare sightings of leatherback turtles (*Dermochelys coriacea*) have been reported in pelagic waters (McCoy 1974) and olive ridley turtles (*Lepidochelys olivacea*) have been observed swimming outside the reef of Yap Proper (Falanruw 1975). Green turtles (*Chelonia mydas*) are the most common species nesting in the neighboring islands and hawksbill turtles (*Eretmochelys imbricata*) are often seen foraging in Yap Proper and neighboring island reefs. Ulithi Atoll, located approximately 185 kilometers (km) northeast of Yap Proper, is home to several "Turtle Islands", of which five are identified as significant green turtle nesting sites by the local people. These uninhabited islands include a cluster of three islands: Loosiep, Bulbul, and Yeew and in a separate reef system are two islands: Gielop and Iar, which may be among the largest green turtle rookeries in Micronesia (Kolinski 1992). Turtles nesting on or mating near these islands have traditionally been hunted for their meat and eggs, which is considered an important source of protein for inhabitants of the outer islands (Lessa 1983). Ulithi turtle populations in the past have been managed and inadvertently conserved due to cultural limitations, regarding take of

turtles for consumption, put in place by traditional leaders (Lessa 1983); however, with inevitable shifts in social and environmental dynamics these customs are being challenged. In 1991, Yap State Marine Resources Management Division tagged and assessed nesting turtles on Gielop Island from May through August in which they encountered over 400 nesting green turtles (Kolinski 1992). Subsequent tagging projects were not pursued on Gielop due to limited resources and restricted access to the island. In 2005, the Ulithi Marine Turtle Program was established by the community of Falalop Island to revive a tagging and monitoring project on Gielop Island. Since then, more than 1,800 nesting green turtles have been tagged and assessed in an effort to establish a long-term monitoring program on Gielop Island. In 2008, the project extended to Loosiep Island where nearly 300 nesting green turtles have been encountered. According to local fishermen, turtles appear to nest year around however the primary nesting season in Ulithi Atoll extends roughly from April through September, although May and June represent the months with highest nesting activity. This program trains and employs up to twenty Ulithian men each year and has been sponsored by The Oceanic Society since 2007.

CONTINUED RECOVERY OF THE LARGEST HAWKSBILL ROOKERY UNDER U.S. JURISDICTION, AT MONA ISLAND, PUERTO RICO

Robert P. van Dam[1], Carlos E. Diez[2], Karla G. Barrientos Muñoz[1], and Cristian Ramirez Gallego[1]

[1] Chelonia Inc, PO Box 9020708, San Juan, PR 00902-0708
[2] Programa de Especies Protegidas, Departamento de Recursos Naturales, PO Box 366147, San Juan, PR 00936

Surveys conducted at Mona Island, Puerto Rico, revealed a new record number of hawksbill nests deposited on the island's beaches during 2010. Green turtle nesting activity also was strong this year. Data on nest loss due to beach erosion, nest density, hatching success and other nest parameters are also presented. Results are presented in the context of local and international conservation efforts. Mona Island is an uninhabited island managed as a Natural Reserve by the Puerto Rico Department of Natural and Environmental Resources. Located in the Mona Passage midway between the Dominican Republic and Puerto Rico, this limestone island has approximately 7.2 km of sandy beaches located along its southern coast. Daytime beach surveys were conducted on the island from early August until early December, 2010. As part of the surveys, a nesting activity index was established in 2003, which consists of daily morning surveys of turtle nesting activity on a subset of beaches along the southwest coast during the months of September and October. For 2010, the index resulted in 481 hawksbill nests and 278 false crawls, a new record for Mona Island and 18% higher than for 2009.

GEOGRAPHIC PATTERNS OF MARINE TURTLE DISTRIBUTION AND DIVERSITY*

Andrew DiMatteo[1], Bryan Wallace[2], and Patrick Halpin[1]

[1] Duke University, Marine Geospatial Ecology Lab
[2] Conservation International, Global Marine Division, Sea Turtle Flagship Program

Marine turtle nesting distributions are spread out globally throughout tropical and subtropical latitudes, and are well documented for individual species. However, nesting site distribution and species diversity patterns have not been examined globally across all species, but could inform research and management by identifying areas of high site density and/or diversity, as well as data gaps to which enhanced monitoring effort should be directed. In addition, distribution patterns of genetic stocks within species have been described with respect to geographic distances that result in separate mtDNA stocks, but geographic patterns of genetic stock distributions are limited to sites that have been physically sampled and analyzed. Therefore, generation of putative genetic stocks based on geographic separations would be useful to orient future sampling and management efforts. To explore geographic patterns of site densities, species diversity, and genetic stock distributions, we utilized the State of the World’s Turtles (SWOT) Regional Management Unit initiative and associated data layers, specificially global nesting site locations and mtDNA stocks (represented by sampled nesting colonies and stock designations). First, we applied a grid cell approach to determine marine turtle species richness and nesting site density on a global scale by generating a straightforward display and tally of species nesting sites present in a given cell. This allows for identification and prioritization of global regions containing high species diversity. Coupling this with coarse estimates of effort based on reported site density can direct future sampling and monitoring efforts to regions that are currently underrepresented. Second, we overlaid the locations of known mtDNA stocks with the database of established yet unsampled nesting sites, and used a minimum at-sea distance buffer – based on threshold distances among genetic stocks identified in literature – to generate predicted mtDNA stocks. Taken together, these products represent an important first step toward a broad understanding of marine turtle biogeography that can inform research and conservation efforts on multiple scales and for multiple species.

GROWTH RATES AND BODY CONDITION INDEX OF EAST PACIFIC GREEN TURTLE (*CHELONIA MYDAS*) AT FOUR MONITORING SITES IN BAJA CALIFORNIA SUR, MEXICO*

Beatriz Dias[1], Volker Koch[2], Eduardo Nájera-Hillman[3], Gustavo Hinojosa[3], John H. Wang[4], Shara Fisler[5], and Yonat Swimmer[6]

[1] Affiliation 1: Universidad Autónoma de Baja California Sur. Affiliation 2: Grupo Tortuguero de las Californias A.C., La Paz, Baja California Sur, Mexico
[2] Universidad Autónoma de Baja California Sur, Departamento de Biología Marina, La Paz, Baja California Sur, Mexico
[3] The School for Field Studies, Center for Coastal Studies, Puerto San Carlos, Baja California Sur, Mexico
[4] Joint Institute for Marine and Atmospheric Research, University of Hawaii at Manoa, Hawaii, USA
[5] Ocean Discovery Institute, San Diego, CA, USA
[6] NOAA Fisheries, Pacific Islands Fisheries Science Center, Hawaii, USA

The East Pacific green (or black) turtle, *Chelonia mydas*, has suffered from severe overexploitation that resulted in a population reduction of >90% by the 1970's. Today, despite a ban on selling or killing sea turtles, studies show that bycatch and poaching remain major threats in Mexican waters. As conservation strategies are being developed, access to regional, multi-year data on the ecology, distribution and growth of the black turtle are be critically important. Thus, the objective of our study was to determine size distribution, body condition index (BCI) and growth rates at four important foraging grounds in Baja California Sur: Laguna Ojo de Liebre (LOL), Estero el Coyote in Punta Abreojos (PAO), Laguna San Ignacio (LSI) and Magdalena Bay (BMA). Over a period of 10 years (from July 2000 to July 2010) a total of 1833 black turtles where captured, including 351 turtles that were recaptured at least once. Average sizes were 61.6 ± 9.9 cm (LOL), 58.24 ± 10.9 cm (PAO), 55.2 ± 8.4 cm (BMA), 54.1 ± 9.4 (LSI), with turtles being significantly smaller in BMA and LSI. BCI ranged from 1.28 ± 0.18 (LSI) to 1.39 ± 0.19 (LOL), presenting significant differences among sites. ANOVA revealed three homogeneous groups, where PAO and BMA were similar ($F=21.3$, $p< 0.0001$). BCI was significantly higher during summer season at all sites. Average growth rate was 2.4 ± 1.41 cm year-1, with the highest values at LOL and the lowest from BMA. In general, growth rate was negatively correlated with body size. Growth rate was always higher in summer compared to winter but statistical analysis was not conclusive. The von Bertalanffy growth function (VBGF) showed that the time needed for a turtle to reach maturity are different at each site, due to the differences in growth rates. Both growth rates and body condition index can be used to infer food availability and quality at the different foraging areas and give some clues about the development and residence times of those juveniles. Water temperatures and primary productivity differences between summer and winter probably account for the observed growth and BCI differences. During the study period we observed that black turtles have high site fidelity, as in ten years of study we only found four turtles recaptured at a different site from where it was first captured. I would like to express my appreciation to the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service, for the travel grant given.

STATUS OF MARINE TURTLES AT PUERTO RICO*

Carlos E. Diez[1], Jessica Castro-Prieto[2], and Robert P. van Dam[2]

[1] Dept de Recursos Naturales y Ambientales de Puerto Rico, San Juan, PR
[2] Chelonia, San Juan, Puerto Rico

The most common sea turtles found either nesting or in the feeding areas of Puerto Rico and its adjacent islands are the leatherback (*Dermochelys coriacea*), the hawksbill (*Eretmochelys imbricata*) and the green turtle (*Chelonia mydas*). In addition, there are several sporadic reports of loggerhead (*Caretta caretta*) in near-by coastal areas of Puerto Rico and two stranding reports of olive ridley (*Lepidochelys olivacea*). All these species are protected by local and federal laws. The main nesting beaches for leatherbacks are at the north-east coast, including Vieques and Culebra. The beaches of the municipalities of Fajardo and Luquillo are the most important ones, recording 456 nests, following by the beaches of Maunabo (314 nests), Vieques (145 nests), and Culebra (136 nests) during a high season (2009). The main nesting beaches for hawksbill turtle are at Mona Island Natural Reserve, harboring over 1,200 nests per season. Other important beaches for hawksbills are in the southern part, particularly in municipalities of Humacao, Maunabo, and Patillas with almost 300 nests, while Caja de Muertos, Vieques and Culebra Islands with 91, 121, and 50 nests respectively during recent seasons. There are very few reports for green sea turtle nesting activities in Puerto Rico, where the highest nesting numbers for this species had been reported for Vieques Island, with 320 nests in 2010. Finally, there is only one official report for a loggerhead nest in Puerto Rico, this was at Culebrita (cay near Culebra Island) in the early 1980's. In overall, leatherback nesting numbers have been increasing in the past seasons, except for Culebra Island, where leatherback nesting activities have been decreasing during the past 6 years. However, increases in nests numbers on mainland PR and other near-by areas (US Virgin Island) may suggest a shift in nesting beaches. Hawksbill nesting has increased not only on Mona Island, but also at other sites of mainland Puerto Rico. Hawksbill and green turtles feeding and developmental habitats are found all over the coastal waters of PR and adjacent cays or islands. The highest density locations for hawksbills are at Mona-Monito Islands, Desecheo Island and Tres Palmas-Rincon, while for green turtles are in the Culebra Archipelago. Although government agencies, local communities, NGO's and other organizations have been conducting public education campaigns, small scale poaching and slaughter continues. The main threats for sea turtles in PR are degradation and destruction of nesting and feeding habitats for tourism and urban development. We recommend the designation of additional critical habitats in places outside the protected areas and more enforcement within the protected ones.

BENEFITS AND IMPACTS OF SOLITARY NESTING FOR OLIVE RIDLEYS, *LEPIDOCHELYS OLIVACEA**

Tera C. Dornfeld and Frank V. Paladino

Indiana University- Purdue University, Fort Wayne, IN, USA

The genus *Lepidochelys* exhibits a mixed strategy, nesting in both solitary and arribada patterns, that results in both high and low density nesting beach scenarios. At low nesting densities female-mediated nest destruction, proliferation of microorganisms and predation are negligible resulting in greater individual nest hatching success. This study examined solitary nesting females on a beach situated between two arribada beaches, Ostional and Nancite in the Eastern Pacific of Costa Rica. The solitary nesting population of olive ridley sea turtles (*Lepidochelys olivacea*) was monitored within Parque Nacional Marino Las Baulas (PNMB); excavations were conducted, instances of predation were recorded, nest temperatures were monitored and emergence success was determined. The greatest number of emergences occurred in the wet season: October 2009 (41) and 2010 (66), November 2009 (56). Numbers decreased in the dry season (2009-10): December (21), January (18), February (14) and early wet season: June (6), July (8) then increased in August (24). Between 0 and 8 turtle emergences were recorded each night through the nesting season. During the 2009-2010 season average hatching success for nests laid during the wet season was 82.6% (n=7) and 48.9% (n=7) for the dry season. 89.1% (n=11) hatching success was recorded for nests laid in early wet season (June-August) 2010. Hatching success for nests laid in PNMB in October 2009 was 76.4% (n=3) and 81.2% (n=4) in

November 2009. In comparison, the arribada beach of Playa Nancite, Costa Rica reported 17.7% hatching success of nests laid in October 2007 and 26.8% in November. Between 0 and 19 instances of nest predation were recorded per month (mean 6.4 ±7.0) with an average of 29.3% (±0.33) instances of predation per emergence each month. Of predated nests, an average of 6.8% (±0.11) were newly laid. In comparison, data from 1992 collected on Playa Nancite reported 50.9% mammalian predation of newly laid solitary nests and 7.6% of newly laid arribada nests. The data from this research with solitary nesting females will provide more information for nesting olive ridleys. When compared to more complete analyses for arribada nesting beaches, including hatching success and rates of predation, may provide real insights on the differences in a solitary nesting beach strategy versus an arribada strategy. I feel most humbled and fortunate to know that several organizations have donated their resources to make my symposium attendance possible: International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service. I also wish to thank my graduate advisor Dr. Frank V. Paladino and all those whose tireless beach-walking has contributed to my data collection.

RECOGNITION OF JUVENILE HAWKSBILLS (*ERETMOCHELYS IMBRICATA*) THROUGH FACE SCALE DIGITIZATION AND AUTOMATED SEARCHING*

Stephen G. Dunbar[1] and Haruka E. Ito[2]

[1] Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, California, USA
[2] Protective Turtle Ecology Center for Training, Outreach, and Research (ProTECTOR), Loma Linda University, Loma Linda, California, USA, 3Turtle Awareness and Protect Protection Studies Project (TAPS), Oak Ridge, Roatán, Honduras
[2] Department of Biology, Pacific Union College, Angwin, CA, 94508

Sea turtles are among many species for which long-term data collection is critical for species conservation and management. Within sea turtle research, methods for identifying individuals have mainly taken the form of applying plastic or metal flipper tags which may be broken, corroded, or torn away from the individual. Less frequently, photo identification has been used to compare current photographs to previous photographs by reviewing the similarity of characteristic features, usually represented by scale patterns of the head or face. We encountered hawksbill (*Eretmochelys imbricata*) sea turtles that were members of an ongoing capture and release study, but who had lost flipper tags and whose shell etching on the second left lateral scute had healed over. To identify these individuals, we digitized a standard set of scales of the lateral view of the face and matched these to digitized scale patterns of photos in the study database. However, because photographs were not initially taken with the aim of photo-identification, photos with various angle distortions were less likely to be matched. Still, manual visual matching of new versus old photos for several turtle subjects resulted in successful matches for 83% of the photographs tested. Using an automated spot pattern recognition system (I3S), we digitized a standard set of scutes on the dorsal surface of the head and compared these spot patterns through both a manual visual process, and the I3S automated matching system. With I3S, 71% of the photos tested were successfully matched with the photos in the database. Of the successful matches, the results were strong. Scores produced by I3S ranged from 0.069 to 0.347, where stronger matches have lower values, and a score below one is a good candidate for a match. Through this study, we recognized the potential for long-term identification of individual turtles within a study area, but that the usefulness of a photo-database is heavily dependent on the quality and standardization of the photos taken for such purposes.

A DEMOGRAPHIC APPROACH TO DETERMINE EFFECTS OF ANTHROPOGENIC MORTALITY AT THE POPULATION LEVEL - IF WE HAD A LITTLE BIT MORE DATA*

Tomo Eguchi

Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA, USA

Determination of possible negative effects of anthropogenic deaths to an animal population is important for successful management. The additional mortality to a population caused by humans, intended or unintended, may or may not

affect the population as a whole depending on a variety of factors. Simply put, if the additional mortality is less than the rate at which the population is growing, the net growth rate will be positive albeit at less than the maximum possible rate. It is well-understood that deaths of certain age groups have more significant consequences to the population than the other age groups. Consequently, it is useful to know how known anthropogenic deaths may affect the future growth of the population. It is also useful to know what may be the limit of such additional deaths that causes the population growth rate to be negative. This concept has been used for some taxa, e.g., marine mammals in the US. This task may be a simple exercise when we have data on both demographic parameters and anthropogenic mortality and their variability. When data are limited, however, it can be a challenging mission. A matrix population model was created to simulate a hypothetical pristine turtle population. The population, then, was subjected to various additional mortalities for combinations of age classes. Through these simulations, I show that long-lived and late-maturing species, such as marine turtles, do not have much room for additional mortality to keep a population from declining. I will also show that there may be a lag between the true change in population size and the observed population trend, especially when a small portion of the total population is monitored. Finally, I will make a list of recommendations for what kind of data are necessary in order to make sound management decisions for marine turtles.

A DECLINING TREND OF NESTING FREQUENCY OF SEA TURTLES AT THE LARGEST ROOKERY IN SRI LANKA

E.M. Lalith Ekanayake[1,2], Thushan Kapurusinghe[1], M.M. Saman[1], and A.M.D.S. Rathnakumara[1]

[1] Turtle Conservation Project, 11, Perera Mawatha, Panadura, Sri Lanka
[2] Postgraduate Institute of Science, University of Peradniya, Sri Lanka

Rekawa rookery, located in the south coast, is the largest sea turtle rookery in Sri Lanka visited by all five species that nest in Sri Lanka (Green, Leatherback turtles, Loggerhead turtles, Hawksbill turtles and Olive ridley turtles). The in-situ nest protection progamme at Rekawa was initiated in September 1996. The beach was patrolled 24 hours per day and 365 days per year. The hatchlings were naturally released to the sea. Nesting data were collected until July 2000 when the in situ protection programm was terminated due to lack of funding. However, it was re-started March 2005 and in August 2006 Rekawa beach was declared as the first marine turtle sanctuary in Sri Lanka. Between July 2000 and March 2005, we estimated by interpolation the number of nests laid when there was no monitoring. There were 973 nests observed from September 1996 to August 1997 and only 375 nests were observed from September 2009 to August 2010 (about 96% were green turtles), suggesting a >60% decline in the turtle population nesting at Rekawa. For at least three decades prior to 1996, we suspect that nearly all freshly laid eggs in Rekawa were harvested for human consumption. Therefore, we presume that there has been little or no recruitment into the Rekawa populations for at least 30 years. If the turtle hatchlings released after 1996 represented a restart of turtle recruitment, we suspect that they will begin return to Rekawa as nesting adults format some point between 2026 to 2046 (assuming that, like other regions, green turtles in the Indian Ocean take 30 to 50 years to reach maturity). Recent development of the Hambantota International harbour only 30 km away from Rekawa, heavy sea traffic and other anthropogenic activities represent increasing potential threats for the remaining turtle population at Rekawa. We would like to acknowledge to the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service, the International Sea Turtle Symposium and National Science Foundation, Sri Lanka for there support to attend to the symposium.

EXPLORING DENSITY-DEPENDENCE IN LOGGERHEAD, *CARETTA CARETTA*, POPULATION VIABILITY ANALYSIS

Elena M. Finkbeiner

Duke University Marine Lab, Beaufort, North Carolina, USA

Population viability analysis (PVA), or the use of quantitative methods to predict the future status of a population, has become an increasingly popular conservation tool. PVA can take on many forms depending on management or conservation goals. Recently, a novel PVA metric, susceptibility of reaching quasi-extinction, has been applied to sea turtle nesting census data (Snover and Heppell 2009), and specifically, to eleven loggerhead subpopulations (Conant *et al*. 2009). In these studies an approach known as diffusion approximation was used to empirically generate susceptibility of reaching quasi-extinction. Diffusion approximation uses time-series abundance data to estimate population growth rate and growth rate variance via linear regression, and relies on three fundamental assumptions: 1) population growth rate and growth rate variance are constant, 2) populations are density-independent, and 3) the data are not autocorrelated. Thus far, few studies have looked at density-dependence in sea turtles due to the supposition that density-dependent properties are unlikely to govern population dynamics of species that are severely depleted in comparison to historic levels (Snover and Heppell 2009). However, allowing population growth rate to vary in population viability models can greatly influence model outputs and subsequent management targets, and merits proper investigation. I use the same loggerhead nesting abundance data from eleven subpopulations around the world to relax the density-independent assumption in predicting the probability of reaching quasi-extinction. Specifically, I fit two models, a density independent and density dependent model, to the nesting data and test for model parsimony. I then apply the coefficients generated from each regression model to simulate 1,000 population trajectories for each subpopulation to calculate the probability of reaching quasi-extinction at different extinction thresholds. I compare the probability of reaching quasi-extinction results between the density independent and density dependent models, and discuss the implications for sea turtle populations.

CALCULATING BODY CONDITION INDEX FOR A LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) POPULATION TO DETECT CHANGES IN POPULATION HEALTH RELATIVE TO ENVIRONMENTAL FACTORS

Leah Fisher[1], Larisa Avens[2], Joanne Braun-McNeill[2], and Larry Crowder[3]

[1] College of Charleston, Graduate Program in Marine Biology, Charleston, SC, USA
[2] NOAA, National Marine Fisheries Service, SEFSC Beaufort Laboratory, Beaufort, NC, USA
[3] Duke University, Nicholas School of the Environment, Beaufort, NC, USA

Threatened loggerhead sea turtles use different habitats, including both pelagic and coastal waters, during the multiple ontogenetic stages that comprise their life history. Understanding the importance of these habitats is crucial to conserve these animals. Juvenile loggerheads in the Atlantic Ocean frequent North Carolina inshore waters during the summer months, often getting caught as by-catch by pound net fishers. As these interactions are typically non-injurious, the pound nets offer an opportunity to access the turtles for study. NC waters provide important feeding grounds for neritic juvenile loggerheads and, given recent global declines in loggerhead populations, an understanding of overall population health is needed to inform inshore management strategies. In this study, trends in health of NC's loggerhead population were monitored by generating a body condition index (BCI) based on the relationship between turtle length and weight. Trends seen in BCI could indicate declines in individual and population health, signaling the need for increased management actions. Weight is needed in order to generate BCI, and many loggerheads caught in pound nets did not have weight recorded due to the difficulty of obtaining an accurate weight at sea. As a result, an equation previously used for green turtles that predicts weight using turtle volume was applied and found it to be an accurate estimator of loggerhead weight. The BCI revealed significant annual variation among the years 1998-2008, with an overall increase observed since 2001. A significant difference between spring (May and June) and summer (July and August) was seen only in 2000, contradicting the hypothesis that BCI would be higher during the summer than in the

spring, when turtles first arrived in their foraging areas. In order to explain variation in annual BCI, regression analysis was used to analyze the effects of two environmental variables on loggerhead body condition: hurricane impact and prey availability (blue crab population). Blue crabs and hurricanes were only seen to affect BCI from 1998-2002. From 2002-2007, blue crab numbers declined while loggerhead BCI increased, perhaps indicating loggerhead ability to adjust to declining prey availability or a lack of a blue crab effect. Analyzing other health parameters such as hematocrit levels of loggerheads along with their overwintering behavior would further investigate causes of the observed deviations in BCI from year to year.

INSIGHTS INTO THE NESTING ECOLOGY OF GREEN TURTLES IN THE MAIN HAWAIIAN ISLANDS DERIVED FROM GENETIC ANALYSIS

Amy Frey[1], Peter H. Dutton[1], and George H. Balazs[2]

[1] NOAA-National Marine Fisheries Service, Southwest Fisheries Science Center, 3333 North Torrey Pines Court, La Jolla, California 92037, USA
[2] NOAA- National Marine Fisheries Service, Pacific Islands Fisheries Science Center, 2570 Dole Street, Honolulu, Hawaii 96822-2396, USA

Occasional nesting of green turtles has been observed in the main Hawaiian Islands (MHI) of Hawaii in recent years. Historically green turtle nesting occurs in the Northwestern Hawaiian Islands at French Frigate Shoals (FFS). Due to logistical constraints, monitoring the nesting activity on the main islands has been mostly confined to nest observation, and without systematic tagging information it is not clear how many females are nesting. We used mitochondrial (mt) DNA sequencing, combined with nuclear DNA analysis, of 15 microsatellite markers to infer the number of individual nesters. The genotypes of approximately 90 dead embryos and hatchlings sampled from 41 nests laid on Maui, Molokai, Kauai and Lanai between 2000 and 2009 were obtained. Our data set also included 41 hatchlings from 16 nests all laid by the same known female sampled at Lahaina between 2000 and 2006, and 85 nesting females that were sampled on FFS between 1995 and 1997. Mt DNA results showed the majority of the MHI nests were laid by females with a relatively rare haplotype only found in 16% of the FFS nesting population. Nuclear DNA results show that nesting in the MHI is experienced by a relatively small and possibly related number of females. Taken together, the mtDNA and nDNA results suggest that the increasing MHI nesting may be the result of new founders derived from the FFS breeding population. Our results show that genetic tools can be applied to provide insights for population assessments where access to nesting females is difficult.

LA PLATA ISLAND: A NEWLY IDENTIFIED AGGREGATION AREA FOR JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) IN THE EASTERN PACIFIC*

Andrés Baquero G[1], José Luis Ferrín[2], Jeffrey Seminoff[3], Bryan Wallace[4], Fernando Vera[5], Juanpablo Muñoz[2], Xavier Chalen[6], and Felipe Vallejo[2]

[1] Equilibrio Azul/Universidad San Francisco de Quito
[2] Equilibrio Azul
[3] NOAA
[4] Conservation International
[5] Ministerio del Ambiente del Ecuador
[6] Conservation International - Ecuador

La Plata Island in Machalilla National Park was recently identified as the main nesting site for Endangered green sea turtles (*Chelonia mydas*) in continental Ecuador. However, until recently there was no information available about the abundance or structure of this population previous to this report. From June 2008 to August 2010 a total of 467 netting and snorkeling hours resulted in 243 sea turtles captured. Curved carapace length (CCL) and mass ranged from 41.5 to 74.5 (mean=61.5 ± 5.8 cm) and 8 – 48 (mean=24.14 ±7.96 kg) respectively. There were not previous data of adult size

for this area. To determine the proportion of possible adults in the in-water population around La Plata Island, we applied the CCLs of 50 nesting females measured during the study period 72.7-103.2 cm to the size distribution of the turtles captured during in-water monitoring. This indicated that La Plata Island hosts a predominantly juvenile green turtle aggregation, with some adults, where mating and feeding events have been confirmed. Recapture periods indicated residence time up to two years. These findings, along with the habitat use and movements of two juvenile individuals tracked using acoustic tags for 48 hours, showed a strong site fidelity by turtles in this population within the two-mile protected area of La Plata area. Despite the protected status of turtles and the Island, a total of 38.8% of the individuals showed injuries from fishery interactions or boat collisions. While the Galapagos Islands hosts the eastern Pacific's largest aggregate nesting population, as well as a large juvenile foraging population, smaller foraging areas within the region merit conservation efforts as well to maintain connectivity and robustness of this widespread population. In addition, because other sea turtle species – including the Critically Endangered eastern Pacific hawksbill – also occur within this national park boundaries, our results confirm La Plata Island as a critical conservation area for sea turtles in the region.

ESTABLISHMENT OF ARRIBADA CENSUSING METHODOLOGY AT OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) NICARAGUAN ROOKERIES*

Perla Torres Gago[1], Roldán Valverde[2], Carlos Mario Orrego[3], Lidice Gutiérrez[4], Heydi Salazar[4], James Spotila[2], Luis Romero[4], Wilbet García[5], Aniett Ríos[5], Carlos Toruño[6], Adriana Espinoza[6], Oscar Sánchez[6], Janet Orozco[6], Wendy Gutiérrez[7], Danelia Mairena[7], Miguel Rodríguez[8], and José Urteaga[4]

[1] Fauna & Flora International, Del portón trasero Oeste de la UCA 1/2 c. al sur, casa N°578, Managua, Nicaragua
[2] Department of Biology, Drexel University, Philadelphia, PA 19104, USA
[3] Department of Biological Sciences, Southeastern Louisiana University, Hammond, Louisiana 70402 USA
[4] Fauna & Flora International, Reparto San Juan, Del Portón Trasero (Oeste) de la UCA 1/2 c. abajo
[5] Universidad Nacional Autónoma de Nicaragua-León, Facultad de Ciencia y Tecnología, De la Iglesia de la Merced Costado Norte, departamento de León, Nicaragua
[6] Universidad de Ciencias Comerciales, UCC-Managua, Facultad de Ciencias Agrarias, Frente al Polideportivo España, Managua, Nicaragua
[7] Universidad Nacional Autónoma de Nicaragua, UNAN-Managua, Departamento de Biología, de Enel Central 2.5 Km al Sur, Villa Fontana, Managua, Nicaragua
[8] Belén, Heredia. Costa Rica

The Nicaraguan Pacific coast features two important arribada rookeries: Chacocente and La Flor, both protected within wildlife refuges. Over 95% of all olive ridley nests laid in Nicaragua are estimated to occur in these two rookeries. Conservation efforts at these rookeries have been promoted since the 80s, leading to the establishment of a monitoring system aiming at establishing accurate estimates of turtle abundance during the massive arribadas. Early methodology was based on a total count of turtles, which may not accurately reflect the actual number of participating individuals. In addition, its implementation requires a significant investment of financial, human and equipment resources. Beginning in 2008 we introduced the strip transect in time methodology to estimate arribada abundance as an alternate way to monitor the nesting population at a smaller cost. During 2008 and 2009 we censused 9 arribadas at Chacocente and 8 arribadas at La Flor using both the total count and the strip transect methods. At Chacocente the transect method yielded a total of 58,689 females whereas the total count method yielded 42,948 females. At La Flor the transect method estimated a total of 1,095,024 females in contrast with 1,228,944 females estimated by the direct count method. Using a mean number of 2.1 clutches per individual in a season combined with the estimates from the transect method we obtained a population abundance of 27,947 effective nesting females for Chacocente, and 521,440 effective nesting females for La Flor over these two years. When comparing both methods we found that the strip transect in time method was 56% to 61% less costly each respective year than the total count method. This difference in cost was mainly due to the larger number of personnel required by the total count method, a minimum of 25 people from neighboring communities. An additional 64% greater cost was incurred when feeding this extra personnel working to conduct the total count. Finally, the cost of painting every turtle to avoid recounting increased expenses by at least 14% when applying the total count procedure. From the logistical stand point, it is not possible to ascertain if every turtle was included while conducting the total count method, especially in the larger arribadas when an unknown number of females may have nested unrecorded. Given our results we recommend the continued use of the strip transect methodology to continue censusing efforts over the long term in order to establish a population trend at these rookeries. Importantly, financial savings accrued by using transect methodology may be devoted to other, complementary conservation measures.

WHERE DO WE GO FROM HERE? THIRTY SEASONS OF LEATHERBACKS: AN UPDATE ON THE STATUS OF THE ST. CROIX POPULATION

Jeanne A. Garner[1], Steven A. Garner[1], Peter Dutton[2], and Tomo Eguchi[2]

[1] WIMARCS, St. Croix, USVI
[2] NOAA/SWFSC, La Jolla, CA

The Sandy Point National Wildlife Refuge in St. Croix, U.S. Virgin Islands supports the largest continuously studied population of nesting leatherback sea turtles in the world. Flipper tagging began in 1977. Since 1981, saturation tagging and consistent night patrols during the nesting season have yielded a comprehensive database of information on each female nesting at Sandy Point. The 2010 nesting season was the thirtieth consecutive full time field season, and began with a nest discovered during U.S. Fish and Wildlife Service surveys February 26th and ended with a final activity on July 29th. Activity was highest during the weeks of April 22nd and May 9th. Ninety four (94) turtles laid a total of 395 potential nests, with an average of 82.35 ± 17.14 yolked eggs per clutch. Of the 337 verified nests laid in 2010 (between April 7th and September 1st), 124 (36.79%) were relocated to protect them from inundation or erosion. The number of documented nests per female ranged from 1 to 8, with an average of 3.60 ± 2.17 nests laid. Sixty-nine (69) of the turtles were remigrants, with remigration intervals of 1 - 11 years. Of the 258 nests analyzed, mean overall hatch success was 55.03% ± 19.28%. Like most previous years, emergence success of *in situ* nests was significantly higher than that of relocated nests ($p<0.01$). We estimate that approximately 3% of the nests were lost to erosion. With the addition of 25 untagged turtles in 2010, a total of 1014 leatherbacks have been tagged since 1981. Nightly patrols and a concerted relocation effort have reduced the major historical threats of poaching and erosion. Research and conservation efforts for the St. Croix population have provided valuable data and resulted in an increase in nesting numbers, with 2009 reaching a record 202 individual females. However, there are underlying concerns for this population. The number of females nesting at Sandy Point has been increasing steadily since 1982 and had shown dramatic increases through the first 21 years of the program. This initial trend, along with an increasing trend in hatchling production was very encouraging, since the leatherback continues to decline globally at an alarming rate. However, the last decade has started to show a decline in SPNWR neophyte nesters, nests laid per turtle, hatchling production and hatch success, as well as an increased remigration interval. Larger sample sizes and more accurate data collection may explain some of these lower percentages, but certainly there is a disturbing and persistent trend. This trend also serves as evidence that long term saturation tagging and nest management must continue to accurately measure the effects of recovery efforts. If the monitoring program had stopped 5 or 10 years ago, we would be unaware of these issues. Although aspects of recent 2008 - 2010 data are encouraging, many are not, and we must address the prevailing issues related to hatchling production and neophyte recruitment immediately.

PHOTOGRAPHIC IDENTIFICATION OF SEA TURTLES IN THE ESTUARINE WATERS OF NORTH CAROLINA, USA

M. April Goodman[1], Joanne Braun-McNeill[1], and Amanda Schworm[2]

[1] NOAA, National Marine Fisheries Service, SEFSC Beaufort Laboratory, Beaufort, NC 28516, USA
[2] Duke University Marine Laboratory, Nicholas School of the Environment, Beaufort, NC 28516, USA

The ability to recognize individuals within a population is essential when examining population structure and trends. Individual recognition of sea turtles typically is accomplished through attachment of external (e.g., plastic or metal inconel) or internal (e.g., Passive Integrated Transponder (PIT)) tags. Our in-water mark-recapture project uses

traditional tagging methods (inconel tagging since 1988 and PIT tagging since 1995) to identify pound net captured sea turtles in the estuarine waters of North Carolina, USA; however, permitting restrictions prevented us from applying tags to turtles captured in this manner in 2008 and 2009. As a result, we used photo-ID to identify pound net captured loggerhead, green, and Kemp's ridley sea turtles to examine trends in catch rates during their autumn emigration from the estuarine waters. Upon capture, digital photographs were taken of each turtles' carapace, as well as the left, right, and dorsal sides of the head. After separating digital photographs into species groups, we compared the shape and arrangement of facial and carapace scutes among all individual turtles to identify recaptures. Dorsal head views were the only photographic view that we examined in 2009, as we found this view to be the easiest to identify turtles by; however, the other three views were examined if the dorsal view was of poor quality. In 2008, 175 loggerheads, 100 greens, and 31 Kemp's ridleys were captured. Of these turtles, visual comparison of the images indicated that 18 (10%) of the loggerheads, 8 (8%) of the greens, and 1 (3%) of the Kemp's ridleys were recaptures. In 2009, 201 loggerheads, 151 greens, and 41 Kemp's ridleys were captured. Of these, we identified 25 (12%) of the loggerheads, 4 (3%) of the greens, and none of the Kemp's ridleys as recaptures from earlier that year. Comparisons of the 2008 Kemp's ridley photographs to those of 2009 did not yield any matches; analysis of the loggerhead and green photos is still underway. Trends in sea turtle catch rates available from 1995-1997 and 2001-2003 (Epperly *et al*. 2007) indicate similar recapture rates: yearly recapture rates ranged 2-13% for loggerheads, with a mean of 8%; greens ranged 0-6%, with a mean of 2%; and Kemp's ridleys ranged 0-25%, with a mean of 3%. Photo-ID has proved to be a viable method for identifying recaptured turtles within our study population, and will continue to be used to examine tag retention, as well as to aid in the future identification of the 2008 and 2009 turtles that were not tagged. The process of visually examining photographs within a large catalog is labor intensive, thus future research will involve the development of an identification tree (based on scale patterns) similar to that of Schofield *et al*. (2008) to decrease the time it takes to examine photographs and to standardize the identification process. In addition, the development of a computer-assisted photo-ID program for sea turtles, as commonly used to assist in the identification of many species, would be beneficial.

GREEN SEA TURTLE SCOPING SURVEY ON MOPELIA ATOLL, LEEWARD ISLANDS, FRENCH POLYNESIA

Sebastien Goutenegre[1] and Eve Perrin[2]

[1] Ngo Chelonia Polynesia, Bora Bora, French Polynesia
[2] Université Lyon 1, Lyon, France

French Polynesia consists on 118 islands and atolls spread over a large geographic area. In this area, geen sea turtles have historically been observed nesting at Tupai, Bellinghausen Scilly and Mopelia atolls. Based on the available, yet out dated information, it is believed that approximately 100-400 green turtles may nest annually in FP. Turtles tagged at Scilly and Mopelia atolls in the late 70s and early 90s have been recovered in Tonga, New Caledonia, Vanuatu, The Cook islands and Fidji; this tag return information suggest that sea turtles originating from FP migrate west through the West and Central Pacific ocean. Our mission was to organise and conduct a 3 weeks expedition to the isolated atoll Mopelia during the peak of the nesting season in November 2010. Knowing that this atoll is wellknown for poaching activity, the main goal of this expedition was to update data such as tissu samples collecting for genetic analysis, PIT tag nesters and nesting sites recording.

PRELIMINARY RESULTS ON GLOBAL GENETIC STRUCTURE AND PHYLOGEOGRAPHY OF OLIVE RIDLEYS (*LEPIDOCHELYS OLIVACEA*)*

Anelise Torres Hahn[1], Michael Jensen[2], Brian Bowen[3], Alberto Abreu-Grobois[4], Jaqueline Comin de Castilhos[5], Benoit de Thoisy[6], Marco da Costa Gadegaste[7], Col Limpus[8], Scott Whiting[9], Nancy FitzSimmons[10], and Sandro L. Bonatto[7]

[1] Laboratório de Biologia Genômica e Molecular, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Brazil
[2] NOAA - South West Fisheries Science Center, 3333 N. Torrey Pines Ct, La Jolla, CA 92037, USA
[3] Department of Zoology, University of Hawaii, USA
[4] Instituto de Ciencias del Mar y Limnologia, Universidad Nacional Autonoma del Mexico, Mexico
[5] REBIO Sta Isabel, Fundação Pró-Tamar, Sergipe, Brazil
[6] Institut Pasteur de la Guyane & Kwata NGO, Cayenne, Guiana Francesa
[7] Laboratório de Biologia Genômica e Molecular, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Brazil
[8] Department of Environment and Resource Management, Brisbane, QLD, Australia
[9] Department of Natural Resources, Environment, the Arts and Sport., Palmerston, NT, Australia
[10] Institute for Applied Ecology University of Canberra, Australia

The olive ridley turtle (*Lepidochelys olivacea*) has a global distribution across tropical and sub-tropical oceans, and is the most abundant marine turtles species. It is closely related to the Kemp's ridley (*Lepidochelys kempii*) and the origin of both species is believed to be related to the closure of the Isthmus of Panama, about 3.5 to 5 million years ago. In this work we expand the previous study of Bowen *et al*. (1998) on the global phylogeography of olive ridley turtles using longer sequences of the mitochondrial DNA (mtDNA) control region and fifteen microsatellites loci. Samples from the paper cited above were re-sequenced, and a further 263 samples were sequenced from nesting sites in Brazil (n=99), French Guiana (n=36), East Pacific (n=59) and Australia (n=69), for a total of 324 olive ridley sequences, plus four sequences from Kemp's ridley. Furthermore, these samples were also genotyped for 15 microsatellite loci. The mtDNA revealed 29 olive ridley haplotypes, five haplotypes for the Atlantic Ocean (AT), nine for the Indo-Pacific (IP) region and 14 for the East Pacific (EP) and finally one haplotype for the Kemp's ridley. A phylogenetic analysis showed four distinct lineages within the olive ridley, two within the IP, one within AT, and one within the EP. A haplotype network showed a close relationship between a central haplotype found in Sri Lanka and Australia rookeries and haplotypes from Atlantic and East Pacific oceans. Olive ridleys show moderate to high genetic differentiation among regional rookeries separated by more than 500 km (pairwise Fst was significant and varied from 0.1 to 0.88), but low genetic differentiation among rookeries located within this distance (e.g. Surinam/French Guiana and Tiwi Island/McCluer Island (Australia) (pairwise Fst from 0 to 0.04). Costa Rica/Mexico even separated by more than 500km, are not genetically distinct. The microsatellite analyses showed lower levels of genetic structure among regional nesting sites than did the mtDNA. Pairwise Fst values varied from 0 to 0.04 among populations within the IP, from 0 to 0.08 among rookeries from AT, and from 0 to 0.02 among rookeries from EP. When we compare the pairwise Fst among the oceans, the pairwise Fst vary from 0.03 to 0.18 among rookeries from IP and AT, from 0.04 to 0.24 among IP and EP, and 0.07 to 0.28 among AT and EP. Results from the software Structure indicated that our data support four genetic clusters that were also associated with Oceanic basins, and Kemp's ridley samples comprised a unique cluster. I would like to thank the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service, Disney Worldwide Conservation Fund and the International Sea Turtle Symposium for the Travel Grant provided. This research was produced in cooperation with Genoma, Projeto Tamar-Ibama, Hawaii Institute of Marine Biology and PETROBRÁS/CENPES as part of the project "Mamíferos e Quelônios Marinhos".

SEA TURTLE ASSESSMENT IN THE TOBAGO CAYS MARINE PARK

Olando Harvey[1], Karen Eckert[2], and Emma Doyle[3]

[1] Tobago Cays Marine Park, Union Island, St. Vincent and the Grenadines
[2] Wider Caribbean Sea Turtle Conservation Network (WIDECAST), Ballwin, Missouri, USA
[3] Caribbean Marine Protected Areas Management Network and Forum (CaMPAM), Houston, Texas, USA

Established in 1997, Tobago Cays Marine Park (TCMP) is located in St. Vincent and the Grenadines in the Eastern Caribbean. Sea turtles were originally identified as significant biodiversity in the park's management plan and were listed as indicator species in the park's monitoring and evaluation plan. However, no research had ever been undertaken to assess the status of the park's sea turtle populations, nor to assess the status of their critical habitat. In 2010 the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) and TCMP undertook the first ever methodical sea turtle assessment in the park. This paper presents the approach taken for the assessment, the research methodologies applied and the findings of the work. The assessment focused on in-water research, primarily of green turtles (*Chelonia mydas*) and some hawksbill turtles (*Eretmochelys imbricata*). It also assessed critical foraging habitat. In this work, TCMP benefited greatly from the accumulated knowledge and the existing strong partnerships offered by the WIDECAST network. Field work training was provided by WIDECAST in partnership with the Barbados Sea Turtle Project, along with TCMP's participation in training by the Bermuda Sea Turtle Project. Tried and tested best practice research techniques were applied in the sampling protocol in the field work. WIDECAST and TCMP worked hand-in-hand during the field work to ensure development of local capacity. Data analysis utilised the existing WIDECAST database. In total n=92 turtles (split between n=85 green turtles and n=7 hawksbill turtles) were captured mostly by hand using snorkel capture, and turtles were measured and tagged. 96 person hours were invested in the fieldwork. Catch per unit effort and sightings per unit effort were recorded, and analyses were made of turtle size (straight and curved carapace length and width), weight and body condition. Findings indicate that the park contains an important foraging aggregation of sub-adult green turtles, with possible under-representation of hawksbill turtles based on the existence of critical habitat. As an established and actively managed marine park that possesses a marine biologist and field staff, plus operational resources such as boats and sustainable financing mechanisms to support ongoing work, TCMP makes for a best-case sea turtle research scenario in a marine protected area. Accordingly, the paper further describes how this initial assessment can become a long-term monitoring program in TCMP and presents a recommended protocol for this. It also identifies possible future directions for sea turtle research and conservation activities in the marine park that build upon the findings of the population assessment.

15 MILLION YEARS AND STILL CHANGING: OCEANOGRAPHIC AND GEOGRAPHIC FLUX IN THE EASTERN PACIFIC OCEAN AND THEIR IMPACTS ON MARINE TURTLE POPULATIONS

Maike Heidemeyer[1] and Jeffrey A. Seminoff[2]

[1] Sistema de Posgrado de la Escuela de Biología, Universidad de Costa Rica
[2] NOAA Southwest Fisheries Science Center, 3333 N. Torrey Pines Ct., La Jolla, CA USA

Examples of oceanographic changes over geological time scales are extremely difficult to find, not only because of the complexity of ocean systems, but also due to the diversity of disciplines that are required to elucidate common patterns. The changes that marine systems experience have captured the interest of many researchers, particularly those working in oceanographic, geological, paleontological and marine ecosystem-level topics. However, few examples linking marine vertebrate population ecologies and distributions are available, and to our knowledge no studies have examined the role of shifting oceanography and coastal geography in shaping the distribution and population structure of marine turtles. In the present investigation we compiled existing information on marine paleontology, geography and climatology and associated them to the known genetic, ecological and behavioral characteristics of marine turtle populations in the eastern Pacific Ocean (EPO), with emphasis on the green turtle, *Chelonia mydas*. Based on the most recent phylogenetic analyses, the green turtles in the EPO split from the Atlantic populations ca. 7 million years ago

(mya), whereas the two *Lepidochelys* species separated ca. 5 mya. However, this estimate predates the formation of the Central American Isthmus, suggesting that these population isolation events may have resulted from changes in oceanographic conditions rather than shifting coastlines. For example, the creation of cold currents in the EPO and warmer currents in the Caribbean Sea may have been a key event for the separation of Pacific and Atlantic populations. In fact, recent phylogeographic studies suggest that some Indian Ocean and western Pacific Ocean marine turtle populations were founded from animals of EPO origin, which if true, would have required suitable habitats (nesting beaches) in the EPO during a much longer timeline than previously believed. Considering Galapagos green turtles as one of the predominant populations for this species in the EPO, we explored several theories that support the existence of historical islands originated by the same geothermal hotspot that created the Galapagos Island around three million years ago. The constant formation and erosion of islands particularly in this area has occurred for nearly 90 million years, and therefore could have provided nesting refugia through glacial periods, and perhaps sustained nesting sites enabling the persistence of the species in the EPO. Discovering the historical changes in ocean conditions and dispersal patterns of marine turtles helps us to understand their natural history, ecological importance and evolutionary success. Greater knowledge about the capacity of marine turtles to adapt to oceanographic changes through geologic time may provide a better understanding about their ability to survive more rapid environmental changes such as global warming. Such an understanding therefore may help in the development of appropriate marine turtle conservation strategies in the EPO.

PASSIVE INTEGRATED TRANSPONDER [PIT] TAGGING OF HATCHLING LOGGERHEAD [*CARETTA CARETTA*] AND KEMP'S RIDLEY [*LEPIDOCHELYS KEMPII*] SEA TURTLES

Benjamin M. Higgins[1] and Joseph P. Flanagan[2]

[1] NOAA/NMFS Sea Turtle Facility, Southeast Fisheries Science Center, Galveston, Texas, USA
[2] The Houston Zoo, Inc., Houston, Texas, USA

Archival-quality tags for marking hatchling sea turtles are not readily available. The NOAA Sea Turtle Facility has used Coded Wire Tags for marking groups or year classes of hatchling sea turtles, but these tags cannot be used to identify individual live animals. Passive Integrated Transponder [PIT], or Radio Frequency Identification [RFID] tags, do allow for distinguishing individual animals and are commonly used to mark juvenile and adult sea turtles. PIT tags were used to mark more than 7,000 yearling Kemp's ridleys [*Lepidochelys kempii*] and loggerheads [*Caretta caretta*], as small as 12 cm straight carapace length [SCL] and 260 g. Methods for PIT tagging hatchling turtles have also been developed and tested at the NOAA Sea Turtle Facility. In an initial study, PIT tags were successfully implanted into loggerhead hatchlings [average SCL=4.56 cm, average weight=18.5g] at 4 days post emergence. Twenty loggerhead hatchlings were randomly selected from a group of 195, 10 received PIT tags and the remaining 10 served as controls. Tags were glass encapsulated, Destron Fearing model 1400L,400kHz, 12 mm long x 2 mm in diameter. Two transponder insertion techniques were experimentally developed, both involving a small incision in the axial region of the right front flipper, at the plastron to skin margin, and insertion of the transponder into the area lateral and caudal to the pectoral muscle. Aseptic techniques were used and the incisions were sealed with tissue adhesive. Hatchlings were monitored every 6 hours for the first 72 hours, then daily for 1 year. To monitor for tag migration, radiographs were taken immediately following implantation, and at 6, 12 and 21 months. Each tag was checked with a PIT tag reader every 28 days, with some turtles being held for up to 33 months [average SCL=54.9 cm, weight=21.13 kg]. All PIT tags were easily detectable, with the best signal obtained from the ventral surface. There was no apparent or statistically significant difference between the experimental and control groups with respect to survival, growth, or behavior. The original technique, used to tag the first 4 hatchlings, required 2 people and took 5-10 minutes per hatchling. This technique was modified for the next 6 hatchlings, reducing application time to 4-5 minutes per hatchling, but still requiring 2 people. A custom PIT tag applicator was then built that combined and mechanized the actions of the first two techniques so that tagging could be performed by 1 person. The applicator was used successfully on a group of 10 loggerhead hatchlings [average SCL=5.29 cm, average weight=28.6 g] selected from a group of 35 at 1 day post-emergence and subsequently on 50 Kemp's ridley hatchlings [average SCL=4.21 cm, average weight=15.2 g] from a group of 181 at 2 days post-emergence. Using the applicator, 1 person tagged all 50 hatchlings in 60 minutes. With these techniques, PIT tag movement and migration was minimal, keeping the tag outside of the coelomic cavity. This work demonstrates that PIT tagging hatchlings is feasible, although locating a tag on larger turtles will require scanning the plastron.

BUCK ISLAND REEF NATIONAL MONUMENT SEA TURTLE NESTING BEACH TRENDS (SINCE 2000) AND NEST RELOCATION PROTOCOL EVALUATION

Zandy Hillis-Starr[1] and Ian F. Lundgren[2]

[1] National Park Service, Buck Island Reef NM, St. Croix, VI
[2] National Park Service, Buck Island Reef NM, St. Croix, VI

Since the turn of the millennium (2000), hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) sea turtles have increased in number on the nesting beach (hawksbill index beach) at Buck Island Reef National Monument (BIRNM), St. Croix, US Virgin Islands (managed by the National Park Service). Concurrently, a small stable population of leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) sea turtles has been consistent over in the past decade. Although the factors that led to the dramatic upward shift in nesting numbers are unknown, it does correspond to conservation efforts implemented by the National Park Service beginning in the late 1980s. We will present those data and discuss how increasing nesting numbers and global climate change issues have changed the National Park Service (NPS) management techniques and focus of the Buck Island Sea Turtle Research Project. Since 2007, the NPS has implemented empirical studies to determine the optimal relocation protocols for hawksbills: 1) when nests should be considered "imperiled" and 2) where to relocate imperiled nests to. These efforts show that: 1) the orientation of storm events to the nesting beach has a dramatic effect on how many nests are lost; and 2) that despite color variances, nesting substrates are more similar than previously thought; and 3) that "tilling" relocation sites shows promise as a measure to increase the hatch success of relocated nests. Lastly, new collaborations have emerged in the past decade that have, and/or will continue to, provide more detailed description of sea turtle populations at Buck Island: T. Wibbles (sex-ratios of hawksbill hatchlings), W. Kendall *et al*. (hawksbill remigration demographics), B. Shamblin (nesting green relatedness), K. Hart (inter-nesting, migration, and resident sea turtle movements). These collaborations and NPS research efforts attempt to increase the production of sea turtle hatchlings in any given year, to protect juvenile and adult individuals while utilizing BIRNM marine habitats, and to add to the scientific knowledge base of each species to support regional recovery efforts.

HISTORICAL BIOGEOGRAPHY OF SEA TURTLES IN THE PACIFIC OCEAN, 1700-1980*

Kyle S. Van Houtan[1], Jack Kittinger[2], Loren McClenachan[3], and Amanda Lawrence[1]

[1] Marine Turtle Assessment Program, NOAA Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, Hawaii 96814 USA
[2] Kainalu Consulting, LLC, 367 Kapaloala Place, Honolulu, HI 96813 USA
[3] National Science Foundation Fellows Program, Simon Fraser University, Vancouver, Canada

What is the historical baseline for sea turtle populations in the Pacific Ocean? Various hypotheses can explain the current biogeography of turtles in the Pacific, but all rely on accurate historical information. Hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) sea turtle populations today result of: (i) inherent population changes, (ii) large-scale ecosystem changes, or (iii) direct and indirect human impacts. We tested these major competing hypotheses by conducting a comprehensive search of historical sources spanning the entire Pacific basin over the last three centuries. These sources included zooarchaeological deposits, ethnographic accounts, fisheries and economic records, naval and expedition publications, and scientific observations. Our database of >3000 records provides and important summary of the historical ecological baseline for both sea turtle species. In addition, we introduce rigorous quantitative methods for estimating the historical anthropogenic population pressures. Historical tortoiseshell harvest data are strongly and inversely correlated with current nesting distributions, suggesting that direct exploitation provides the best explanation for the differences between the colonial and modern era populations. Green sea turtles were likewise widely distributed in the colonial era, but exploitation before European contact may be the major driver for reductions in these populations. Our analyses support the human disturbance hypothesis explains the current biogeography of sea turtle distributions. This research also demonstrates that historical data not commonly relied on in current population

assessments (e.g. anecdotal accounts, ethnographic information) can enable a greater understanding of the role of disturbance (human and natural) in altering marine turtle populations and the ecosystems in which they are embedded.

ECOLOGICAL ASPECTS OF MATURATION OF LOGGERHEAD TURTLES IN THE NORTH PACIFIC*

Takashi Ishihara[1,2], Suguru Yamashita[1], and Naoki Kamezaki[3]

[1] Sea Turtle Association of Japan, Osaka, Japan / University of Tokyo, Tokyo, Japan
[2] University of Tokyo, Tokyo, Japan
[3] Suma Aqualife Park Kobe, Hyogo, Japan / Sea Turtle Association of Japan, Osaka, Japan

The ecological aspects of maturation process and life history of loggerhead turtles in the North Pacific were examined. The turtles were incidentally captured using large pound net sets around Cape Muroto, Japan, located in close proximity to the Kuroshio Current. SCLs of 1539 turtles were measured from July 2002 to June 2010, and the mean ± SD value was 758 ± 68 mm (range, 563–1050 mm). The sex and maturity level of 134 dead turtles were confirmed by gonad observation. In addition, humeri of 79 dead loggerhead turtles were collected for skeletochronological analysis to estimate the age and growth rate. It was estimated that the North Pacific loggerhead turtles re-entered the natal waters of Japan when they were 16 or more years old and their SCLs were 560–749 mm. When secondary sexual characters developed, the SCL was found to be 683 mm, and growth rate in Japanese waters was calculated as 13.9 ± 7.8 mm/year. Furthermore, after the turtles re-entered the waters, they remained premature for more than 6 years and attained maturity at the age of 43 ± 10 years. It seemed same-sex competition was not a key factor for reproductive success, because differences between the sexes in this regard were not detected ($p > 0.05$, Mann–Whitney U-test). However, considerable individual variability was observed; for example, maturity age ranged from 22 to 61 years and intra-population diversity was high. Subsequently, the duration between re-entering and maturity also suggests that Japanese waters are suitable as foraging areas of the loggerhead turtles, and it is suggested that loggerhead turtles that are able to swim through transpacific waters actively re-enter Japanese waters. The percentage of immature females was 61.0% ($n = 105$), and this percentage did not differ when comparisons were made on a monthly and yearly basis and according to the SCL class ($p > 0.05$, chi-square test and Kolmogorov–Smirnov test). This indicated that the hatchling sex ratio was roughly constant at least 2–6 decades ago when the turtles hatched. Subsequently, annual survival rate was calculated as 85.7% using catch-curve analysis. Thus, it is indicated that ≥ 60.4% of loggerhead turtles in Japanese waters die from the time of re-entering through maturity. It is necessary to assess and mitigate mortality for conservation of these turtles. The loggerhead turtles probably have highly diverse life-history strategies, and further studies should be conducted to understand the detailed life history of these turtles. Their diverse strategies may be associated with their adaptation to the global environmental changes.

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

Jean Wai Jang[1] and Roldán Valverde[2]

[1] Royal Roads University, Victoria, British Columbia, Canada
[2] Department of Biological Sciences, Southeastern Louisiana University, Hammond, LA USA

Olive ridley sea turtles (*Lepidochelys olivacea*) are thought to be globally abundant because ridleys typically nest in mass aggregate nesting. Over the past four decades, incidental fish capture and excessive egg harvesting has led to drastic declines of ridleys in the eastern Pacific Ocean coastline along Central America. Ostional National Wildlife Refuge (ONWR) was officially established in 1983 to support ridley conservation efforts. In attempts to control the severe poaching of eggs at ONWR, the Costa Rican government permitted the Association for Integral Development of Ostional to sustainably harvest ridley eggs for commercial use through Law 6919. This allows for a limited amount of animal product from the refuge to be used for commercial sale. The egg harvest program was also founded to take advantage of the egg loss caused by consecutive nesting turtles during the first couple of days of the arribada, which

was considered an unacceptable waste. The rationalization of the harvesting program was initially based on two principles: 1) scientific research is required to validate harvesting limits, and 2) the community forms a legal development association. In spite of these stipulations, the current harvesting program does not consider ridley biology or its population status. Biological research is needed to determine the main factors that control the demographics of ridleys at OWNR. The main purpose of this study is to generate an accurate estimate of hatchling production and test the null hypothesis that all areas of Ostional beach produce the same number of hatchlings. Identifying characteristics within different microzones and their relationship to the fecundity rate of ridleys will help improve our understanding of the overall hatchling production of the beach and its ability to sustain the adult population. This field-based research was conducted from September 2010 to January 2011. Information gathered from this study will help refine management and harvesting practices at ONWR and inform policy and conservation management programs internationally.

DETERMINATION OF NATAL ORIGINS OF JUVENILE GREEN TURTLES FORAGING AT SIPADAN WATERS, SABAH, MALAYSIA*

Juanita Joseph[1] and Chong Yee Kuen[2]

[1] Institute of Oceanography, Universiti Malaysia Terengganu, 21030 Terengganu, Malaysia
[2] Department of Marine Science, FMSM, Universiti Malaysia Terengganu, 21030 Terengganu, Malaysia

Sea turtles spend most of their time at foraging grounds, and adults will only migrate to the nesting area once in every two to three years or more. Even so, very limited studies had been conducted at foraging grounds in Malaysia. Most of the conservation efforts focused only on the protection of nesting beaches. Previous studies had reported that foraging grounds will consist of mix stock of sea turtles from several nesting colonies. Therefore, exploitation of sea turtles at foraging areas can also impact distant and possibly vulnerable source populations. In recent years, the poaching of sea turtles at foraging grounds around Southeast Asian waters had becoming more serious, especially those in Malaysia and Indonesia. Sadly, very little is known about the foraging grounds in Malaysia. Determining genetics composition of turtles at foraging grounds will help to understand the migratory pathways and the source (nesting colony) for foraging stocks. This study aimed to investigate the genetic composition and to determine natal origin of juvenile green turtles occupying Sipadan waters. Blood samples were collected from 33 juvenile green turtles caught either by snorkeling or SCUBA diving. DNA was extracted using a quick CTAB protocol and sequenced at the mitochondrial (mtDNA) control region (380 base pair). Seven mtDNA haplotypes were found (D2, A2, C3, C5, E2, A3 and Caru), which was previously described by Moritz *et al*. (2002) for the Indo-Pacific green turtles. Results obtained from this study revealed that juvenile sea turtles at Sipadan waters are consists of mix stocks, drawn primarily from Sabah Turtle Islands and Philippine Turtle Islands (D2 – 34%), followed by Australia, Micronesia and Papua New Guinea (A2 – 18%, A3 – 12% and E2 6%). The foraging ground also consist of turtles from Indonesia (C5 – 3% and Caru – 3%), but in a small contribution. Effective conservation and protection of sea turtles foraging at Sipadan may increase nesting populations throughout Southeast Asia and Western Pacific. My sincere thanks to the 2011 ISTS for granting me a travel and bed Grant. This grant has been made available through generous donations by the following organizations: International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service.

EVALUATING BUCCAL AND CLOACAL SWABS AS METHODS FOR OBTAINING GENETIC SAMPLES FROM MARINE TURTLES

Amy K. Jue[1], Suzanne E. Roden[2], Amanda Bowman[2], Peter H. Dutton[2], Erin LaCasella[2], and Amy Frey[2]

[1] Ocean Associates, Incorporated 4007 N. Abingdon Street Arlington, Virginia USA 22207
[2] National Marine Fisheries Service, Southwest Fisheries Science Center, 3333 N. Torrey Pines Ct. La Jolla, CA 92037

A variety of sampling methods have been used to obtain DNA for genetic studies in marine turtles. For live turtles, DNA of suitable quantity and quality for PCR-based analyses can be extracted from blood samples or skin samples, both of which are considered to be standard practice. Blood is usually taken from the cervical sinus or surface veins in the hind flipper, while skin is collected using a razor blade or biopsy punch to collect from the top few layers of the turtles' epidermis Both methods, particularly blood sampling, require experience and skill and may not be feasible or permitted under challenging field conditions. Buccal and cloacal swabs have been used for genetic sampling on a variety of reptiles, and may offer a simple and quick way to sample cells from live marine turtles when it is not feasible to obtain blood or skin. We evaluated buccal and cloacal swabbing as a means to obtain DNA for marine turtle genetic studies. Sampling tools tested in this study consist of Whatman Omni Swabs, falcon tubes, and instruments to open the mouths of the animals for buccal swabs. These tools were chosen for ease of use and easy accessibility for field biologists who would like to try this alternative to tissue sampling. Once a turtle was on land, we used our tools by swabbing the buccal area 6 times with one Whatman Omni Swab and inserting the instruments 5mm into the cloaca for about 6 seconds with another Whatman Omni Swab. All samples, were extracted within 5 days of tissue collection using the DNEasy® Mini Kit. Once samples were extracted, we proceeded to test quantity and quality of DNA. Quantity of DNA was evaluated using the Nanodrop® Spectrophotometer. Quality of DNA was tested by using the polymerase chain reaction (PCR) to see if/and how well it replicated for mitochondrial and nuclear markers. While buccal and cloacal swabs provide an alternate method for obtaining sufficient DNA for PCR with mtDNA sequencing primers, the DNA yields are substantially lower than from skin snips or blood that are the accepted standard protocols. Collecting enough viable cells for DNA extraction is not consistent for every buccal and cloacal swab since only a few cells can be collected per animal. Therefore, we recommend buccal or cloacal swabs as a viable alternative when blood or skin sampling is not possible, but it should not replace skin or blood sampling as the preferred method for sea turtle genetic studies.

COMPARISON OF THE DEMOGRAPHY OF TWO CARIBBEAN NESTING POPULATIONS OF HAWKSBILL SEA TURTLE*

William L. Kendall[1], Seth Stapleton[2], Ian F. Lundgren[3], Jun Yoshizaki[4], James I. Richardson[5], and Zandy Hillis-Starr[3]

[1] USGS Colorado Cooperative Fish & Wildlife Research Unit, Fort Collins, Colorado, USA
[2] Jumby Bay Hawksbill Project, St. Paul, Minnesota, USA
[3] National Park Service, St. Croix, U. S. Virgin Islands, USA
[4] Colorado Cooperative Fish & Wildlife Research Unit, Fort Collins, Colorado, USA
[5] University of Georgia, Athens, Georgia, USA

The hawksbill sea turtle (*Eretmochelys imbricata*) is a critically endangered species. Informed conservation of this species requires knowledge of changes in its abundance and stage structure. Furthermore, demographic information is necessary to interpret change in abundance and factors that cause these changes, including anthropogenic sources. Nesting populations of hawksbills have been monitored through saturation tagging programs since the late 1980's at Jumby Bay, Antigua, and at Buck Island Reef National Monument, U. S. Virgin Islands. Both populations are protected from human exploitation on the beaches, and can provide benchmarks for regional demographic trends. We present demographic analyses of the first 20 years for each of these studies, based on multistate open robust design capture-

recapture models. We compare their results with respect to population size; apparent survival rate for neophytes and remigrants; and remigration probabilities as a function of nesting experience and number of years since last nesting. Apparent survival of remigrants was similar for both populations, at 0.94. However, apparent survival for first-time captures (presumed neophytes) was lower at Buck Island (0.73), indicating some combination of higher mortality and lower fidelity to the nesting beach. For Jumby Bay, apparent survival for neophytes did not differ from remigrants. In both populations, remigration probability was lower for neophytes than for remigrants, and remigration probability for individuals that had last nested three years previous was higher than for those that had last nested two years previous. For individuals with further delayed remigration, remigration probability attenuated for the Jumby Bay population and decreased for the Buck Island population. In addition, remigration interval overall declined over the first 10 years, followed by a partial recovery. These results indicate that population dynamics for adult female hawksbills is driven more by variability in remigration probability than survival for these benchmark populations. Future directions include finding measurable covariates, both environmental and anthropogenic, that are predictive of remigration interval for these populations; and could include comparing these populations against others from the Caribbean that are subject to additional mortality factors.

PROGRAM MARK: SOFTWARE FOR ESTIMATING DEMOGRAPHIC PARAMETERS FROM TAGGING DATA

William L. Kendall

USGS Colorado Cooperative Fish & Wildlife Research Unit, Fort Collins, Colorado, USA

Estimating demographic parameters for sea turtles is necessary to identify causes of changes in population status over time. By tagging or applying telemetry devices to individuals on nesting beaches or foraging areas, their fates can be tracked over time. By using proper study design and statistical methodology, this ‘capture-recapture’ data can be used to estimate demographic parameters and population size, even when a subset of the population is either not captured or not available for capture at a given point in time. Program MARK is a user-friendly and flexible software package developed for a large variety of tagging studies of fish and wildlife populations. Several modules within MARK are directly useful to sea turtle biologists. Some modules utilize recovery of tags from dead turtles. Multistate modules permit estimation of survival and transitions among life history states. Robust design modules utilize multiple captures per season of the same turtle to increase precision in parameters; provide robust estimation of remigration probabilities; and estimate within season parameters such as population size, population structure, and number of nests laid. MARK can also be used to develop hierarchical models of sea turtle dynamics. I will outline how program MARK is used for sea turtle studies, and its features.

GENETIC COMPOSITION OF GREEN TURTLES AT GORGONA ISLAND FORAGING GROUNDS IN THE COLOMBIAN PACIFIC*

Diego F. Amorocho LL.[1], F. Alberto Abreu-Grobois[2], Richard D. Reina[3], and Peter Dutton[4]

[1] Research Center for Environmental Management and Development, Cali, Valle, Colombia
[2] Laboratorio de Genética, Unidad Académica Mazatlán, Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Mazatlán, Sinaloa, México
[3] School of Biological Sciences. Monash University, Clayton, Victoria, Australia
[4] Southwest Fisheries Science Center, La Jolla, California, USA

Mitochondrial DNA (mtDNA) analyses have been useful for resolving maternal lineages and migratory behavior to foraging grounds of loggerhead, hawksbill and green turtles. However, little is known about source rookeries and haplotype composition of foraging green turtle aggregations in the southeastern Pacific. We used mtDNA control region sequences to identify the haplotype composition of 55 green turtles sampled in marine habitats of Gorgona National Park in the Colombian Pacific. A total of seven mtDNA control region haplotypes (457 bp) were resolved which included the most common East Pacific green turtle rookery haplotype (CMP4) observed in 84% of the

individuals, besides others apparently endemic to Michoacan (CMP8; 2% of individuals) and to Galapagos (CMP15; 2% of individuals). Seven individuals contained “orphan” haplotypes (of no known rookery origin) with sequences nesting within phylogenetic clades that clustered haplotypes of central-eastern (CMP17; N=1) or western (CMP21, 22, 97; N=6) Pacific rookeries. Turtles of putative western Pacific origin were associated with carapace morphologies distinct from those of typical East Pacific green turtles- broadly oval with yellowish to brownish colorations for the former vs posteriorly tapered with indentation above hind limbs and black skin with blackish patterns on a grayish to green background for the latter. Assuming a 11% (6/55) from western Pacific origins, a mixed stock analysis for the remaining samples indicates an overall major contribution from Galapagos (71%) and minor from Michoacan (14%). If turtles are using Gorgona during juvenile development stages, it is necessary to establish the existence of connectivity and migratory patterns between nesting sites and developmental grounds. The results generated by this study are expected to assist in the establishment of better management measures at Gorgona National Park, such as updating the protected area Marine Turtle Action Plan. This knowledge will be also useful for creating transnational policy and management strategies between Mexico, Ecuador, and Colombia to enhance the protection of sea turtles against threats currently faced along the eastern Pacific such as habitat degradation and fisheries. Although future studies are needed to determine the absolute size of the green turtle foraging aggregation using Gorgona, considering our results conservation actions implemented in Colombian habitats that effectively reduce by-catch will have a positive impact on widely spaced Pacific rookeries.

ABUNDANCE ESTIMATES OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) IN THE PELAGOS SANCTUARY, NORTHWESTERN MEDITERRANEAN SEA

Giancarlo Lauriano[1], Simone Panigada[1,2], Paolo Casale[3], Nino Pierantonio[1,2], and Greg P. Donovan[4]

[1] Institute for Environmental Protection and Research (ISPRA), Roma, Italy
[2]Tethys Research Institute, Milano, Italy
[3] Department of Biology and Biotechnologies “Charles Darwin”, University of Rome ‘La Sapienza’, Roma, Italy
[4] The International Whaling Commission, Impington, Cambridge, UK

Systematic monitoring of density and abundance of large vertebrates is among the priority actions listed in the Pelagos Sanctuary Management Plan, ACCOBAMS and by the Specially Protected Areas and Biodiversity Protocol under the Barcelona Convention. Aerial line transect surveys were performed in winter and summer 2009 in the Pelagos Sanctuary (88,267 km2), NW Mediterranean Sea. Survey effort consist of 82 parallel transects 10km apart. A total of 207 loggerhead sea turtles were sighted in 16,590 km surveyed (8,144 in winter and 8,446 in summer); nevertheless, noticeable differences in presences occurred between winter (9 sightings reported) and summer (198). The average summer ‘surface’ density was calculated by Multi Covariate Distance Sampling methods (MCDS) run by the program Distance. Density was 0.0453 turtles km-2, with a total ‘surface’ estimate of 4,001 animals (95% CV=15.17; 95% CI: 2956- 5413). The Pelagos Sanctuary, established primarily for the protection of marine mammals, appear to be also an important area also for Mediterranean loggerhead sea turtles. Nevertheless, the area in summer face high human disturbances and the potential for human induced mortalities of turtles summering in the Pelagos Sanctuary is high. This paper shows that aerials survey which have been usually aimed to apex predators such as cetaceans, can be an useful and accurate tools in order to provide reliable and accurate data, for loggerhead sea turtle, too.

A REPORT ON RECENT GREEN SEA TURTLE PRESENCE AND ACTIVITY IN THE SAN GABRIEL RIVER AND VINICITY OF LONG BEACH CALIFORNIA

Dan Lawson[1], Christina Fahy[1], Jeff Seminoff[2], Tomo Eguchi[2], Robin LeRoux[2], Pam Ryono[3], Lance Adams[3], and Melissa Henderson[1]

[1] NMFS Southwest Protected Resources Division, Long Beach, California, USA
[2] NMFS Southwest Fisheries Science Center, La Jolla, California, USA
[3] Aquarium of the Pacific, Long Beach, California, USA

The presence of green sea turtles (*Chelonia mydas*) has been occasionally recorded in inland waterways and the coastal region near Long Beach, California since at least the 1980s. While the ecological significance of this area for green sea turtles has yet to be established, periodic sightings and strandings of this species were generally considered a reflection of ephemeral foraging visits by transient individual animals. As the federal agency responsible for the management and conservation of sea turtles in the marine environment, NMFS has been engaged in efforts to opportunistically collect information about green sea turtle presence and movement in the area in cooperation with other local groups such as the Aquarium of the Pacific. In 2008, NMFS received information from local residents that indicated the presence of sea turtles in the San Gabriel River appeared to be more regular and consistent than previously known. After confirmation by NMFS, a more dedicated effort to observe and record sea turtle presence in the San Gabriel River was initiated. A specific area of interest includes a stretch of the San Gabriel River located approximately 1.5 miles inland and adjacent to two coastal power plant facilities. The power plants release warm water into the river generated from once-through-cooling of the facilities during power production. Numerous observations collected by several individuals from 2008-2010 suggest that green sea turtle presence in the San Gabriel River is persistent year-round. In combination, the available information is beginning to indicate that the Long Beach area may be supporting significant numbers of green sea turtles, widely ranging in size, and that this area may serve as more important habitat for green sea turtles in southern California than was previously understood. In 2010, a tag and recapture study was initiated in the San Gabriel River in an effort to systematically collect data on the dynamics of green sea turtle presence. In addition we plan to study movement patterns, habitat usage, and the overall health of green sea turtles in this area. This poster represents the initial synthesis of information that has become available in recent years describing green sea turtle presence and activity in this highly urbanized location.

UTILIZATION OF TESTOSTERONE RIA TO EVALUATE THE SEX RATIO OF JUVENILE LOGGERHEADS INHABITING THE ATLANTIC COASTAL WATERS OF FLORIDA

Jenny E. Layton[1], Thane Wibbels[2], Elliot Jacobson[3], and Michael Bresette[4]

[1] Samford University, Birmingham, AL, USA
[2] University of Alabama at Birmingham, Burmingham, AL, USA
[3] University of Florida, Gainsville, FL, USA
[4] Inwater Research Group, Inc., Jensen Beach, FL

All sea turtles have temperature-dependent sex determination (TSD). This type of sex determination has the potential of producing biased sex ratios which are of ecological and evolutionary interest. The loggerhead sea turtle population inhabiting the coastal waters of the southeastern U.S. is one of the largest loggerhead populations in the world. The current study utilized a testosterone-based sexing technique to evaluate juvenile sex ratios in this population. It is advantageous to evaluate juvenile sex ratios because they represent a condensation of many years of hatchling production. In the current study, several hundred juvenile loggerheads were captured at the St. Lucie Nuclear Power Plant on the Atlantic coast of Florida. This area represents a major nesting location and juvenile foraging ground for loggerheads. Blood samples were taken immediately after capture and the turtles were released into the Atlantic Ocean. A radioimmunoassay for testosterone levels was used to evaluate the sex of the captured turtles. Previous studies of sea turtle sex ratios indicate that TSD can produce a variety of sex ratios including significant biases. Further, a previous study of loggerheads in this same location over two decades ago indicated a significant female bias. The results of the

current study are consistent with those of previous studies. The results provide insight on the temporal stability of the population sex ratio in a species with TSD. Further, the results have implications for the ecological and evolutionary significance of TSD.

POPULATION ESTIMATES FOR SEA TURTLES NESTING ON THE ISLAND OF TOBAGO

Suzanne R. Livingstone[1], Amy Robb[1], Adrian Bowman[1], Tanya Clovis[2], J. Roger Downie[1], Giancarlo Lalsingh[2], Marie L. Nicolini[1], and Mike Shand[1]

[1] University of Glasgow, Glasgow, Scotland
[2] Save Our Seas (SOS) Tobago, Scarborough, Trinidad and Tobago

Three species of marine turtles nest and forage around the island of Tobago in the West Indies; the leatherback (*Dermochelys coriacea*), the hawksbill (*Eretmochelys imbricata*) and the green turtle (*Chelonia mydas*). Turtles lay eggs on sandy beaches on all coasts of the island. Some of the beaches are in remote areas making them difficult to survey for turtle nest numbers. Estimating the total number of marine turtles nesting on Tobago is therefore a challenge. Three index beaches on the northwest coast; Turtle Beach, Grafton and Mt. Irvine Back Bay, were intensively surveyed during the night for nesting turtles throughout the nesting season (from March till August) by the local NGO, Save Our Sea Turtles (SOS) Tobago, between 2005 and 2010. In 2010, an additional eleven beaches distributed around the Island were surveyed during the day on a weekly basis for fresh turtle tracks. Using a combination of the nesting data from the three index beaches and the eleven remote beaches, the total number of nesting leatherbacks on Tobago was estimated using a previously developed Poission regression model. This study shows the applicability of the population model to irregular datasets collected from difficult to survey regions. There were not enough data for hawksbills to make an estimate using the model. GIS was used to present the distribution and percentage of sea turtle nesting on the surveyed beaches around the island.

A POPULATION MODEL FOR IRREGULAR DATASETS: ESTIMATING LEATHERBACK (*DERMOCHELYS CORIACEA*) NEST NUMBERS ON THE NORTH COAST OF TRINIDAD

Suzanne R. Livingstone, Adrian Bowman, J. Roger Downie, and Malcolm Kennedy

University of Glasgow, Glasgow, Scotland

Trinidad's north and east coasts support a globally important population of nesting leatherbacks (*Dermochelys coriacea*), one of the largest remaining rookeries in the Atlantic Ocean. Evaluating the population size of sea turtles is a valuable conservation tool and supports the assessment of conservation management and consequences of environmental threats and change over time. Most population estimates for sea turtles are based on annual numbers of nesting females or nests numbers. Since complete datasets are practically impossible to collect for most regions, particularly for high density and difficult to reach nesting areas e.g. the north coast of Trinidad, such datasets require some level of extrapolation to make estimates. This study presents a GLM-based (Poisson Regression) model that fits and describes the annual rate of nesting within acceptable error margins and a set of stated assumptions. The method was developed using a four year (2000-2004) combined dataset of clutches laid and observed hatched nests from the five main nesting beaches on the north coast. The model has been designed as a tool that can be applied where regular and intensive beach surveys are challenging. The estimate for leatherback clutches laid on the main north coast beaches in 2004 is 17,043 (13,830, 20,250). This is likely an under-estimate for the entire coastline, as this figure does not include nest numbers from several other lower-density nesting beaches on the coast. However, this figure is considerably higher than previous estimates for the north coast region, and consequently, for Trinidad as a whole. As leatherbacks are currently considered to be Critically Endangered (IUCN, 2010), it is encouraging to report on a stable, possibly increasing leatherback population in the Atlantic. This research will serve as an effective tool in assisting the conservation management and monitoring of the leatherback population in Trinidad, and offers a simple and achievable method to monitor turtle populations in difficult to survey areas with irregular datasets.

ROCAS ATOLL, NE BRAZIL: A NATURAL LABORATORY FOR GREEN TURTLE POPULATION ASSESSMENTS

Guilherme Ortigara Longo[1], Alice Grossman[2], Fábio Daura-Jorge[3], and Maurizelia de Brito Silva[4]

[1] Programa de Pós-Graduação em Ecologia e Conservação – UFPR; Laboratório de Biogeografia e Macroecologia Marinha – UFSC, Santa Catarina, Brasil
[2] All Angle Images LTDA. Arquipélago de Fernando de Noronha, PE, Brasil
[3] Programa de Pós-Graduação em Zoologia-UFPR, Curitiba, Paraná
[4] Chefe da Reserva Biologica do Atol das Rocas/ICMBio, Parnamirim, Rio Grande do Norte, Brasil

Rocas Atoll lays approximate 144 miles off northeast Brazil (03°50'S, 33°49'W) and is regarded as the third greatest rookery for green turtles in South Atlantic, behind Ascension and Trindade Islands. In 1979 Rocas Atoll was legally declared a Biological Reserve, but was actually implemented in 1991 as the first marine no-take area in Brazil. In addition, Rocas Atoll was considered a World Heritage by UNESCO in 2001. Brazilian Sea Turtle Conservation Program (Projeto TAMAR/ICMBio) implemented their first efforts in Rocas Atoll during the 80's consolidating an annual systematic monitoring in 1990. Since then important information on the green turtle nesting (e.g. approximate number of nesting females, hatch success, remigration interval), reproduction (e.g. court observations), genetics (females and juveniles) and population assessments (e.g. morphometrics and most recently males' survival and abundance estimates) have been generated. Along these years, Rocas Atoll demonstrated an amazing potential for population assessments mainly because: 1) There is no female harvesting, egg collection or direct human impact resulting from the urbanization process (i.e. artificial lights, car traffic or straight sewage outfall); 2) Fishing activities are forbidden, minimizing negative interaction specially with juveniles; 3) There is a great diving condition for in-water research (i.e. capture-mark-recapture, behavioral observation); 4) The geographical position is attractive for population genetic researches; and 5) There is a great and consolidated partnership with the Biological Reserve administration, that provide valuable logistical support. According to the available literature, around a 1000 green turtle nests are laid at Rocas Atoll in each reproductive season and a total of 623 females were tagged in a 10 year study from 1990 to 2000. In a recent study reproductive males' population between 2003 and 2007 was estimated in 294 individuals also reporting individuals recaptured 10 years after first capture. Juveniles have also been part of a long term mark-recapture study and are now part of a robust analysis for estimating population parameters. Some juveniles were recaptured from 5 to 7 years after first capture, which might indicate a sort of resident pattern for these individuals. Concerning genetics, the stocks from Rocas Atoll and Fernando de Noronha Archipelago have been considered as a single one. Despite this patchy but valuable information in the literature, green turtles from Rocas Atoll remain relatively poorly acknowledged. A great volume of data was already collected and it is now being carefully analyzed by TAMAR and associated researchers in order to cover that blank. Nevertheless, it is possible to notice the lack of an integrative approach in population assessment, putting together estimates for adult females and males, and also juveniles. Rocas Atoll assembles several positive characteristics that support these proposals. In this context it is fundamental to keep a constant monitoring effort in Rocas Atoll, increasingly supporting and widening the researches ranges towards an integrative approach and contributing to the knowledge on sea turtle biology and conservation.

ANNUAL REMIGRANT AND NEST TEMPERATURE TRENDS OF WEST KIMBERLEY FLATBACKS

Glenn McFarlane

Conservation Volunteers Australia, Darwin, Australia

This presentation analyses the first three nesting seasons of an annual tag and recapture program at Eco Beach on the remote Northwest coast of Western Australia. What appears to be a small yet robust nesting population of Australian flatback (*Natator depressus*) marine turtles, has been monitored for tag recaptures, fluctuations in nest and beach temperatures, levels of nest predation and erosion, plus annual migratory tracking through the deployment of Platform Terminal Transmitters. The annual 40-night tagging program is followed by a hatchling component which conducts

nest exhumations to gauge nest hatch success rates at this harsh and volatile nesting environment. With a large percentage of the nesting flatback population annual remigrants, together with extreme nest temperatures, this study site is producing productive results for this species. This program is operated by the marine turtle research division of not-for-profit Conservation Volunteers Australia.

CORRECTED LOGGERHEAD (*CARETTA CARETTA*) SEA TURTLE POPULATION DENSITY AND ABUNDANCE ESTIMATES IN ESTUARINE AND COASTAL WATERS OF NORTH CAROLINA, USA*

Joanne Braun McNeill[1], M. April Goodman[1], and B. Wren Patton[2]

[1] NOAA, National Marine Fisheries Service, SEFSC Beaufort Laboratory, Beaufort, NC, USA
[2] Oregon State University, Corvallis, Oregon, USA

Although aerial surveys are the most pragmatic method for obtaining sea turtle abundance estimates over large scales, these estimates may not be accurate if they do not account for the proportion of time that turtles are at the surface, ‘available’ to be counted. To improve on a recent aerial survey abundance assessment in North Carolina waters (Goodman *et al*. 2007), we satellite tagged sea turtles to estimate the amount of time they spent at the surface of the water, and then applied a correction factor to previous density estimates. We deployed 8 Wildlife Computer SPOT5 satellite tags from July to October 2007 and 13 Wildlife Computer SPLASH satellite tags from May to June 2008 on loggerhead (*Caretta caretta*) sea turtles incidentally captured in pound nets set in Core and Pamlico Sounds. Transmitters measured the amount of time per 24-hour period that a tag’s salt water switch was dry, providing us with a minimum estimate of percent time the turtle spent at the surface per any given 24-hour period. In addition, SPLASH tags were equipped with a pressure sensor to calculate the percentage of time spent at different depths, providing the proportion of time turtles spent swimming within 1 meter of the surface and would most likely be visible to observers during an aerial survey. We archived and filtered the data from satellite tags using the Satellite Tracking and Analysis Tool (STAT) (Coyne and Godley 2005) and tested surface interval data for differences among habitats (coastal versus estuarine) and seasons. Length of transmission ranged 0 to 276 days for SPOT5 tags and 26 to 224 days for SPLASH tags. Loggerhead sea turtles spent 0.1 to 12.5% of their time on the surface of the water, with a minimum of 23% of their time spent within 1 m of the surface of the water. They spent a significantly greater average amount of time on the surface of the water in coastal (2.4%, t-test, P*et al*. (2007). Corrected density estimates ranged from 0.01 to 2.2 turtles/km2 in the sounds and from 0.2 to 25.6 turtles/km2 in the coastal region compared to uncorrected density estimates of 0.002 to 0.02 turtles/km2 in the sounds and 0.04 to 0.62 turtles/km2 in the coastal region. Corrected abundance estimates ranged from 16 to 4497 turtles in the sounds and from 44 to 3552 in the coastal region compared to uncorrected abundance estimates of 4 to 25 turtles in the sounds and 10 to 85 turtles in the coastal region.

SITUATION OF THE 3RD WORLD'S LARGEST POPULATION OF *CARETTA CARETTA* NESTING IN CAPE VERDE ISLANDS

Tommy Melo[1], Pedro Lopes[2], and Sónia Araújo[3]

[1] Biosfera I, Mindelo, São Vicente, Cape Verde
[2] Natura 2000, Ervatão, Boavista, Cape Verde
[3] DGA, Praia, Santiago, Cape Verde

We intend to present a poster with the following information gathered by the projects undertaken by NGO BiosferaI and a little about the details of similar projects throughout Cape Verde: - What species of turtles that can be sighted in Cape Verde; - What is the breeding species and their distribution in which the nesting areas of the islands of Cape Verde; - What are the existing threats to the species for nesting (poaching by fishermen for their meat and eggs, pollution, predation by birds, cats and crabs; clash with pleasure boats). - What measures are being taken to conserve the species in Cape Verde. With this information we hope to move to the other participants an idea on the situation of *Caretta caretta* in the country which has the third largest nesting population of the world.

DISTRIBUTION, SIZE COMPOSITION AND GROWTH OF IMMATURE HAWKSBILL TURTLES (*E. IMBRICATA*) IN THE JARDINES DE LA REINA ARCHIPELAGO, CUBA

Félix G. Moncada, Gonzalo Nodarse, Yosvani Medina, and Erich Escobar

Centro de Investigaciones Pesqueras, Ministerio de la Industria Pesquera, 5ta Ave y 248, Barlovento, Santa Fé, Ciudad Habana, Cuba, E-mail: tortugas@cip.telemar.cu

Juvenile hawksbill turtles are studied in Jardines de la Reina Archipelago, the main area of distribution of this species in the Cuban archipelago. Areas of more occurrence, size composition, movements range and growth rate in that region are presented. Individuals were caught diving with nets between-0.5 y 5 meters of depth. Turtles were tagged with metal monel flipper tags on the trailing edge of the front flippers and measured both in straight line and over the curve. Results indicate the benthic habitats of Doce Leguas Keys are favorable for establishment of juvenile hawksbill turtles when they finish the pelagic phase and are distributed along all of keys, mainly in Cayo Grande, Cayo Caballones, Cayo Anclitas y Cayo Cinco Balas, with the most occurrence in the places known like Boca de Guano and Las Auras, in Cayo Grande. Size composition of individuals (n=495) varied between 19 and 64 cm. with a size average of 35.7 cm. The 8.5 % of individuals were recovered between 1 and 4 times (56 recaptures) with the mean being 1.31 times. The 91% of recaptures was obtained in the same areas Doce Leguas Keys to minor distances of 1 Km. in an interval average of 288 days of recaptured. Growth rate of hawksbill turtles studied in that region was of 2.72 to 12.83 cm/ year.

GENETIC CHARACTERIZATION OF HAWKSBILL JUVENILES FORAGING AT CAPE VERDE ISLANDS INDICATES MAJOR UNDISCOVERED NESTING POPULATIONS IN THE REGION

Catalina Monzón-Argüello[1], Ciro Rico[2], Adolfo Marco[2], Pedro López[3], and Luis F. López-Jurado[4]

[1] Instituto Canario de Ciencias Marinas, Telde, Gran Canaria, Spain
[2] Estación Biológica de Doñana, CSIC, Sevilla, Spain
[3] Naturalia, Cape Verde Ltd. Sal-Rei, Boa Vista, Republic of Cape Verde
[4] Universidad de Las Palmas de G.C., Gran Canaria, Spain

The hawksbill sea turtle (*Eretmochelys imbricata*) is a circumglobal tropical species listed as Critically Endangered by the IUCN. While it is known that at least one stock occurs around the rookeries of São Tome and Principe and Bioko Islands, the eastern Atlantic remains genetically unexplored. We present the first analysis of mitochondrial DNA (mtDNA) sequences (n = 28) of hawksbill juveniles in a foraging aggregation at the Cape Verde Islands, an archipelago located in the eastern Atlantic. The mean size (minimun curve carapace length) of the studied individuals was 42.45 cm. The results showed three haplotypes non-reported in any nesting population to date: EATL (relative frequency 68%), Ei-A49 (14%) and Ei-A82 (4%). These three haplotypes were closely related to each other but highly divergent from all known Caribbean and Western Atlantic haplotypes. Furthermore, we detected three other haplotypes - Ei A (relative frequency 7%), Ei B (4%) and Ei F (4%) - that have been previously detected in rookeries from the western Atlantic. Cape Verde feeding ground showed a high degree of genetic differentiation with respect to known nesting populations and foraging areas. Furthermore, this juvenile aggregation presented the second lowest level of haplotype diversity and the highest value of nucleotide diversity from all the studied Atlantic foraging aggregations. We were not able to determine the population composition of this aggregation since more than 86% of the individuals carried orphan haplotypes whose origin has not been identified to date. These findings highlight the fact that the incomplete haplotype baseline of contributing nesting populations in the eastern Atlantic currently hampers progress of genetic studies and consequently, a priority for evaluation on the conservation and management issues related to foraging aggregations in this region. The results suggest that this aggregation appears to be composed primarily of turtles from regional nesting colonies (eastern Atlantic). Moreover, the finding of the haplotypes Ei A, Ei B and Ei F at low frequencies suggests the existence of occasional transatlantic movements. This study highlights the necessity of Cape Verde conservation and

the need additional research, particularly expanding the genetic analysis throughout the west coast of Africa to include unsampled areas.

CURRENT STATUS AND CONSERVATION OF SEA TURTLES IN THE REGION OF PALMEIRINHA, LUANDA - ANGOLA

Miguel Morais

Universidade Agostinho Neto / Departamento de Biologia – Repartição de Ecologia (Projecto Kitabanga) Av. 4 de Fevereiro, Nº71, 4 andar, Sala 4.23. Luanda

The 3.6 km-long beach in the region of Palmerinha, Luanda, Angola has been monitored since 2003. The overall objectives of this project has been to determine the nesting status of each species, to collect biological data on the nesting turtles, and to determine the necessary conservation measures. Between 2003 and 2010, 809 olive ridley, *Lepidochelys olivacea*, nests and 71 leatherback, *Dermochelys coriacea*, nests were recorded through direct and indirect methods on this beach south of Luanda. The nesting season occurs between October and February with a peak in December. The average clutch size for olive ridleys was approximately 115 eggs with an average incubation period of 49.6 days and an average hatching success of 81.8% . The current population estimate of breeding females in the region of Palmeirinhas is estimated at around 240-720 females, compared to the previously estimated 500-1500 females. Based on nesting estimates in the 1980s, there appears to be at least a 50% reduction in the populations of the two species. Threats impacting reproductive females need to be addressed aggressively to ensure continued nesting in the Palmerinhas region.

FIRST RESULTS OF THE STANDARDIZATION PROCESS FOR MONITORING THE DISTRIBUTION, HABITAT USE AND BEHAVIOR OF *CHELONIA MYDAS* AND *ERETMOCHELYS IMBRICATA* IN SAN CRISTOBAL ISLAND, GALAPAGOS

Juanpablo Muñoz[1], Judith Denkinger[2], Leandro Vaca[3], Daniela Alarcón[2], Constanza Carrasco[2], and Andres Baquero[4]

[1] GAIAS (Galápagos Institute for Arts and Science)- USFQ (Universidad San Francisco de Quito)/Equilibrio Azul, San Cristobal Island-Galapagos, Ecuador
[2] GAIAS (Galápagos Institute for Arts and Science)-USFQ (Universidad San Francisco de Quito),San Cristobal Island-Galapagos, Ecuador
[3] PNG (Parque Nacional Galápagos), San Cristobal Island-Galapagos, Ecuador
[4] Equilibrio Azul, Av. Amazonas 2915, Quito–Ecuador

Most research on sea turtles has been conducted on nesting beaches. In this context, the data that exists about the ecology and biology of this group of animals is generally on adult females. Taking into account that these animals remain underwater for almost 90% of their life cycle; there is an urgent need for long- term studies that consider all stages of their life cycle. Therefore,the collection of in-situ information about the distribution, habitat use and behavior is the minimum amount of data required in order to make decisions for management and protection. This study on San Crístobal Island-Galápagos shows the occurrence of two endangered species; *Chelonia mydas* and *Eretmochelys imbricata*. We are presenting the first results of the standardization process on the underwater monitoring project carried out by GAIAS/USFQ (Universidad San Francisco de Quito) since 2008. It is important to emphasize that the data used to generate the base catalog for comparison corresponds to images taken in August 2010, which are the result of 10 hours of monitoring. We have established a long-term method for noninvasive identification of sea turtles generated from a unique code made from the numerical analysis of the combination of patterns recognized in postocular scales, temporal scales and tympanic scales. Each individual was captured once with the intention of having a complete record of sizes and photos. Then we continued with the noninvasive records. At the moment we have a complete record of 30 individuals Curved Carapace Length (CCL)=71.43±13.7; Curved Carapace Width

(CCW)=66.06±11.35; Tail Length (TL)=17.33±11.74. Finally, it is worth to mention that the whole process is completed underwater. With this method we try to disturb the animals as little as possible. Based on the comparison of the catalog list with random photos taken since 2008, we have been able to establish the presence of 9 individuals of *C. mydas* (one of which has been recorded in the same site for the last three consecutive years) and the occurrence of 6 individuals of ***E.*** *imbricata*. The high density and the relative ease of underwater sightings and captures of sea turtles in San Crístobal Island throughout the year opens the possibility of a great number of studies applicable to appropriate management and timely protection.

---

105 DEAD SEA TURTLES RECORDED IN 2005 AND 2006 IN BUNCHE BEACH-CANTON MUISNE, ESMERALDAS PROVINCE-ECUADOR

Juanpablo Muñoz[1], Andrés Ledergerber[2], and Eduardo Rebolledo Monsalve[2]

[1] GAIAS (Galápagos Institute for Arts and Science)-USFQ (Universidad San Francisco de Quito)/Fundación Equilibrio Azul. San Cristobal Island ,Galapagos-Ecuador
[2] Estación Biológica Congal-Fundación Jatun Sacha, Muisne-Ecuador. Pasaje Eugenio de Santillán. Quito-Ecuador

All species of sea turtles are endangered. In Ecuador they are protected by agreements, laws and strategies. However, these agreements as well as data on the Ecology and Biology of the different species, are infrequently upheld and often times non-existent. In the year 2005, taking into account the high density of individuals found dead in the villages surrounding the Biological Station Congal, we established a pilot monitoring program with the aim to find out the number and species found dead on one of the beaches near Congal Station. The beach was patrolled at day time on an average of once every two weeks for 7 months in 2005 and 6 months in 2006. Each dead sea turtle was measured in centimetres (Curved Carapace Length CCL, Curved Carapace Width CCW), marked with red acrylic waterproof paint and removed from the monitored area to avoid duplications. The results show the occurrence of 3 species: Olive Ridley (*Lepidochelys olivacea* mean±SD:CCL=59.26±6.52; CCW=60,58±8,23 n=66), Green (*Chelonia mydas* mean± SD:CCL=60.15±7.2; CCW=61,68±8,6 n=32), and Hawksbill (*Eretmochelys imbricata* mean±SD:CCL=63.0±10.14; CCW=56.0±11.26 n=3). L.*olivacea* appears to be the most abundant followed by C.*mydas* and then ***E.*** *imbricata*. The measurements of the dead sea turtles were compared to those of the females in a nearby nesting beach (Portete). Our comparisons showed that most of the dead Olive Ridleys were juveniles. After doing the same comparisons with the Green species we found similar results. We only found three dead Hawksbill Turtles on our study area, therefore our comparisons were insignificant. However, the finding of these Hawksbills was still important because it was the first confirmed record of that species in the area. It is important to note that these results belong to a relative small beach in the Ecuadorian coast. This report aims to show the death of a significant number of sea turtles in order to fill a gap in existing data which is necessary for appropriate management. Our ultimate goal is to establish continuous monitoring programs in the area to identify the causes of these deaths as well as to accumulate scientific knowledge on sea turtles that can be applied to their conservation.

SURVIVAL AND ABUNDANCE ESTIMATES FOR GREEN TURTLES (*CHELONIA MYDAS*) IN ESTERO BANDERITAS, BAJA CALIFORNIA SUR, MEXICO*

Eduardo Nájera-Hillman[1], Beatriz Dias[2], Volker Koch[3], and Gustavo Hinojosa[1]

[1] The School for Field Studies, Center for Coastal Studies
[2] Universidad Autónoma de Baja California Sur-Grupo Tortuguero de las Californias A.C.
[3] Universidad Autónoma de Baja California Sur, Departamento de Biología Marina

Except for adult females, which can be counted on nesting beaches, the estimation of abundance in sea turtle populations is extremely difficult. Mark-recapture methods are among the few viable methods to estimate abundance of sea turtle aggregations on their feeding grounds. This information is needed to enable informed decision making and guide conservation and management of endangered species. We used 10 years of capture-mark-recapture data to

estimate abundance and survival rates for East Pacific green turtles (*Chelonia mydas*) in Estero Banderitas, Baja California Sur, Mexico. As a large portion of our sample consisted of encounter histories with captures on only a single occasion, we elected to use time-since-marking models, which take into account the presence of transient individuals in the sample to estimate apparent survival and capture probabilities. The goodness of fit test on the Cormack-Jolly-Seber fully time-dependent model also suggested the presence of transient individuals (test 3.SR, P = 0.046). Selection of the best model was based on the Akaike information criterion. Abundances were calculated from estimated capture probabilities and observed data. During the study period a total of 485 turtles were caught, of which more than 95% were juveniles. Our best model considered constant survival for transients and residents, constant capture probabilities for spring-summer and fall-winter periods, and used the number of sampling occasions per season as a potential covariate that affected capture probabilities. Apparent survival rate for transient individuals was 0.50 (SE = 0.06, 95% CI = 0.38–0.61), and 0.82 (SE = 0.02, 95% CI = 0.77–0.85) for resident turtles. Abundance ranged from 101 (SE = 18.9, 95% CI = 64–138) to 292 (SE = 52.1, CI = 189–394) for Estero Banderitas within an area of 42 km2. Our survival estimates were similar to estimates of other populations of green turtles in developmental habitats of the northeast Pacific. However, our estimates represent survival probabilities in a region experiencing human-induced mortality. This investigation reports an application of the time-since-marking models to sea turtle populations and demonstrates their advantages. The study also provides the first survival rate and abundance estimates for the green turtle population in Bahia Magdalena, Baja California Sur, Mexico.

NATAL ORIGIN OF THE HAWKSBILL FORAGING AGGREGATION FROM GLOVER'S REEF ATOLL, BELIZE

Luisa Otero[1], Ximena Velez-Zuazo[1], Robin Coleman[2], Isaias Majil[3], Janet Gibson[2], Peter H. Dutton[4], and Tomas Hrbek[1]

[1] Department of Biology, University of Puerto Rico-Rio Piedras
[2] Wildlife Conservation Society, Belize
[3] Belize Fisheries Department
[4] Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA, USA

The Caribbean coral reefs are important habitats for the hawksbill sea turtles (*Eretmochelys imbricata*) that recruit and aggregate here for feeding and development. There are several foraging aggregations identified throughout the Caribbean; however, these are mostly located in the Greater and Lesser Antilles while those on the Caribbean coast of Central America remain understudied. Identification of new foraging aggregations and their linkage to breeding sites is important for improving our understanding of dispersal and migratory behavior of sea turtles and the mechanisms that influence them. The Glover's Reef Atoll (GRA) is situated 45 km off the coast of Belize and was established as Marine Protected Area in 1993. Since 2007, Wildlife Conservation Society in partnership with the Belize Fisheries Department established a long-term monitoring program to investigate the hawksbills at GRA with the goal of improving sea turtle conservation efforts through information gathering and capacity building. Specific research objectives include investigation of the natal rookery origin and genetic stock composition of the GRA hawksbill aggregation. This type of information is relevant to identify the role this protected area plays for the future recruitment of adult hawksbills in the region. To investigate the stock origin of the GRA hawksbills and the contribution of the rookeries, we assessed the genetic variability of a 740bp fragment of the mitochondrial DNA (mtDNA) d-loop of 48 juvenile hawksbills sampled between 2007 and 2009 in GRA. Eleven variable sites defined six haplotypes, most of them previously identified in other rookeries but we also observed a haplotype reported only in other foraging aggregations. Estimates of haplotypic (0.7075 ±0.656) diversity indicate that the GRA aggregations exhibit a similar diversity as exhibited by other hawksbill foraging aggregations in the Caribbean. Results from mixed stock analysis in the R-package Mixstock and using baseline data from rookeries that have been surveyed to date suggested that the rookeries of Cuba and Costa Rica are the primary source of the GRA hawksbills,. We also detected lesser contributions from Barbados and US Virgin Islands. Surprisingly, the Mexican rookery only had a small contribution to the GRA foraging aggregation, despite its proximity to Belize. This agrees with previous observations based on drifting of modeled particle that suggest a great north-direction effect of the Gulf of Mexico gyre on hatchling dispersal. Whether recruitment from the rookeries to GRA varies over time is unknown but the long-term sampling efforts of WCS in this area will allow this question to be addressed. Changes in the genetic structure and composition of the aggregation over time can be linked to fluctuations in hatchling productivity or disturbance of the mechanisms influencing sea turtle dispersal and recruitment (i.e. currents). The GRA represents an important area for the development of hawksbills from different areas in the Caribbean but particularly from the Tortuguero rookery (Costa Rica) so conservation of the GRA juvenile hawksbills

aggregation in Belize will support the long-term conservation of Tortuguero nesting stock and other rookeries in the Caribbean.

THE POTENTIAL OF THE SIDE-SCAN SONAR TECHNOLOGY FOR THE STUDY OF SEA TURTLES

Maria L. Parga[1], Jordi Sánchez[1], Carlos Oldani[2], and Alejandro Monnà[2]

[1] Submon: divulgación, estudio y conservación, Barcelona, Spain
[2] Ecohydros, Maliaño, Cantabria, Spain

Sea turtles are difficult to study because of their relatively small size, the long time spent under water and their low activity. This is specially so during winter, when the low water temperatures reduce their activity further. In several areas of the Mediterranean Sea, juvenile and sub-adult specimens of sea turtles have their foraging grounds in coastal, shallow water areas, where they seem to spend several years. However, the existing limits in the study of these animals complicate further research into these life stages. The side-scan sonar (SSS) is a relatively new technology, which emits a series of ultrasounds that bounce against the bottom of the sea and the objects on it, creating an image (sonogram) of them. It is mainly used for mapping the seabed for a wide variety of purposes, including creation of nautical charts and detection and identification of underwater objects and bathymetric features, and is especially useful in limited water visibility, or to cover large areas in short times. In winter of 2010 a series of trials were carried out at the Ebro Delta in order to assess the effectiveness of this technology for the detection of resting sea turtles. The bay studied is an enclosed area of 965 Ha, with a maximum depth of 5m. Two dead specimens of juvenile (CCL 35-45cm) loggerhead turtles (*Caretta caretta*) were used, placed in known points on the bottom of the bay while the SSS was used to detect them. Two machines were compared, the Edgetech 4200 MP and the Klein System 3900, at frequencies of 100, 300, 400, 600 (all with the first machine) and 900 (with the later) kHz. In all cases could animals be detected, although with lower frequencies the detectability was not as good. Higher frequencies gave a much better image of the turtles, and of other objects found. Because of the many other objects present on the bottom of the bay (seagrass, old nets, garbage), these higher frequencies were preferred in order to be able to distinguish between them and the turtles. The reduced distance reached by the beam when higher frequencies are used was not a problem in this case, because of the small depth of the area. Unfortunately, no life turtles were detected during the trials. Although more tests need to be done in different situations and environments, the SSS technology has proved to have a very interesting potential for the study of sea turtles in large, shallow coastal areas, which should be further investigated. The authors would like to acknowledge the donors of the travel grant: the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service, as well as the International Sea Turtle Symposium, for making their attendance to the 2011 ISTS possible.

SURVIVAL PROBABILITY ANALYSIS AS A TOOL TO IDENTIFY GREEN TURTLE JUVENILE DEVELOPMENT SITES

Ana R. Patrício[1], Ximena Velez-Zuazo[1,2], Carlos E. Diez[3], Robert P. van Dam[4], and Alberto M. Sabat[1]

[1] Department of Biology of the University of Puerto Rico - Río Piedras Campus, San Juan, Puerto Rico
[2] ecOceanica, Lima 41, Peru
[3] Programa de Especies Protegidas, DRNA-PR, San Juan, Puerto Rico
[4] Chelonia Inc., San Juan, Puerto Rico

Inshore bays are key areas for green turtles during several stages of their development. At these confined areas, mark-recapture programs can generate valuable information that can be used to estimate vital rates, and population abundance trends, essential for the effective management and conservation of endangered populations. We compiled the capture-mark-recapture (CMR) history profiles of 273 individuals, from 13 years (1997 - 2010) of in-water surveys and employed a live-recapture population dynamics model (Cormack-Jolly-Seber) to estimate the apparent survival probabilities of green turtles in two nearby neritic bays at Culebra municipality, Puerto Rico. Our main goal was to infer the importance of these areas for the development of green turtles. The CMR profiles were classified into two size-classes: juveniles and subadults. No adults were captured during the study. We found no differences in the size structure of the green turtles occupying both bays, and more than 80% of marked turtles fell within the juvenile size-class. Juveniles showed a higher apparent survival probability (0.8322, CI95% = 0.7875 - 0.8690) than subadults (0.5290, CI95% = 0.3851- 0.6682). Our results support the conclusion that green turtles in the juvenile size-class use these areas for long-term development, whereas subadults migrate out of these bays probably due to ontogenic habitat shift. This study is the first to present an analysis of survival probability for green turtles in the Caribbean Sea and propose the application of survival probability analysis from live-recaptures as a useful tool to identify key resident areas.

SCUBA DIVERS CONTRIBUTION TO MARINE TURTLES MONITORING THROUGH PHOTO ID ON BORA BORA, FRENCH POLYNESIA

Eve Perrin[1], Sébastien Goutenègre[2], and Sophie Leroy[3]

[1] Université Lyon 1, Lyon, France
[2] Ngo Chelonia Polynesia, Bora Bora, French Polynesia
[3] Université catholique de Louvain, Belgium

Juveniles *Eretmochelys imbricata* and *Chelonia mydas* are the most common species encountered in Bora Bora, French Polynesia. Till now, we have very few knowledge about the stock of that population. No Hawksbill nesting activity has been record in French Polynesia. With scuba divers contribution, we started an inventory in 2007 through photo ID using facial scales. Each facial sacle is consider as a unique finger print. We can even use natural marks on the turtle's body. That method is efficient and usefull to identify animals without stress of harm. It is not necessary to catch animals and convenient to identify untagged turtles. In the future, this study will tell us how long individuals stay on their foraging ground. This inventory allows us to involve directly divers and tourists.

AGE AND GROWTH OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN SOUTHERN BRAZIL*

Roberta Petitet, Paul G. Kinas, and Eduardo R. Secchi

Universidade Federal de Rio Grande (FURG), Rio Grande, Rio Grande do Sul, Brazil

Sea turtles of the species *Caretta caretta* use the Brazilian coast for development and reproduction; the majority of loggerhead turtle nests are situated on beaches from Bahia and Espirito Santos states. Thus, most studies on loggerheads in Brazil deal with adult females on nest beaches and information on immature individuals in their pelagic and neritic stages is fragmentary. A total of 69 loggerhead sea turtles had their age estimated through skeletochronogical analysis of humeri; 49 humeri from loggerhead washed ashore and 20 humeri from loggerhead incidentally caught in longline fisheries. Since it was validated that each increment growth corresponds to one year for loggerhead sea turtle, the number of lines of arrested growth (LAGs) was taken as the age estimated. For larger turtles a correction factor was applied to solve for lost LAGs. This correction factor was based on two models, the first denoted “naïve” makes no distinction between inter- and intra-individual variability and the second denoted “hierarchical”, takes this distinction into account. The hierarchical model had the best fit to the data set, probably because these reptiles experience stochastic conditions through their life cycle, so that some individuals may grow more than others. The duration of oceanic stage was estimated in 8 to 19 years (average 11.5 years) for turtles which recruit at a size range of 47.0 to 65.5cm CCL (curve carapace length). These estimates were similar to those obtained for the north Atlantic population (9 to 24 years) through skletochronological analysis. Schnute’s growth model was fitted to age-at-length data due to its versatility in shape and no requirement for size data from hatchlings up to individuals at old ages with near asymptotic size. However, since the shape of Schnute`s curve resulted almost linear for the age-window comprising our data, a linear regression obtained a slightly better fit, suggesting that in this size range (45.0 to 80.0cm

CCL) the growth is linear. Therefore, the age-at-maturation was estimated by a linear model, to be between 25.7 and 39.2 years (average 31.8, for 83.0-123.0 cm CCL). This was very similar to recent studies (average 30.8 years) but quite different from former studies (20 to 26 years) both for the North Atlantic. In general, the age-at-maturation is around 30 years, depending on average size of mature loggerhead turtles in some given population. The "Body Proportional Hypothesis" was incorporated in the calculation of growth rates. Growth rates of neritic loggerhead turtle were lower than growth rates obtained for the North Atlantic but higher than those observed in Australia. This suggests that the growth rates may vary due to environment conditions of a given location, as temperature, food resource and migration energy.

BEYOND THE BEACH: POPULATION TRENDS AND FORAGING SITE SELECTION OF A LOGGERHEAD NESTING ASSEMBLAGE*

Katrina Phillips

University of Miami Rosenstiel School of Marine and Atmospheric Science, Miami, Florida, USA

The beaches of state of Florida host one of just two rookeries in the world that support more than 10,000 loggerhead nests a year and represent over half of all western Atlantic nesting for the species. Loggerhead nest counts on Florida's vital nesting beaches have shown a marked decline in the past decade – but what does this tell us about the Atlantic population? While coastal development, erosion and recreational use put a strain on nesting habitats, nest counts for both greens and leatherbacks, which share the same nesting beaches with loggerheads, have increased over the same period. To help explain the drop in loggerhead nesting we must look at other factors, such as population dynamics and offshore habitat selection. Very few night-time saturation tagging projects exist in the state of Florida; however in-depth evaluation of the long-term datasets that are available may shed light on broader population trends. For this study a twenty year mark-recapture dataset from the loggerhead nesting beach on Keewaydin Island, off the southwest coast of Florida, was analyzed using a two-state open robust design model in Program MARK. A total of 2,292 encounters representing 841 individual tag IDs were used for this analysis. Parameters such as survival, encounter probability, population size and residence time for this nesting assemblage were estimated and examined for trends over time. The mark-recapture analysis was supplemented with a satellite tracking component to identify the offshore foraging areas utilized by Keewaydin nesters. Eleven nesting females were outfitted with platform terminal transmitters: four during the 2009 nesting season and seven in 2010. The released turtles transmitted for 42 to 300+ days, including interesting intervals and subsequent migration to foraging grounds. Site fidelity tests and density kernel home range analyses were used to identify and describe foraging habitats. Ten of the eleven satellite turtles displayed fidelity to foraging sites in the along the eastern Gulf of Mexico while one migrated into Bahamian waters to a site just south of Andros Island. While the loggerhead females from this particular nesting beach do not frequent the same foraging area, the sites they selected are near those used by other loggerheads tracked from the western coast of Florida. Areas identified as important habitats during the remigration interval may be used to inform managers to create targeted management strategies and aid population recovery without the use of broad fishery closures.

MONITORING NESTING ACTIVITY FOR OVER A DECADE ALONG THE SOUTHWESTERN COAST OF ANTIGUA, W.I.: WORKS OF A SELF-TAUGHT TURTLER

Jepson Prince[1], Dominic Tilley[2], and Kathryn Levasseur[2]

[1] Antigua Sea Turtle Project, Crabb Hill Village, Antigua, W.I.
[2] The Jumby Bay Hawksbill, Long Island, Antigua, W.I.

The sister islands of Antigua and Barbuda in the Northern Leeward Islands have a combined 153 km of coastline; Antigua, with 87km of coastline is mainly known for its 365 beaches, one for every day of the year. Since its inception in 2007, the Antigua Sea Turtle Project has been monitoring beaches across Antigua with the help of Environmental Awareness Group, a local non governmental environmental organisation. However, monitoring of a stretch of beaches along the southwestern coast of Antigua commenced in 1999, predominantly with the efforts of one individual. The objective was to determine population trends and species distribution. Nesting activity for the leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*) turtle has been documented for over a decade on five beaches surrounding Crab Hill Village (17º 02', 61º 53'), totalling 1.7 km in length: Ffryes, Darkwood, Crab Hill, Turners, and Johnson's Point. These sites were chosen in part due to their proximity to the primary field researcher's residence, but were also known locally to be important nesting locations. We present 11 years of nesting data, including: population and nest numbers, beach use, fecundity, and hatching success. We also discuss the challenges faced in the conservation of the sea turtles nesting on Antigua. My attendance to this symposium has been made possible through the generous grants from the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service, and support from the Jumby Bay Hawksbill Project, Antigua Sea Turtle Project, and the International Sea Turtle Symposium.

THE WESTERN MEDITERRANEAN IS A DEMOGRAPHIC SINK FOR LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) FROM THE WESTERN ATLANTIC*

Irene Alvarez de Quevedo[1], Marcel Clusa[1], Gloria Fernández[2], Anna Ríos[1], Carles Carreras[1], Marta Pascual[3], Àlex Aguilar[1], and Luís Cardona[1]

[1] Department of Animal Biology, University of Barcelona, Av.a Diagonal 645, 08028 Barcelona, Spain
[2] Fundación Aspro Natura, C/ Garcilaso de la Vega 9, 07181 Costa d'en Blanes, Calvià (Mallorca), Spain
[3] Department of Genetics, University of Barcelona, Av.a Diagonal 645, 08028 Barcelona, Spain

Previous research has demonstrated that young loggerhead sea turtles (*Caretta caretta*) from rookeries in the western Atlantic reach Europe with a length of 20.5 cm. Large numbers of them enter the Mediterranean, where they remain trapped by strong currents till they are 54.5 cm SCL. Because of high levels of fishing bycatch, young loggerhead sea turtles experience a much higher instantaneous mortality rate in the Mediterranean than in the central north Atlantic (0.27 vs. 0.11) and most of them would die before grow large enough to come back to the Atlantic if the growth rate in the Mediterranean was close to that in the Atlantic. However, food availability is thought be much higher in the Mediterranean than in the subtropical Atlantic, which may allow loggerhead sea turtles to grow faster in the Mediterranean and hence come back to the Atlantic earlier than expected. We collected tissue samples from loggerhead sea turtles dead stranded in the Balearic Islands (western Mediterranean) and identified their natal region (Atlantic or Mediterranean) using mtDNA markers and microsatellites. Incremental growth marks revealed by microscopic examination of cross sections of the left humeri of 35 turtles were used to determine the length-at-age function of Atlantic loggerheads inhabiting the foraging grounds of the western Atlantic. That function was used to calculate the time spent in the Mediterranean growing large enough to come back to the Atlantic. As expected, turtles of Atlantic origin inhabiting the western Mediterranean grew much faster than their conspecifics inhabiting the subtropical northern Atlantic and reached the 54.5 cm SCL threshold at an age of 6 years. On the other hand, satellite tracking of 19 turtles Mediterranean revealed an annual mortality rate for oceanic loggerheads in the southwestern Mediterranean consistent with previous estimates (0.27). These results revealed that only 33.96% (95% CI 26.7-41.5) of the turtles entering the Mediterranean as 20.5 cm long juveniles will come back to the Atlantic as 54.5 cm immatures, whereas 64.9% of the members of the same cohort remaining in the Atlantic will be still alive at the same age. In conclusion high fishing mortality has transformed a suitable foraging ground into a demographic sink, although its actual significance for the dynamics of the Atlantic rookeries will depend on the proportion of each cohort entering the Mediterranean.

GREEN TURTLES (*CHELONIA MYDAS*) IN THE BERAU ARCHIPELAGO, INDONESIA: POPULATION ASSESSMENT, NESTING ACTIVITIES, AND PROTECTION STATUS

Thomas Reischig[1], Nono Rachmad Basuki[2], Vany Ahang Moord[2], Hiltrud Cordes[1], and Reisa Latorra[3]

[1] Turtle Foundation Germany, Ammerlander Hauptstrasse 1, D-82541 Muensing, Germany
[2] Yayasan Penyu Berau, Jl. Nusantara. No. 83, RT 36, Kel. Ambun, Kec. Tanjung Redeb, Berau, Indonesia
[3] Turtle Foundation USA, 2615 Jefferson Street, Bellingham, WA 98225, USA

In the Berau or Derawan archipelago of Borneo (East Kalimantan, Indonesia), nine of its 31 islands are important nesting beaches of the green turtle with three islands (Sangalaki, Bilang-Bilangan, and Mataha) contributing about 75% of the total nesting activities (Adnyana *et al*. 2008). Recently it was estimated that about 1800 females nest in Berau every year (Spotila 2004). The population is critically endangered as a result of commercial egg collection in which over several decades nearly 100% of all eggs were harvested. Since 2002 Sangalaki, and since 2008 Bilang-Bilangan and Mataha are fully protected by the Turtle Foundation, which organises a staff of 15 locally hired rangers. During this time, data for various aspects of nesting activities were collected. Each day, numbers of landing females and new nests were determined. Nests that were threatened by inundation were relocated or incubated in a fenced hatchery. To determine hatching success, contents of hatched nests were analysed. Between January 2003 and December 2009, 25571 nests were counted on Sangalaki (Bilang-Bilangan 2008–2009: 9541, Mataha 2008: 2203). The yearly average number of nests was 3653 +/- 681 (mean +/- standard deviation) on Sangalaki, and 4771 +/- 6 on Bilang-Bilangan, which together with the one year of Mataha data results in a yearly average of 10627 nests for all three islands. Nesting took place throughout the entire year with a clear seasonal peak between July and September and a trough between January and March. On Sangalaki, 4.4% of nests were destroyed by monitor lizards, inundation or unknown reasons (in relocated nests and nests in hatchery 0.4% and 0.7%, respectively). The average number of eggs per nest was 91.2 +/- 3.9. Of these eggs about 11.4% +/- 3.8 did not develop, 4.4% +/- 2.5 developed but did not hatch, 0.9 +/- 1.0 hatchlings were dead, and 1.3% +/- 1.7 were deformed, thus yielding an average hatching success of 81.9% +/- 6.6 (n=7446 nests). The respective numbers for relocated nests or nests in hatchery were not significantly different (p*et al*. 2008), a nesting season of 2.9 years (Miller 1997), and 25% of the whole Berau population nesting on other islands). This may rank the Berau archipelago among the 10 most important nesting sites of the green turtle in the world. However, due to the long period of virtually 100% egg collection and the late age (about 25-30 years) at which green turtles reach maturity, we expect a further decline of the population during the next one or two decades, which eventually might change only through continuous and increased protection efforts.

SINGLE NUCLEOTIDE POLYMORPHISMS (SNPS) DETECT GREEN TURTLE POPULATION STRUCTURE THROUGHOUT THE PACIFIC

Suzanne E. Roden[1], Peter H. Dutton[1], Phillip A. Morin[1], George H. Balazs[2], Patricia Zarate[3], and I. Juinn Cheng[4]

[1] NOAA-National Marine Fisheries Service, Southwest Fisheries Science Center, 3333 North Torrey Pines Court, La Jolla, CA 92037 USA
[2] NOAA-National Marine Fisheries Service, Pacific Islands Fisheries Science Center, 2570 Dole Street, Honolulu, Hawaii 96822 USA
[3] Charles Darwin Foundation, Galapagos Islands, Ecuador
[4] National Taiwan Ocean University, Institute of Marine Biology, Keelung, Taiwan, Republic of China

We developed and applied a set of nuclear single nucleotide polymorphisms (SNPs) to detect genetic stock structure among Pacific *C. mydas* nesting populations. Sampled populations included Galapagos n=56, Mexico n=74, Hawaii n=136, Micronesia n=72, and Taiwan n=55, to represent eastern, central, Pacific Island, and western Pacific regions. A combination of single independent loci and linked loci combined as haplotypes were used for a total of 21 independent

markers. Fst values ranged from 0.025 to 0.128 ($p \leq 0.001$) with significant differentiation among all population pairs, including nesting populations from Galapagos and Mexico. This regional differentiation between rookeries in the eastern Pacific based on nuclear data provides new information that suggests that male-mediated gene flow does not occur to the extent that has been previously suggested by limited microsatellite studies. In addition, we discuss the value of SNP markers as an addition to the use of mitochondrial DNA and as an alternative to other nuclear DNA markers such as microsatellites in *C. mydas* population studies.

ESTIMATING DENSITY OF SEA TURTLES AND OVERLAP WITH HUMAN ACTIVITIES IN THE NATIONAL PARK OF LORETO BAY, BCS, MEXICO*

Roberto Rodríguez-Retana[1], Volker Koch[1], and Tomoharu Eguchi[2]

[1] Posgrado en Ciencias Marinas y Costeras (CIMACO). Universidad Autónoma de Baja California Sur, México
[2] Southwest Fisheries Science Center. National Marine Fisheries Service. La Jolla, California. U.S.A.

The National Marine Park of Loreto (NMPL) covers an area of 2,065 km2, including five islands and 785 km of coastline. It is considered very important for marine conservation for its high species diversity. Further, five marine turtle species are present in the Park (in order of abundance): the East Pacific green turtle (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*) and loggerhead turtles (*Caretta caretta*). Little information is available on their density and distribution in the area, and their annual variability. The distribution overlap of sea turtles with human activities such as commercial and sport fishing and tourism activities in the park has not been documented. The main objective of this study was to determine the distribution and abundance of sea turtles in the NMPL through aerial surveys and identify priority areas for conservation. Aerial surveys were conducted every 1-3 months from 2007 to 2010, using a Cessna 170 at an altitude of 500 feet and ground speed of 80 knots. Using GPS and data recording software *CARETTA*.COM, location and the number of turtles and various human activities were recorded. The data were analyzed in a Geographic Information System (GIS) to show the spatial distribution of organisms, human activities and their overlap. The program Distance 5.0 was used to obtain sighting probability functions and turtle density. To improve the precision of parameter estimates, we used observer, visibility, and transect type (coastal or pelagic) as covariates. To account for those turtles that were submerged at the time of sampling, we used dive data from a study in Bahía de Los Angeles to compute the proportion of turtles that were available for sampling. High density areas, or hot spots, were found at Catalana, Coronado and Carmen Islands, while the pelagic transects showed the lowest densities. The majority of turtle sightings were green turtles (85%) in the coastal areas. The areas of greatest overlap between turtle distributions and human activities were located on Catalana and Coronado Island. High density aggregations of sea turtles are threatened by poaching and by-catch in the park, as sea turtle meat is still commonly eaten in the region. Although the use of nets near the shoreline is not permitted, they were observed during our study, elevating the by catch risk for green and hawksbill turtles. The results of this study provide a baseline that will enable the NMPL authorities to improve conservation strategies for the protection of sea turtles in the Park.

TAG RECOVERY AND PHOTOGRAPHIC IDENTIFICATION: TOOLS TO VALIDATE RESIDENCY AND RECAPTURE OF SEA TURTLES IN THE GULF OF VENEZUELA

Nínive Espinoza Rodríguez[1] and Héctor Barrios-Garrido[1,2]

[1] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV) Maracaibo, Venezuela
[2] Laboratorio de Ecología General. Departamento de Biología. Facultad Experimental de Ciencias. Universidad del Zulia. Maracaibo, Venezuela

Recognition of individuals within a population is a key issue for most behavioral and demographic studies of wild animals. Whether through identification by natural markings (spots, injuries, particular characteristics of flippers, scales, etc) or artificial markings (metallic or plastic tags, scales removal, etc) all data generated by these recognitions

in their capture - recapture can be used to answer countless questions of biological and conservation relevance. Although the artificial tagging in Sea Turtle (ST) populations has allowed the development of studies to estimated population size and several parameters in its life history, these methodologies have a number of difficulties, mainly because their execution in long-lived, highly migratory animals. These setbacks have led to the implementation of new methods in order to join efforts to establish management plans required to contribute to the conservation of these species. Thereby, this paper aims to analyze photo-identification and tag recovery as an effective set for the validation of individual residents and recaptures of ST in the Gulf of Venezuela (GV). To this end, the Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV, by its Spanish acronym) has carried out the tagging program on captured or stranded ST since 2000, most recently, between 2009 to 2010 has incorporated the photographic recognition of individuals as a new methodology for certification, firstly, of those individuals who could not be tagged or those with total tag loss. A total of 5 turtles were identified by tag evidence, of which 3 were killed by local fishermen for consumption. Other 3 turtles were positively identified through photo-identification and a "potential recapture" was roundly rejected. Despite the high number of captures (114 sea turtles between 2009 - 2010) and low sample size of recaptures (N = 7), turtles identified, belonging to juveniles stages, showed a residence from 2 to 10 months to this feeding ground. The recruitment and settlement of juveniles in feeding areas as the GV, has been established by the tagging program and photo-identification assemble, allowing the acquisition of new data that can be applied in population monitoring, behavior, ecology and other long-term studies to encourage and increase public awareness about these endangered species, and also, promoting the protection of this area considered and recognized as one of the main feeding ground for ST in Venezuela.

NESTING AND IN-WATER POPULATION SURVEYS FOR THREE SPECIES OF MARINE TURTLES IN MARTINIQUE AND GUADELOUPE, FRENCH WEST INDIES

Le Scao Rozenn[1], Cyrille Barnerias[2], and Eric Delcroix[1]

[1] Office National de la Chasse et de la Faune Sauvage (ONCFS)
[2] Direction de l'Environnement et de l'Aménagement et du Logement (DEAL)

Martinique's Marine Turtles Conservation Network was created in 2003 and was operated by local NGO SEPANMAR. In Guadeloupe, the marine turtle network was created in 1999 and was managed by different local NGOs AEVA (1999-2003) KapNatirel (2004-2008). In 2006 and 2009, respectively for Martinique and Guadeloupe, the Ministry of Environment DEAL, delegated management of both networks to the National Wildlife Hunting Agency (ONCFS). The sea turtle recovery plan for the French Antilles was adapated in 2008 for both Martinique and Guadeloupe. These three plans set conservation priorities for five species of marine turtles: the leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*), loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*). Martinique and Guadeloupe are part of the French overseas territories, as such, all marine turtles and their habitats are protected under ministerial decrees. Three main actions are in place in the French Antilles to monitor nesting and in-water marine turtles populations. 1- Nesting surveys: A saturation tagging programme of nesting population begun in 2000 for Guadeloupe and 2003 in Martinique. Selected sites were surveyed at the pic of nesting season for periods of fifteen consecutive days. In 2008, a new protocol developped by Prof. Girondot, from Orsay University, France, was implemented in both Guadeloupe and Martinique. Additional information are being collected such as biometric data and genetic samples. 2 - In-water programme - Martinique: In 2010, an in-water programme was initiated in collaboration with the Barbados Sea Turtles Project (BSTP). green and hawksbill turtles are captured while free-diving, biometric data, genetic samples are collected, turtles are tagged using iconel tags. 3 - Genetic surveys: Tissue samples are collected from : nesting females, turtles captured during in-water surveys and turtle beaching. A set of hawksbills genetic samples are currently being analysed by the team of Prof. J. Horroks at the University of Barbados laboratory and leatherback tissue samples are in the process of being analysed by Dr. De Thoisy's team from the laboratory of Institut Pasteur, French Guyana. These analysises could result in futur joint publications for the French Antilles. Special thanks to DEAL French Ministry of Environment, FEDER European Regional Development Funds, ONCFS National Wildlife and Hunting Agency. In-water project BSTP: Barbados Sea turtles Project. Data collection − Martinique: AMEPAS, Eco-civisme, Kawan, Reflet D'Culture, SEPANMAR, SEVE, Parc Naturel Régional de la Martinique − Guadeloupe: Le Gaîac, Kap'Natirel, AEVA, Eco-Lambda, Réserve Naturelle de St Martin et de St Barthélemy, Ti-Té, Parc National de Guadeloupe et Evasion Tropicale. − Local volunteers − Office National des Forets − Service Mixte de Police et de l'Environnement (SMPE-ONCFS/ONEMA).

CHARACTERIZATION OF MARINE TURTLE AGGREGATIONS IN THE CHARLOTTE HARBOR ESTUARY, FLORIDA

Jeffrey R. Schmid[1] and Anton D. Tucker[2]

[1] Conservancy of Southwest Florida, Naples, Florida, USA
[2] Mote Marine Laboratory, Sarasota, Florida, USA

A number of long-term tagging studies have been conducted to characterize aggregations of marine turtles in certain nearshore areas of western Florida; however, information gaps still exist along the extensive west coast. Mote Marine Laboratory collected extensive sighting data (250+ turtles) and conducted field surveys to study the in-water ecology of marine turtles in the Charlotte Harbor National Estuary. These surveys have documented habitat partitioning among the species and identified certain areas in Pine Island Sound as foraging habitat for Kemp's ridley turtles, but efforts have been hampered by the after effects of hurricanes and the ineffectiveness of set nets in capturing turtles. The purpose of the current study is to continue earlier efforts using an active fishing method (i.e., strike netting) to characterize the aggregation of marine turtles inhabiting the waters of eastern Pine Island Sound. Seven week-long sampling trips have been conducted since August 2009. Locational data were collected for a total of 98 marine turtles: 67 Kemp's ridley (39 sightings and 28 captures), 25 loggerhead (23 sightings and 2 captures), and 6 green turtles (5 sightings and 1 capture). Kemp's ridleys, the target species of the study, had the highest relative abundance and the aggregation was composed of immature turtles. Loggerheads have the second highest abundance and this aggregation appeared to be dominated by adult-size turtles. Green turtles were the least abundant, perhaps due to their more cryptic behavior (i.e., short surface time), and were comprised of immature turtles. Captured turtles were measured, flipper and PIT tagged, and biopsy samples were collected for stable isotope analysis. Kemp's ridleys were held overnight at a shoreside facility for fecal sample collection and cursory examination of the samples to date indicated they all contain spider crab (Libinia spp.) with only a few that included purse crab (Persephona mediterranea). Sponges and tunicates have been observed at capture locations, suggesting turtles are using areas of live bottom habitat.

INTRODUCING THE SWFSC MARINE TURTLE MOLECULAR RESEARCH SAMPLE COLLECTION

Gabriela N. Serra-Valente, Kelly M. Robertson, Robin A. LeRoux, Erin L. LaCasella, Peter H. Dutton, Jeffrey A. Seminoff, and Nicole E. Beaulieu

National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California, USA

The National Marine Fisheries Service's Southwest Fisheries Science Center (SWFSC) in La Jolla, California, houses one of the largest and richest marine turtle sample collections in the world: The Marine Turtle Molecular Research Sample Collection (Collection). The Collection consists of over 94,000 samples of tissue and DNA from all seven existing marine turtle species, collected worldwide over the past century. Samples originate from nesting sites, foraging areas, fisheries by-catch, and strandings, and have accumulated over the years from ongoing or completed genetic and other molecular studies conducted by NMFS, NGOs and several Academic collaborators. Upon arrival at the SWFSC they undergo a meticulous inventory, accessioning, and tracking process that allows for their secured long-term storage and use in current projects. The samples have been used in a variety of studies that address the biology and conservation of sea turtles, including evolution, phylogeography, stock structure, the origin of fisheries by-catch, strandings, and foraging area animals, gaining insights to trophic information, contaminant and health assessments, molecular marker development, paternity studies, and species identification. The Collection is designated as the national repository for marine turtle samples collected by NMFS and also serves the national and international communities by providing a long-term and secure facility to store scientifically valuable samples. With continued sample contributions, we will have the capacity to gain future insight into topics such as the effects of global warming, long-term population health, and changes in population distributions over time. Here we present details about the Collection, including specimen distribution, sample types, and sample management.

GENETIC MARK-RECAPTURE OF THE FEMALE LOGGERHEAD POPULATION NESTING IN GEORGIA, 2008-2009: ABUNDANCE, NEST SITE FIDELITY AND RELATEDNESS*

Brian M. Shamblin[1], Mark G. Dodd[2], Kristina L. Williams[3], Michael G. Frick[3], Terry M. Norton[4], Stephanie Ouellette[4], Rebecca Bell[5], Douglas M. Hoffman[6], Debra Barnard-Keinath[7], Gale G. Bishop[8], Scott Coleman[9], Stacia Hendricks[10], Tammy Smith[11], and Campbell J. Nairn[1]

[1] Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia, USA
[2] Georgia Department of Natural Resources, Brunswick, Georgia, USA
[3] Caretta Research Project, Savannah, Georgia, USA
[4] Georgia Sea Turtle Center, Jekyll Island, Georgia, USA
[5] Little Cumberland Turtle Project, Jekyll Island, Georgia, USA
[6] Cumberland Island National Seashore, St. Marys, Georgia, USA
[7] Blackbeard National Wildlife Refuge, Townsend, Georgia, USA
[8] St. Catherines Island Sea Turtle Program, Fayette, Iowa, USA
[9] Little St. Simons Island, Georgia, USA
[10] Sea Island Company, Sea Island, Georgia, USA
[11] Tybee Island Sea Turtle Project, Tybee Island, Georgia, USA

Most clutch frequency and remigration interval estimates for marine turtle rookeries have been generated by flipper-tagging studies. Estimates of these reproductive parameters are potentially biased by the small scale of tagging efforts relative to the nest site fidelity of females and the logistical difficulty of intercepting all females on a particular study beach. Telemetry technologies have recently proven useful in overcoming these obstacles; however their application on the earliest arriving nesting females may lead to biased sampling of the nesting population at large, and their expense often limits sample sizes. Therefore alternative and supplemental means of individual identification are required. We conducted a pilot study during the 2006 nesting season to assess the feasibility of producing unique maternal microsatellite fingerprints from unincubated egg shells. We compared multi-locus genotypes (14 markers) from skin biopsies taken from females nesting on Wassaw and Little Cumberland islands to genotypes from 59 egg shells taken within 15 hours of oviposition. High amplification success (> 90%) combined with modest genotyping error given low DNA quantities (mean 2.4%) demonstrated the utility of the egg sampling technique for assigning nests to known, tagged turtles and matching multiple nests of unknown turtles. During the 2008 and 2009 nesting season, a single unincubated egg was collected from all nests on regularly monitored beaches along the Georgia coast including Tybee, Little Tybee, Wassaw, Ossabaw, St. Catherines, Blackbeard, Sapelo, Little St. Simons, Sea Island, St. Simons, Jekyll, Little Cumberland, and Cumberland. Sampling effort of recorded nests (including "wild" nests) was 98.2% in 2008 (1618 of 1648) and 99.5% in 2009 (994 of 997). Samples collected since 2009 have been genotyped at 17 loci with a combined non-exclusion probability of identity of 6.99 X 10-31. Samples matching perfectly across at least eight loci and containing single allele mismatches at no more than two loci were considered as originating from the same female. Using these criteria, approximately 93% of 2008-sampled clutches and 95% of 2009-sampled clutches have been successfully assigned to nesting females. Genotyping revealed a total of 465 unique nesting females in 2008 and 328 females in 2009. Nest site fidelity varied from one female laying seven clutches on less than 2 km of beach to a few turtles nesting on both Cumberland and Wassaw Island, approximately 125 km apart. The predominant pattern was fairly high nest site fidelity with clutches laid on one island or on adjacent islands. Several potential mother-daughter pairs and sister pairs have been identified, although these require genotyping at additional loci to bolster confidence in the relationship assignments. Some of these presumed relative pairs nested on the same beach. Others nested several 10s of km apart. To better characterize connectivity among widely scattered rookeries and evaluate clutch frequency, the project was expanded to include all monitored beaches in South Carolina, North Carolina, and Virginia in addition to Georgia during the 2010 nesting season- effectively encompassing the Northern Recovery Unit.

SEA TURTLE HYBRIDIZATION IN BRAZIL: WHAT DO WE KNOW?

Luciano S. Soares[1], Alan Bolten[1], Maria Â. Marcovaldi[2], Sibele T. Vilaça[3], Sarah M. Vargas[4], Fabrício R. Santos[4], and Karen Bjorndal[1]

[1] Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, Gainesville, Florida
[2] Projeto TAMAR-ICMBio, Fundaçao Pró-TAMAR, Salvador, BA, Brazil
[3] Department of Biology and Evolution, University of Ferrara, Via L. Borsari 46, 44100 Ferrara, Italy.
[4] Laboratório de Biodiversidade e Evolução Molecular (LBEM), Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, MG Brazil

The Brazilian hawksbill, Eretmochleys *imbricata*, nesting population is the largest known population in the South Atlantic. It is endangered and under pressure, especially from coastal development. Its distinctiveness has been revealed by genetic analyses, making it a priority for conservation. The loggerhead turtle, *Caretta caretta*, is also considered endangered and faces the same conservation challenges in its nesting areas. Brazil supports the largest loggerhead colony in Latin America, and it is also genetically unique. In the main hawksbill and loggerhead nesting areas, in the state of Bahia, a hybridization and introgression process between these two species has been monitored for the past few years. The unusually high (more than 40%) proportion of hybrids in this population is apparently unique and may represent a serious conservation concern for both parental species. Projeto TAMAR (The Brazilian Sea Turtle Research and Conservation Program) has conducted standardized field monitoring for the past 30 years. They have had great success, as indicated by the increasing trend in the populations of these two species. TAMAR has also conducted experiments to understand sea turtle migratory behaviour. Satellite transmitters were attached to 15 turtles: 6 hybrids and 9 "pure" hawksbills. Tagged hybrids presented a distinct migratory behaviour from "pure" individuals, suggesting a genetic component in migratory patterns and the need for different conservation and management measures (Marcovaldi *et al*, 2009). By using TAMAR`s database, and collecting new information (in collaboration with TAMAR), we intend to study the biology of the hybrids and to evaluate potential depensation in these populations. What happens when a population gets to a very low level? Is hybridization more common because of lack of suitable mates? What are the patterns in reproductive output (remigration interval, clutch size, hatching success, clutch frequency), and female and hatchling body sizes between hybrids and parental species? In addition, we will evaluate movements from more satellite telemetry, foraging ecology from stable isotopes, and deeper genetic relationships for comparisons between the parental species and their hybrids. The expected results should give us important information to better understand hybridization patterns and implement appropriate conservation and management measures.

CONTRIBUTION TO THE CONSERVATION AND PROTECTION OF THE MARINE TURTLE IN PLAYA CEUTA SINALOA MEXICO 1991-2009

Ingmar Sosa-Cornejo[1], Fernando Enciso-Saracho[2], Marcos Bucio-Pacheco[1], Jesus I. Guardado-Gonzalez[3], Dulce I. Montaño-Valdez[1], Jorge Rodriguez-López[2], Joana Nicolau[4], Reyna Lopez-Mendoza[1], Alvaro de los Huertos y los Ríos[5], and Hipólito Castillo-Ureta[1]

[1] Escuela de Biología de la Universidad Autónoma de Sinaloa, México
[2] Facultad de Ciencias del Mar de la Universidad Autónoma de Sinaloa, México
[3] H. Ayuntamiento de la Cruz de Elota, Sinaloa, México
[4] Escola Superior de Tecnologia do Mar, Portugal
[5] Museo del Mar Ceuta España

Human activities related with marine turtles in nesting beaches cause mortalities, in all stages of their development (females nesting, eggs, turtle hatchlings, youthful and adult). They are vulnerable to diverse potentially lethal interactions; these include direct predation and modification of the habitat. Sea turtles programs exist to implement and support investigations that promote the restoration and survival of sea turtle populations, furthermore involving the

local communities in the handling of the conservation. The Universidad Autonoma de Sinaloa from 1976, has like main objective helping to the conservation and investigation of the sea turtles; simultaneously support educational activity and all related academic practices (thesis projects and investigation focused on conservation of the coastal resources), having one of their beach campings in Ceuta Municipality of Elota, Sinaloa, Mexico. In this beach with 37 km in length during the months of June to January, were established nocturnal routes to collect nests and data field about these marine organisms. From 1991 to 2009, effort as come making in the conservation and it is the same one, being 2007 the greater record than 2009 in number of nests, and exists a tendency increase. The percentage of the hatching average in the 5 seasons of study was 72.4%.

CONSERVATION STATUS OF SEA TURTLES AT THE PALMYRA ATOLL NATIONAL WILDLIFE REFUGE, CENTRAL PACIFIC*

Eleanor J. Sterling[1], Katherine McFadden[1], Eugenia Naro-Maciel[2], Erin Vintinner[1], Andrés Gómez[1], and Felicity Arengo[1]

[1] Center for Biodiversity and Conservation, American Museum of Natural History, New York, NY, USA
[2] Biology Department, College of Staten Island, City University of New York, New York, NY, USA

The demographic characteristics, distribution, and population status of globally endangered sea turtles at the remote Palmyra Atoll National Wildlife Refuge (PANWR) in the Central Pacific is poorly known. As part of a research and conservation program to inform a sea turtle management plan for the Refuge, we studied sea turtle distribution, abundance, health, and threats at the PANWR from 2005-2010. Our research shows that the PANWR constitutes a regionally important mixed stage-class foraging ground for green turtles (*Chelonia mydas*). We note the presence of hawksbill turtles (*Eretmochelys imbricata*) but limited sightings preclude conclusions about age/stage-classes. From 2008 – 2010, we captured one juvenile hawksbill (weight = 16.3 kg; Curved Carapace Length (CCL) = 57 cm) and 137 green turtles (including four individuals recaptured) ranging from small post-pelagic juveniles to large adults of likely breeding age (weight: mean = 67.5 kg, range = 7.2 - 233.0 kg; CCL: mean = 71.9; range = 41.0-113.6 cm). Three green turtles captured in 2009 showed phenotypic variation, specifically a noticeable peduncle and darker carapace coloration, consistent with turtles of Eastern Pacific origin. No turtles had either flipper or PIT tags other than the recaptures. Turtles were generally healthy and Body Condition Indices (CI) did not significantly differ between site or year of capture. CI values for turtles at Palmyra are within the range of CI values reported for green turtles in other studies in both the Caribbean and Pacific Oceans. Turtles showed no evidence of tumors or heavy epibiont load, though they showed a variety of healed injuries including carapace damage (N=7) and severely damaged or missing flippers (N=7). Standardized turtle relative abundance surveys were conducted at least once a year from 2005-2010 and indicate that the PANWR supports a wide range of stage classes. The primary threats to the conservation of sea turtles at the Refuge include alteration in marine ecosystem structure due to climate change, predation by the atoll's sizeable population of sharks, and potential exposure to toxins associated with past military occupation of the atoll.

SURVIVAL OF IMMATURE LOGGERHEAD TURTLES (*CARETTA CARETTA*) IN THE INDIAN RIVER LAGOON, FL, USA

Andrew T. Sterner and Llewellyn M. Ehrhart

Department of Biology, University of Central Florida, Orlando, FL, USA 32816

Concerns over the status of loggerhead sea turtle populations in the United States have been raised due to a dramatic decline in nest production between 1998 and 2004. The decrease in nesting females has led to renewed interest in data gaps involving other stages in the loggerhead lifecycle. Survivorship of immature turtles is one of the vital rates called for by the 2008 Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle. Very few reliable values currently exist in the literature for immature loggerheads and none based on mark-recapture analysis are available for populations located in the state of Florida. Reliable survivorship values for all life stages are necessary for population viability analysis. For this study, immature loggerhead turtles (*Caretta caretta*) captured in the central

Indian River Lagoon, FL, USA by the University of Central Florida Marine Turtle Research Group will be subjected to a mark-recapture analysis using Program Mark. The objective of the mark-recapture analysis is to provide an estimate of annual survival for the sub-adult loggerheads living in a shallow water embayment along central Florida's Atlantic coast. Barker's model will be used to elucidate patterns in survival and movement through the use of competing model sets. Turtles for this study were captured between 2000 and 2009. During this time frame, 335 loggerhead captures were recorded, including 265 distinct individuals. Uniquely identifiable turtles were observed between 1 and 5 times during the duration of the study. Individual turtles ranged from 45.6 to 100 cm straight carapace length. Individuals greater than 81cm were suspected of being adults and were excluded from the analysis as they are not resident in the area and few if any recaptures are available. Input for the models includes recaptures, live-resightings and dead recoveries. Captures are broken down into two categories: those that occurred during the primary capture period (May-August) and those that were seen during the remaining eight months of the year. Individuals captured outside the primary sampling period, as well as data from turtles observed alive between September and April, are included in the models as incidental captures. All available information on dead recoveries is also included in the models. The results of this analysis provide valuable information that can be used for future population viability analysis.

NESTING BEACH ORIGINS OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) FORAGING IN CRITICAL HABITAT OFF NOVA SCOTIA, CANADA*

Kelly R. Stewart[1], Peter H. Dutton[1], and Michael C. James[2]

[1] Southwest Fisheries Science Center, La Jolla, CA, USA
[2] Department of Biology, Dalhousie University, Halifax, Nova Scotia, B3H 4J1 Canada

It is now well established that leatherback turtles nesting in the Western Atlantic migrate north to forage in the cold waters of New England and Eastern Canada. The waters off Nova Scotia provide critical foraging habitat for the species. When leatherbacks are caught incidentally or are found stranded dead along shorelines here, it isn't possible to identify the turtles or to determine their nesting beach origin based on external characteristics. While some turtles that are caught or stranded do carry flipper tags or PIT tags, most remain unidentified. The purpose of this study was to use genetic fingerprinting techniques to assign turtles captured in Nova Scotia to their nesting beach origins. Foraging leatherback turtles were live-captured off the coast of Nova Scotia as part of a long-term study looking at habitat use and migration patterns. Once turtles were on board, standard morphometrics were taken (curved carapace length CCL, curved carapace width CCW, etc.) and either a small skin sample was taken using a 6-mm biopsy punch or 10 cc of blood was drawn for genetic studies. Using standard protocols, DNA was extracted and microsatellite markers were used to genotype (fingerprint) all turtles. We compared results from 3 different assignment testing programs: ONCOR, STRUCTURE and GENECLASS. Our reference dataset of nesting populations included 1,720 turtles from 7 distinct rookeries in the Atlantic. We also had a supplementary dataset for some of the turtles captured off Nova Scotia that were traced to nesting beaches using flipper tags, PIT tags, or satellite tags, enabling ground-truthing of assignment testing program results. From 2001-2009, 222 turtles were sampled (130 females, 62 males, 30 unknown sex). We first assigned turtles using only the genetic information, and then used the supplementary information (tag returns, satellite tracks, etc.) to correct the assignments. GENECLASS and STRUCTURE performed best at assigning turtles to nesting beaches. The assignments reflected relative population sizes with Trinidad/ French Guiana having the highest number of turtles assigned (145), followed by Costa Rica (42), Florida (19), and St. Croix (16). No turtles were assigned to 3 other Atlantic rookeries (Brazil, West Africa, South Africa). Although Atlantic Costa Rica, St. Croix and Florida have been shown to be genetically distinct, they are more closely related to each other than they are to the Trinidad/ French Guiana nesting assemblage. Many turtles that assigned to one of these 3 nesting rookeries were assigned at <90% probability, reflecting the close relationships between these 3 nesting areas. However, once tag returns and satellite tracks were taken into consideration, these assignments resolved nicely. Here we demonstrate the usefulness of genetic analysis for determining nesting beach origins for leatherbacks as well as highlighting the importance of tagging programs on foraging grounds and on nesting beaches. Tag returns allowed us to adjust nesting beach origins for 61 of the 222 turtles, when genetic results were ambiguous. This method shows promise for examining stock-specific effects of fisheries on global turtle populations, and identifying where coordinated, international recovery efforts may be most relevant and effective.

MARYLAND, USA: A 20 YEAR SUMMARY OF DEAD SEA TURTLE STRANDINGS

Jamie C. Testa, Cindy P. Driscoll, Brenda J. Kibler, and Tricia L. Kimmel

Maryland Department of Natural Resources, Oxford, Maryland, USA

The Maryland Department of Natural Resources (MD DNR) formed the Sea Turtle & Marine Mammal Stranding Program in 1990. MD DNR is responsible for all dead stranded sea turtles in Maryland waters. The National Aquarium (NA) is responsible for all live stranded sea turtles in Maryland waters. Maryland waters include the Maryland portion of the Chesapeake Bay and Atlantic Ocean coastline. This poster summarizes nearly 20 consecutive years of dead sea turtles standings in Maryland. Data examines size, condition, evidence & occurrence of human interactions, and cause of death trends. The majority of stranded sea turtles are found along the Atlantic Ocean coast (64%). A total of 477 sea turtles have stranded in Maryland waters and four species of sea turtles have been documented: loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and Kemp's ridley (*Lepidochelys kempii*). The most commonly stranded of these is ***C.*** *caretta* (n=392). Eighty-six percent of all dead stranded sea turtles are found to be moderately or severely decomposed. Stimulus for summary is twofold 1) the 20th anniversary of the program's inception and 2) need for data based evaluation of dead stranded animals to compare with upcoming live sea turtle surveys scheduled to begin in Spring of 2011. Little is published about Maryland sea turtles yet there is a need to provide information when conservation measures are being developed. A thorough analysis of dead strandings, in combination with live survey data, will help evaluate the status of sea turtles in mid-Atlantic waters. Representative stranding events and interesting cases are also highlighted.

REPRODUCTIVE OUTPUT OF LOGGERHEAD FEMALES (*CARETTA CARETTA*) IN SOUTH AFRICA*

Jenny Tucek and Ronel Nel

Nelson Mandela Metropolitan University, Port Elizabeth, Eastern Cape, South Africa

The South African research and conservation program started in 1963 and is thus one of the oldest sea turtle programs in the world. During each nesting season, an area of 56 km is regularly monitored, and nesting females have been marked and measured since the beginning of the program. The mean size of nesting female turtles was calculated for each season clearly showing that nesting females decreased (920 mm to 842 mm) in straight carapace length (SCL) over the past four decades. This decrease in growth is possibly due to the fact that more neophytes are nesting and that the program is successful, or that environmental factors that influence growth, such as water temperature and food supply, have changed over the past decades. It is feared that the South African population might be suffering from this size decrease as females may lay less or smaller eggs. Thus the reproductive output of females in relation to SCL measurements was investigated over one nesting season (2009/10). Significant relationships were found between SCL and clutch size (n = 79) and mean egg volume (n = 87). No significant relationships were found between SCL and mean hatchling size (n = 12) or emergence success (n = 32). There was also no significant relationship recorded between mean egg volume and hatchling size (n=10). A comparison between the reproductive output of neophyte and experienced nesting females did not show a significant difference either. Further research and a larger sample size are required in order to make any conclusions. Therefore data from an additional sample season (November 2009 – March 2010) will be included. In addition, possible changes of environmental factors which influence sea turtle growth over the past four decades will be investigated.

LEATHERBACK, *DERMOCHELYS CORIACEA*, NESTING BEACH CONSERVATION IN THE PACIFIC COAST OF NICARAGUA (2002-2010)

José Urteaga[1], Perla Torres[1], Ofelia Gaitan[2], Guillermo Rodríguez[2], and Pedrarias Dávila[3]

[1] Fauna & Flora International, Reparto San Juan, Del Portón Trasero (Oeste) de la UCA 1/2 c. abajo Casa Nº578, Managua, Nicaragua
[2] Reserva Silvestre Privada Quelantaro, Municipio de Villa El Carmen, Departamento de Managua, Nicaragua
[3] Universidad Nacional Autónoma de Nicaragua-León, Facultad de Ciencia y Tecnología, De la Iglesia de la Merced Costado Norte, departamento de León, Nicaragua

Nicaragua encompasses the third leatherback, *Dermochelys coriacea*, nesting concentration in the Eastern Pacific after Mexico and Costa Rica. Based on aerial census, Barragan and collaborators (2006) estimated in 488 the number of nests of this species on the 2005-2006 season. Due to the dramatic collapse that the Eastern Pacific Leatherback population has faced since early 1980 decade, in 2002 we started conservation efforts in three of the most important nesting beaches of the Pacific coast of Nicaragua. In all these beaches eggs poaching pressures was almost taking 100% nest until project started. Nesting beach protection and monitoring were conducted Veracruz beach (N 11° 33' 20", W 86° 13' 04.5") since 2002, Juan Venado (N 12° 18' 54", W 86° 57' 26") since 2004, and Salamina (N 11° 59' 49.8", W 86° 40' 26") since 2008. An average of ten community team members (most are ex-poachers) worked each season on three beaches. The teams worked under the supervision of a biologist; they were trained on protocols designed for beach monitoring and hatchery operation. In Salamina and Veracruz a reward program was promoted in order to facilitate collaboration of poachers with the project. On this period up to 420 leatherback nests were recorded, protecting 94% and documenting the emergence of at least 4,361 hatchlings. A total of 48 individual females have been indentified using Microship PIT tags and Inconel flipper tags. 15 females have nested in two or more seasons showing nesting beach fidelity. Until present no sign of recovery has been observed and during the last three seasons the number of nest has been lower compared to the four previous one. Leatherbacks reach sexual at long age. Recent skeletochronological analysis (Avens *et al*., 2009) that describes the growth and age of leatherbacks, indicated these turtles reach sexual maturity at the age of approximated 30 years. In this scenario we can anticipate a long term process of recovery for the Nicaraguan rockeries. In which efforts to conserve both sea turtle individual and habitat should be promoted, therefore we recommend: 1) Sustain leatherback conservation projects at three nesting beaches; 2) promote coastal habitat conservation near each Leatherback nesting beach; 3) strengthen local environmental education programs and national awareness campaign.

IDENTIFYING CRITICAL HABITAT FOR THE EAST PACIFIC GREEN TURTLE IN PERU: THE CASE OF EL ÑURO*

Ximena Velez-Zuazo[1,2], Shaleyla Kelez[1,3], Luciana Klinge[1], Sebastian Silva[4], and Nadia Balducci[1,5]

[1] ecOceanica, Lima, Peru
[2] University of Puerto Rico, San Juan, PR
[3] Duke University Marine Laboratory, North Carolina, US
[4] Pacifico Adventures, Organos, Peru
[5] Universidad Nacional Agraria La Molina, Lima, Peru

The marine habitats of Peru host large aggregations of sea turtles that are migrating from different places throughout the Pacific Ocean. Records of the five sea turtle species that occur in Peru are mainly the result of observations of stranded animals, abandoned carapaces and turtles that are incidentally captured during fisheries activities. This suggests that although sea turtles are relatively common in Peru, we lack basic information about their biology and ecology on the foraging grounds. Therefore, information that can be gathered from the turtles when they are in foraging areas is essential for defining high concentration zones, short-term movements and life history parameters. This

information is not only important for understanding the ecology of the species but also important for identifying and reducing threats (e.g., bycatch, direct capture), as well as proposing conservation measures and developing effective recovery plans. The coastal habitat of El Ñuro (4.2130 S, 81.1713 W), in northern Peru, has an unusually high density of green sea turtles (*Chelonia mydas*), which is concentrated around the fishing pier. We conducted in-water surveys at the pier to investigate the abundance of individuals, to examine the structure of the aggregation and to take samples to identify the natal origin of each individual. During four days in the austral winter of 2010, we captured 30 green turtles (29 new captures and 1 recapture) using an entanglement net. The capture per unit of effort (CPUE) was 2.3 turtles per hour for a total of 13.03 hours of netting effort. Turtle sizes ranged from 50.4 to 81.5 cm CCL n-t (mean ± SD: 69.6 ± 7.21 cm). Based on size information from the Galapagos green turtle nesting population and from oceanic turtles incidentally caught by Peruvian longliners, it appears that the turtle aggregation in El Ñuro is composed mainly of sub-adults that have recruited to neritic foraging areas. This would mean that El Ñuro is an important developmental habitat for the East Pacific green turtle. Our results highlight the importance of El Ñuro as a foraging site for green turtles in the Eastern Pacific and draw attention to the need to conserve the area and maintain the quality of the habitat. Further surveys will provide additional information on population ecology, growth rates and foraging habits of this aggregation. These critical pieces of information will enhance conservation plans for this endangered species.

Threats

EXPERIMENTAL STUDY ABOUT THE IMPACT OF ARTIFICIAL LIGHTING ON LOGGERHEAD FEMALE NESTING IN CAPE VERDE

Mara Abu-Raya[1], Eder Cruz[1], Adolfo Marco[2], and Luis Felipe López-Jurado[3]

[1] University of Cape Verde, São Vicente, Cape Verde
[2] Estación Biológica de Doñana, CSIC Sevilla, Spain
[3] Universidad de Las Palmas de Gran Canaria. Spain

Artificial illumination of nesting beaches is one of the main threats to endangered sea turtle populations. Nocturnal lighting can impair female nest site selection and nesting success, as well as behavior and hatchling survival in their way from the nest surface to the seashore. The island of Boavista (Cape Verde) hosts the third largest loggerhead nesting aggregation in the world and the only relevant population in the Eastern Atlantic coast. Several threats such as fishing by-catch and female slaughter during nesting are severely threatening its conservation. Tourism development in the emerging archipelago of Cape Verde is the basis of economic developments and social development (mainly on the islands of Sal, Boavista and Maio) but could have negative impacts on nesting population of *Caretta caretta* due to increased lighting of hotels, streets and vehicles in coastal areas. So it is important to devise a strategy for sustainable development, assessing the impact of artificial lighting on nesting beaches of *C. caretta* in Cape Verde. Currently the few beaches of Boa Vista that hosts villages or touristic resorts that cause nocturnal pollution almost have no significant turtle nesting activity. More than 99% of loggerhead nesting on the island occurs on beaches without sources of light during the night. However, the lack of long-term data about loggerhead nesting does not permit to establish a cause-effect relationship among nocturnal lighting and low nesting activity on urbanized beaches. The present study was conducted on the island of Boavista, in order to evaluate the impact of artificial light on the loggerhead nesting. We tried to identify types of environment friendly lighting that have low impact on turtle nesting, and thus could contribute to the development of tourism compatible with conservation of sea turtles. The study was conducted on undisturbed nesting beaches without any type of artificial light in the southeast of the island during the month of September 2010. A small source of artificial light directed to the sea was installed on the center of every beach. We alternated nights with white, red (red filter covering the white light) and no light and studied loggerhead nest site selection, nesting behavior and success as a function of the type of artificial light. During the 28 nights of study, the mean daily number of nests on nights with white light (0.55 nests) was less than half of the men daily nests laid during nights with red lights or darkness (1.28 nests). Due to the high variability on the daily number of nests, these differences were not statistically significant. Without light or with red light the nests were randomly scattered along the beaches. However, during nights with white light the nests were concentrated on the extremes of the beaches, far from the light source. The mean distance between the nest and the light source significantly varied among light treatments ($P<0.01$). Females clearly avoided white lights and red lights significantly reduced female avoidance behavior.

MALAYSIAN GREEN TURTLE EGGS: A SHOCKING DISCOVERY ON TOXIC HEAVY METALS AND SATURATED FATTY ACIDS COMPOSITION

Siti Norazliyana Ali and Juanita Joseph

Sea Turtle Research Unit, Institute of Oceanography, University of Malaysia Terengganu, Kuala Terengganu, Terengganu, Malaysia

Sea turtle eggs have been exploited since time immemorial. In Malaysia, sea turtles eggs are considered as an aphrodisiac by the local people, although there is no scientific proof for these claims. Sadly, these eggs are still sold commercially in Malaysia, even though there is a clear decline in all nesting populations. Worst, there is still no legislation enacted in Peninsular Malaysia to ban the commercial sales of green and hawksbill turtle eggs. Currently only Sabah and Sarawak prohibited the selling of sea turtle eggs. Undoubtedly, it has been proven that eating turtle eggs may be hazardous to human health due to the presence of bacteria, parasites, biotoxins and environmental contaminants. This present study was conducted as the first attempt to assess the concentration of heavy metals (Mn, Cu, Zn, Cd, Pb) in green turtle eggs (fresh and un-hatched/rotten eggs) taken from nesting beaches in Terengganu. Statistical analyses (ANOVA – multivariate) shows that there was no significance difference ($P > 0.05$) between concentration of heavy metals in yolk of rotten eggs and yolk of fresh eggs. Toxic elements such as Lead, Pb (9.46 µg g -1) and Cadmium, Cd (0.61 µg g -1) were detected. The concentration of Pb exceeds the permissible limits of Malaysian Food Regulation (1985) (2.0 µg g -1). The concentration of Pb in this study was higher than those reported in previous studies. The significant differences in the contaminants found in the tissue or eggs of sea turtles can be attributed to chemical pollutants present in both their feeding range and breeding sites. Excessive Pb can cause physiological, neurological and biochemical effects on humans. Even though, Cd concentration was below the permissible limits, excessive consumption can accumulate the toxic contaminant in humans' body. Cd can caused miscarriages and variety of cancers. Zn was detected as the highest concentration and represent as the essential element for the embryonic development of eggs. A total of 38 fatty acid compositions detected in Malaysian green turtle eggs. Non-essential fatty acid such as saturated fatty acid (SAFA) was found to be higher in green turtle eggs (51.82%) compared with chicken eggs (32.4%). SAFA have the ability to raise cholesterol in blood levels, and cause coronary heart disease. However, essential fatty acids such as polyunsaturated fatty acids (ω3 and ω6) were found lower in green turtle eggs hence contained less nutritional values for human essential diet. The presence of toxic metals (Cd and Pb) and saturated fatty acids (SAFA) confirmed that excessive consumption of sea turtle eggs may cause an adverse effect to human health. It is hope that the finding can improve public awareness and indirectly enhance sea turtle conservation in Malaysia. Apart from that, this study also developed a non-killing method of heavy metal monitoring using eggs that failed to hatch and it is more appropriate to be used on endangered species such as the sea turtles.

THE KEMP'S RIDLEY SEA TURTLE: FROM IXTOC TO DEEPWATER OCEAN HORIZON

Carole H. Allen

Sea Turtle Restoration Project, P.O. Box 370, Forest Knolls,CA 94933

The Kemp's ridley sea turtle was declining to near extinction levels in 1980 when the documentary, "The Heartbreak Turtle" was first seen on PBS stations around the country. It had been exploited on the Mexican nesting beach by poachers stealing eggs and others killing the turtles. While in US waters, Kemp's ridleys were being drowned by the thousands in shrimp trawls. Dr. Archie Carr warned that little time remained to save the Kemp's ridley. An amazing coalition of scientists from the U.S. and Mexico devised a bi-national approach to preventing the extinction of the Kemp's ridley. The Mexican government began protecting its nesting beaches while the US government invented Turtle Excluder Devices for shrimp trawls. An experiment was developed bringing 2000 Kemp's ridley eggs from

Mexico to incubate, raise and release in Texas waters. In 1979, the Ixtoc oil spill in Mexican waters was a huge threat to the Kemp's ridleys when oil covered the nesting beaches near Rancho Nuevo. Following that were years of bitter fighting with the shrimp industry to force shrimpers to use TEDs even though federal legislators had enacted legislation to place them on shrimp trawls. Now, a new documentary, "The Heartbreak Turtle Today," produced by the Sea Turtle Restoration Project, follows the story of the Kemp's ridleys from the Ixtoc well to a promising recovery before the Deepwater Oil Spill dumped millions of gallons of oil into the Gulf. Sea turtle pioneers who discuss the Kemp's ridley in the documentary include: Drs. Rene Marquez of Mexico, Peter Pritchard, Pat Burchfield, Charles W. Caillouet, Jr., Andre M. Landry, Jr., Donna Shaver, Joe Flanagan and Roger Zimmerman. Others in the film are Ben Higgins of NOAA, Tony Amos, ARK; Jeff George of Sea Turtle, Inc., Mary Ann Tous, Ila Loetscher's niece and Carole Allen of Sea Turtle Restoration Project. Questions remain about the millions of hatchlings that were released into the Gulf from Mexico and the Padre Island National Seashore while the BP well was still uncapped. The food sources for all sea turtles may have been contaminated by the spill and problems may extend well into the future. The documentary ends placing the responsibility for the problems of the Kemp's ridley and all sea turtles at the feet of society and presenting a challenge to help them recover.

DEVELOPING NET ILLUMINATION TECHNIQUES TO REDUCE SEA TURTLE BYCATCH IN GILLNET FISHERIES

Richard Alvarez[1], Joel Barkan[1], Cielo Corado[1], Khanh Chi Dam[1], Shara Fisler[1], Maria Puga[1], Carlos Rodriguez[1], Santos Sillas[1], Yonat Swimmer[2], Diem-Hong Tran[1], and John Wang[3]

[1] Ocean Discovery Institute
[2] NOAA Pacific Islands Fisheries Science Center, Honolulu, Hawaii
[3] University of Hawaii Joint Institute for Marine and Atmospheric Research, Honolulu, Hawaii

Incidental capture in small-scale gillnet fisheries can have negative impacts on threatened and endangered sea turtle populations. Developing strategies and solutions to reduce sea turtle bycatch while maintaining fishing profitability are important components to any management regime. Our previous work has found that illumination of nets via LED (light-emitting diodes) effectively reduces sea turtle interactions without affecting capture rates of target fish species. In this study, we develop two additional methods to illuminate nets: 1) chemical lightsticks and 2) incorporation of luminescent materials (eg., glow in the dark ropes and buoys) into fishing nets. Using pairs of nets (with and without illumination) we tested the effect of net illumination on rates of green sea turtle (*Chelonia mydas*) captures in Punta Abreojos, Baja California, Mexico. We also investigated the role of net illumination capture rates of target fish and their associated market value in a small-scale gillnet fishery in Bahía de los Angeles, Baja California, Mexico. Placing chemical lightsticks every 5 m along a net reduced sea turtle catch per unit effort (CPUE) by 60% with no significant decrease in target fish CPUE or market value, suggesting this could be a potentially viable marine turtle conservation tool. When luminescent material was incorporated into float line, lead line, and buoys of nets sea turtle CPUE did not significantly change. When similar materials were adapted into bottom set gillnets, there was no significant effect on sea turtle or target fish CPUE and a decrease in market value of target catch. However, the composition and materials of the luminescent materials varied significantly from the standard materials used by fishermen. For future trials, we will incorporate luminescent pigments into the standard net materials. Through fishermen surveys, we learned there is interest in illumination nets if costs and negative effects on catch revenue are minimized. Depending on the methods employed, net illumination can be a promising strategy to reduce sea turtle bycatch in small-scale gillnet fisheries. We wish to thank the International Sea Turtle Society, the International Sea Turtle Symposium, Western Pacific Regional Fisheries Management Council, U.S. Fish and Wildlife Service, and the U.S. National Marine Fisheries Service for their generous support in helping us attend this symposium.

INFERRING VESSEL CHARACTERISTICS FROM WOUNDS ON STRANDED SEA TURTLES: CAN WE APPLY THE MANATEE METHOD?

Susan G. Barco[1], Christina M. Trapani[1], and Alex M. Costidis[2]

[1] Virginia Aquarium & Marine Science Center Foundation Research & Conservation Division, Virginia Beach, Virginia, USA
[2] Aquatic Animal Health & Dept. of Physiological Sciences, College of Veterinary Medicine, University of Florida, Gainesville Florida, USA

Vessel interactions frequently appear in Virginia sea turtle stranding records. Like other species that are affected by vessel interactions, injuries to sea turtles are characterized by both blunt and sharp trauma. Blunt trauma injuries consistent with vessel impact include multiple, jagged edge fractures of the carapace, plastron or skull. Sharp trauma injuries consistent with vessel collision include one or more roughly parallel, roughly equidistant, straight or curved incising wounds through the carapace, flippers, neck or skull and are often associated with a propeller. Rommel *et al*. 2007 developed a series of measurements and calculations, here referred to as the “manatee method” to systematically determine propeller size, propeller rotation direction, vessel direction of travel relative to the body and infer characteristics of vessels that collided with recovered manatee carcasses. These measurements include chord length from entry to exit wound, cut shape, number, depth, and span. For this project, we reviewed images of Virginia stranded sea turtles from 2006-2009 to (1) categorize the wounds on sea turtle carcasses that appeared to have collided with vessels and (2) determine our ability to use the “manatee method” to infer vessel characteristics. For the first objective, we categorized stranded animals as having wounds consistent with vessel interaction and further classified injuries as probable blunt, sharp, or both blunt and sharp trauma. Of the 881 stranded sea turtles we recorded, 195 (22%) were characterized as probable vessel trauma. Of the 195 probably vessel interactions, we characterized 68 (35%) as blunt, 89 (46%) as sharp, 25 (13%) both and 13 (6%) could not be determined. Most (n=70; 61%) of the 114 sharp trauma cases presented with propeller cuts where only a minimum cut length could be estimated and chord length measurements were impossible because either the entry and/or exit of the cut was a ‘through cut’ (at the body perimeter). In an additional 20 cases, the carapace was too shattered (due to injury and/or decomposition) to have collected measurements. Nine sharp trauma cases showed some sign of healing. Thirteen sharp trauma cases were bisected by a single cut wound. Most of these were loggerheads at least 60cm SCL, suggesting large propellers and, therefore, large vessels. Although the vessel interaction rate was estimated as 22%, leatherbacks appeared to be disproportionately affected by vessel interactions with 29% of carcasses having injuries consistent with vessel trauma. Loggerheads followed with 22% and Kemps ridleys and greens with 12% and 15% respectively. When we examined the 114 cases with apparent propeller wounds, only <6% (n=20) presented with wounds that could be measured for chord length, cut span and depth using the manatee method, making this methodology of limited use for sea turtles. We do not consider the stranding interaction rate equivalent to mortality since some carcasses were likely hit post-mortem. We do, however, consider the estimated 22% vessel interaction rate in the Virginia stranding record as a minimum estimate since many carcasses were too poorly documented or too decomposed to evaluate and some carcasses may not have been reported and recovered.

SEA TURTLE MORTALITY AT INDEX BEACHES OF THE MEXICAN PACIFIC: ANALYSIS OF 10 YEARS OF DATA

Ana R. Barragán[1], Carlos Salas[2], Marlem Zenteno[2], and Laura Sarti[1]

[1] Programa Nacional para la Conservación de las Tortugas Marinas, CONANP. Mexico City, Mexico
[2] Kutzari, Asociación para el Estudio y la Conservación de las Tortugas Marinas, AC. Mexico City, Mexico

This paper presents the analysis for 10 years of stranding data (2000 – 2010) obtained for the four leatherback index beaches in the Mexican Pacific: Mexiquillo, Tierra Colorada, Cahuitán and Barra de la Cruz as part of the conservation activities for the Leatherback Project in Mexico. During each leatherback nesting season (October to April) daily surveys were conducted along the four beaches, during which all stranded and dead turtles were recorded. The

stranding data included species, location, sex, stage (adult or juvenile), condition of the remains and possible cause of death. A spatial and temporal analysis of the level of mortality was conducted, as well as per species and life cycle stage. All the possible causes of death were compiled in 5 categories which included predation, poaching, interactions with fishing gear, boat strikes and unknown. As can be expected due to the abundance of the population, the most common strandings were from adult olive ridleys (*Lepidochelys olivacea*), but our findings also show some mortality of Eastern Pacific hawksbills (*Eretmochelys imbricata*) and leatherback turtles (*Dermochelys coriacea*); given the critical condition of these two species in the Mexican Pacific, we grant special importance to these reports. Also, we found a high incidence of mortality related to interactions with fishing gear close to the nesting beaches.

BEST MANAGEMENT PRACTICE DESIGN CRITERIA FOR HOPPER DREDGE/SEA TURTLE FRIENDLY BORROW SITES

Phillip C. Bates and Terri Jordan-Sellers

US Army Corps of Engineers, Jacksonville, FL USA

The use of hydraulic dredges known as hopper dredges to maintain navigation channels and mine sand for storm damage reduction projects (also referred to as beach restoration or nourishment projects) has led to documented incidental lethal take of threatened and endangered sea turtles in the United States. In an effort to reduce incidental take associated with storm damage reduction projects, the US Army Corps of Engineers, Jacksonville District, developed Best Management Practice (BMP) Design criteria for “sea turtle friendly” sand mining locations (also called borrow sites). The District believes that implementation of these criteria during project design, were applicable, can reduce the potential for incidental take of sea turtles. The Corps’ Sea Turtle Community of Practice recommends that these BMP Design Criteria be utilized by all project proponents (local, county, state, federal and private entities and their engineering design consultants) when initially selecting and designing project borrow sites and that the criteria be carried forward throughout the detailed engineering and environmental permitting for the project. The BMPs include criteria for optimum water depth for borrow sites; minimum design criteria for length of the borrow site in relation to dredge operations; recommendations with regard to the geometry of borrow sites and the volume of sand needed to be contained in borrow sites when compared to the volume of sand needed to complete the project. While selecting and designing borrow sites for storm damage reduction projects is an intensive, detail driven process, including sea turtle protection as a site selection criterion, instead of a post-design consideration, and incorporation of the BMPs recommended by the Jacksonville District, should result in a reduction of incidental take of sea turtles during sand mining dredging operations for storm damage reduction projects, and reduce project delays and costs associated with incidental sea turtle take.

SYNCHRONISATION OF NESTING SPACE AND ITS RELATION WITH THE ARRIBADA SIZE OF OLIVE RIDLEY TURTLES (*LEPIDOCHELYS OLIVACEA*) AT GAHIRMATHA, ORISSA COAST IN INDIA

Satya R. Behera[1], B. Tripathy[2], Binod C. Choudhury[1], K. Sivakumar[1], and C.S. Kar[3]

[1] Wildlife Institute of India, Post Box 18, Dehradun – 248001, India
[2] Zoological Survey of India, M-Block, New Alipore, Kolkata – 700 053, India
[3] Wildlife Wing, Orissa Forest Department, Neelakantha Nagar, Bhubaneswar–751 002, India

The post super-cylcone of Orissa has brought considerable changes in the geomorphology of beaches at Gahirmatha, Devi and Rushikulya rookeries; all these beaches known to hold major population of migratory olive ridley turtles along the Orissa coast. The possible impact due to such changes includes influencing the recruitment by loss of eggs due to clogging of nesting turtles on the beach as space is a limiting factor. This paper describes the arribada population estimation, projecting the carrying capacity of nesting turtles and possible impact due to overcrowding of the nesting females at the Gahirmatha beach during the arribada of 2010. Turtle nest in available nesting area was estimated to be 85,176 turtle’s i.e. the carrying capacity of Gahirmatha nesting beach. During 2010 season, two successive arribada

occurred within an inter-nesting interval of 14 days, the population was estimated to be 2,11,408 and 1,32,852 respectively. If we consider one nest hole occupies 475.4 cm-2 areas on the beach, it can only support total 85,176 clutches. Our hypothesis showed that there are possibilities of overlapping of nests with respect to area available for egg-laying. Due to high density of eggs deposition it was observed that the females destroy a high number of older nests when digging their own nesting pit. This adds to the high erosion at Gahirmatha, which also destroy substantial number of nests every year and as a result of which the hatching success is below 60%. Suitable conservation and management intervention is required to safeguard the nesting habitat at Gahirmatha to enhance the recruitment of olive ridley turtles along the Orissa coast of India.

THE EFFECT OF FLORIDA'S ORGANIZED TURTLE WALKS ON LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) NESTING BEHAVIOR

Rae Blake[1] and Phil Allman[2]

[1] Florida Gulf Coast University, Dept of Marine and Ecological Sciences, Fort Myers, Florida, USA
[2] Florida Gulf Coast University, Dept of Biological Sciences, Fort Myers, Florida, USA

Sea turtle ecotourism has brought recognition to sea turtle conservation and has been a staple of tourism profit to Florida. However, little research has been done to determine if sea turtle ecotourism may be harmful to the turtles. The purpose of this experiment was to determine if the presence of observers influenced the amount of time a sea turtle spends camouflaging a nest. The experimental group was an organized turtle watch of 20 or more people. Control turtles (n=15) were observed through a night-time spotting scope at a distance greater than 50 feet. Turtles in the control group spent an average of 15 minutes camouflaging whereas experimental turtles spent an average of 13 minutes camouflaging. Although control turtles spent two additional minutes camouflaging, the difference was not significant (Fdf=?= 1.19, p = 0.28). The lack of statistical difference is likely due to the large variation in camouflage time witnessed by experimental turtles (range =4.50-23.11) compared to that of control turtles (range = 6.51-28.29). Johnson *et al*. (1996) indicated similar results by reporting a significant difference of camouflage times for turtles being observed by people. These results indicate that additional effort should be applied to determine if, and how much, sea turtle ecotourism impacts the natural nesting cycle of sea turtles. Impacting activities such as camouflage time can potentially influence the susceptibility to predators, incubation temperature, emergence success, and ultimately hatchling recruitment.

PREHISTORIC SEA TURTLE BARNACLES FROM SAN SALVADOR, BAHAMAS: ARCHAEOLOGICAL EVIDENCE FOR CHELONIBIA TESTUDINARIA AND CHELONIBIA *CARETTA* (CA. A.D. 950-1500)*

Jeffrey P. Blick[1], John D. Zardus[2], Michael G. Frick[3], Doug Dvoracek[4], and Mark T. Clementz[5]

[1] Georgia College & State University, Milledgeville, GA, USA
[2] The Citadel, Charleston, SC, USA
[3] Smithsonian National Zoological Park, Washington, D.C., USA
[4] University of Georgia, Center for Applied Isotope Studies, Athens, GA, USA
[5] University of Wyoming, Laramie, WY, USA

Recent archaeological excavations at the Minnis-Ward Site (SS-3) and North Storr's Lake Site (SS-4) on San Salvador, Bahamas have yielded evidence for sea turtle butchery and cooking in pre-Columbian times (ca. A.D. 950-1500) by the indigenous Lucayan people of San Salvador. Thirty-three specimens from two different archaeological sites have been identified as *Chelonibia testudinaria* and *Chelonibia caretta*. Radiometric dates on charcoal, sea turtle bones, and sea turtle barnacles indicate that sea turtle harvesting, cooking, and processing was taking place at Minnis-Ward and North Storr's Lake during the ca. five centuries before the arrival of Columbus on San Salvador. Stable isotope evidence suggests three different dietary patterns detected in the sea turtle skeletal remains (carnivory, herbivory [sea grass], and marine algae diet) suggestive of the presence of at least two sea turtle species and at least three individual marine turtles: loggerhead (*Caretta caretta*), green turtle (*Chelonia mydas*), and immature green turtle, respectively. The sea turtle barnacle, *Chelonibia testudinaria*, is a widespread species today, and represents the majority of the sea turtle barnacles recovered. Recent identification of a few specimens of *Chelonibia caretta* in the archaeological remains in association with sea turtle bone leans heavily towards the additional consumption or use of hawksbill turtles (*Eretmochelys imbricata*) in addition to loggerheads and greens. The sea turtle remains and barnacles thus indicate prehistoric exploitation of the loggerhead, green, and hawksbill turtles on San Salvador by the prehistoric inhabitants of the island. This is a rare case in which sea turtle barnacles have been reported in the archaeological record in association with prehistoric sea turtle remains.

AN OVERVIEW OF THE FISHERIES AND THE IMPACTS OF RECENT ACTIVITIES ON THE CONSERVATION OF SEA TURTLES IN NIGERIA

Solarin Boluwaji, D. A. Bolaji, R. O. Akinnigbagbe, J. Obienu, C. A. Kumolu-Johnson, Oyeronke Adegbile, and Akintunde Abiodun Ajulo

Nigerian Institute for Oceanography and Marine Research, Victoria Island, Lagos, Nigeria.

The Nigerian brackish and marine coastal waters have provided tremendous economic benefits through fisheries production. Fishing provides dietary requirements and contributes substantially to human welfare wealth creation and empowerment of youth and women fisher folks especially in the rural communities. Sea turtle conservation and maintenance of biodiversity are integral parts of Ecosystem Approach to Fisheries (EAF) which is one of the most current global environmental management instrument. International collaboration between National Oceanic and Atmospheric Administration (NOAA) and San Diego State University Research Foundation (SDSU), USA and Nigerian Institute for Oceanographic and Marine Research (NIOMR), Nigeria on the improvement of assessment of Protected Large Marine Resources (PLMR) in Nigeria highlights the principle of EAF. Priority considerations include sustainability of all fisheries systems and maintenance of biodiversity (with a link to intergenerational equity) and wide stakeholders participation. The reports also highlights Eko Atlantic City project (a public-private partnership (PPP) initiative between Lagos State Government of Nigeria and the developers South Energyx) for the sand filling and reclamation of a 9 million square meters, stretching 7km along the shorelines of the Atlantic Ocean in the Gulf of Guinea, in relation to sea turtle conservation. The project described as earth friendly initiative received the blessing of Clinton Global Initiative (CGI) at its fifth annual meeting held in New York, USA in 2009. Recommendations are proffered for conservation of the fisheries resources and sea turtles as well as the preservation of the environment in order to bring about sustainable development.

RECORD HIGH BEACH TEMPERATURES: IMPLICATIONS FOR LOGGERHEAD TURTLE (*CARETTA CARETTA*) HATCH AND EMERGENCE SUCCESS IN BOCA RATON, FLORIDA, USA

Jason W. Bosley[1], Micah M. Rogers[1], Zachary D. Anderson[1], Cody R. Mott[2], Kirt Rusenko[2], and Jeanette Wyneken[1]

[1] Florida Atlantic University, Boca Raton, Florida, USA
[2] Gumbo Limbo Nature Center, Boca Raton, Florida, USA

Global climate change is likely to affect sea turtle population abundance. Temperature and rainfall play important roles in development, incubation duration, growth, sex, and hatchling emergence success. Warmer sand temperatures may exceed the thermal tolerance of developing embryos and alter thermal cues that regulate nest emergence. Decreased rainfall can result in dehydration of eggs, developmental anomalies, small hatchling size, and egg failure. In 2010, southeast Florida's loggerhead (*Caretta caretta*) nesting season (May-September experienced the hottest summer (June-August) on record with average temperatures 1.1 – 1.4^{o}C above normal. Statewide monthly precipitation averages also document the season as the driest of the past 10 years. Here we examine the fates of the 2010 loggerhead

nests, in Boca Raton, Florida, USA, as a natural experiment. This study documents the impact of record-breaking heat and dry conditions on loggerhead hatch and emergence success as compared to previous years; we highlight the potential consequences of small climatic shifts on nests. An 8 km section of beach was monitored for loggerhead hatch and emergence success during the 2002-2010 nesting seasons. Sample nests from each season were equipped with Onset® Temperature data loggers positioned in the middle of the clutch to record internal nest temperatures. Sample nests were selected based on temporal and spatial considerations to ensure unbiased sampling of the beach. The data loggers recorded nest temperature no less than every hour for the duration of incubation (approximately 53-68 days), including emergence. Emergence success was compared across seasons and related to mean nest temperatures and mean seasonal precipitation. Emergence success varied among years; 2010 mean nest emergence was significantly lower than all other years. We found that higher nest temperatures, coupled with reduced moisture, during the 2010 nesting season, negatively affected emergence success resulting in low hatchling production. Similar across-season analyses of hatching success are in progress. Mortality occurred both at the level of the embryo and the hatchling. Global climate change is expected to cause a warming trend and increased frequency of extreme weather events. Climatically shifted weather patterns likely will lead to decreased loggerhead hatch and emergence success due to already recognized threats and thermal barriers.

BIODIVERSITY AND THREATS ON LOOSIEP ISLAND, ULITHI ATOLL, YAP, FEDERATED STATES OF MICRONESIA

Jennifer A. Cruce, Alexander Sau, Juanito Mangirechog, Michael Lingelmar, and John Rulmal Jr.

Ulithi Marine Turtle Program, Ulithi Atoll, Yap State, Federated States of Micronesia

Yap State is comprised of approximately 134 islands and 11 atolls located within the Federated States of Micronesia and stretches from 6 to 10 degrees North Latitude and 137 to 148 degrees East Longitude. The uninhabited islands of Ulithi Atoll, located approximately 185 kilometers northeast of Yap mainland, are home to native bird species including red-footed boobies, various species of terns (Anous sp.), and the Great Frigatebird (Fregata minor), also ghost crabs (Ocypode cordimana), hermit crabs (Coenobita compressus), coconut crabs (Birgus latro), the endemic giant Micronesian gecko (Perochirus scuttelatus), a significant population of endemic fruit bats (Pteropus mariannus yapensis), and a newly discovered endemic species of blind snake (Ramphotyphlops sp. nov.). An introduced species of monitor lizard has populated the island of Loosiep, which has also been identified as an important green turtle (*Chelonia mydas*) nesting beach. Monitor lizards are not currently found on the other four surrounding turtle nesting islands in Ulithi. This species is believed to be the mangrove monitor lizard (Varanus indicus) and is the only species of monitor lizard found throughout Yap's islands. The mangrove monitor was introduced to many of the islands throughout Micronesia during the Japanese occupation in the early twentieth century to be used as a food source and pest control (Lever 2003). Local inhabitants of Yap do not utilize monitor lizards as a resource and consider them a threat to native nesting bird and turtle populations. Monitor lizards are known to be opportunistic predators and will prey on bird and turtle nests (McCoid & Wittman, 1993). Loosiep Island is also populated with two species of rats (Rattus norvegicus and Rattus exulans) and feral pigs and chickens. During the 2008 through 2010 monitoring seasons (April through July), it was readily apparent that these introduced species have eliminated many of the island's native nesting birds, crabs, and reptiles. Since 2008, the only species of bird observed nesting on Loosiep was the Micronesian Starling (Aplonis opaca). Monitor and pig tracks have been observed along the beach especially on or near fresh turtle tracks. Monitors appeared to be most active at dawn and are not seen during the night (from 2000 to 0600 hours). Rats were only observed at night presumably due to the monitors' diel pattern. Evidence of turtle nest predation by pigs and monitor lizards was regularly observed with more than 80% depredation of marked nests (Cruce 2009). The goal of the research conducted on Loosiep Island is to collect information on the nesting green turtle population by counting the number of turtles emerging, and assessing the internesting interval, reproductive success, health and population genetics, and to assess the affects of monitor lizard predation of turtle nests. The high number of nests predated by monitor lizards warrants further investigation of the monitor lizard population on Loosiep in addition to implementation of a program to control or eradicate them. In addition, recommendations have been made to landowners to remove feral pigs from the island to reduce nest predation on Loosiep Island.

USING VISUAL CUES TO REDUCE SEA TURTLE INTERACTIONS WITH FISHING GEAR

Khanh Chi Dam[1], Edgar Alva[1], Alex Alvarez[1], Joel Barkan[1], Ulisses Barraza[1], Luis Cueva[1], Antonio Figueroa[1], Shara Fisler[1], Yaffet Mehari[1], Kim Chi Nguyen[1], Carla Pisbe[1], Nazael Rangel[1], Marlem Rivera[1], Ahiram Rodriguez[1], Erick Ruiz[1], Vanessa Sandoval[1], Santos Sillas[1], Yonat Swimmer[2], Edgar Trujillo[1], and John Wang[3]

[1] Ocean Discovery Institute
[2] NOAA Pacific Islands Fisheries Science Center, Honolulu, Hawaii
[3] University of Hawaii Joint Institute for Marine and Atmospheric Research, Honolulu, Hawaii

Many nesting populations of leatherback (*Dermochelys coriacea*), olive ridley (*Lepidochelys olivacea*), green (*Chelonia mydas*), and loggerhead (*Caretta caretta*) turtles have dramatically decreased. Bycatch in a variety of fisheries has been implicated as a significant source of mortality and subsequently population declines for these sea turtle species. Recent studies have raised concerns regarding the high rates of incidental capture and mortality of sea turtles in coastal gill net fisheries. Some studies suggest that small scale coastal gillnet fisheries can have potentially high sea turtle interactions equal to or in some cases exceeding sea turtle interactions with industrial scale pelagic fisheries. Visual cues play important roles in sea turtle foraging behavior and likely influence their interactions with fishing gear. Altering these cues may be a useful strategy to reduce the incidental catch of sea turtles in various fisheries. We examined the potential effectiveness of two visual cues to reduce green sea turtle bycatch: predator shapes and nets illuminated by LED lights. We then adapted these potential deterrents into a commercial bottom gill net fishery to quantify their effects on target fish catch rates and the catch value. Our results indicate that the presence of shark shapes significantly reduced the mean catch rates of green turtles by 54% but also reduced target catch by 45% and, correspondingly, catch value by 47%. In contrast, nets illuminated by LED lights significantly reduced mean sea turtle catch rates by 40% while having negligible impacts on target catch and catch value. These results illustrate the potential for modifying fishing gear with visual deterrents to effectively reduce sea turtle catch rates. We wish to thank the International Sea Turtle Society, the International Sea Turtle Symposium, Western Pacific Regional Fisheries Management Council, U.S. Fish and Wildlife Service, and the U.S. National Marine Fisheries Service for their generous support in helping us attend this symposium.

DESCRIPTION OF THE ARTISANAL SMALL MESH GILLNET FISHERIES AND ITS INTERACTION WITH MARINE TURTLES IN ZAPARA ISLAND, GULF OF VENEZUELA

Gabriela Delgado-Ortega[1], Sandro Sánchez[2], Luis Vilchez[1], Natalie Wildermann[1], and Héctor Barrios-Garrido[1]

[1] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV)
[2] Laboratorio de Ecología General, Departamento de Biología, Facultad Experimental de Ciencias. La Universidad del Zulia (LUZ)

There are five marine turtle species reported for the Gulf of Venezuela (GV): green, loggerhead, hawksbill, leatherback and olive ridley. The GV is an important feeding ground for these reptiles, but there are also several threads such as the fishing activities. Zapara island (10°58’58’’N- 71°33’45’’W) is located in the southern part of the GV, and there are near 150 artisanal fishermen. They develop deveral fishing arts, such as longline, drifting gillnets, purse seining gillnets and trawling gillnets. The objective of this study was to describe the artisanal small mesh gillnet fishery of Zapara island and its impacts on marine turtles. During 2008-2010 the Grupo de Trabajo de Tortugas Marinas del Golfo de Venezuela (GTTM-GV) developed 24 semi-structured interviews and direct observations of the small mesh gillnet fisheries and its interaction with marine turtles. Based on this, we determined that the gillnets were made of monofilament (mesh size: 3,5 inches and 5,5 inches) and polypropilene (mesh size: 5,5 inches), and were placed approximately 4 Km away from the shore at 15-20 meters depth. In each fishing trip there are two vessels (8x15 mts) with a maximum of 4 fishermen each; they place two adjoining gillnets (each 450 mts long). The target species are mainly the Common snook (Centropomus undecimalis), Acoupa weakfish (Cynoscion acoupa) y White Catfish (Arius

proops), capturing between 500 and 2300 Kg per trip. Some of the by-catch species are marine turtles, and smaller fishes such as Haemulon sp. that are sold or used as bait. From 1 up to 6 marine turtles are captured annually per fishing port. The relative low percentage of captured marine turtles with these gillnets could be because the fishermen place the nets very tight, which hinders the turtle's entanglement. In this manner, there have been reports of loggerhead sub-adults and adults in the GV. The small size of the mesh could prevent the entanglement of these large animals. The small mesh gillnets are used only when the environmental conditions do not favor the other fishing arts (longline, purse seining, drifting and trawling gillnets), because the fishing efficiency is lower in relation to the other fishing arts. Finally, we evidenced that the small mesh gillnets do not represent a large scale threat to the populations of marine turtles in the GV.

THE PROMISE AND FAILURE OF SUSTAINABLE SEAFOOD -- IS THE MARINE STEWARDSHIP COUNCIL CERTIFYING FISHERIES TO CAPTURE SEA TURTLES?

Marydele Donnelly

Sea Turtle Conservancy, Gainesville, FL, USA

In 1999, two years after its founding by the World Wildlife Fund and the European food giant Unilever, the Marine Stewardship Council (MSC) became an independent non-profit organization established to recognize and reward sustainable fishing and influence choices made by seafood consumers. Since that time, the MSC has awarded its blue eco-label for sustainability to 98 fisheries around the world; an additional 131 fisheries are currently undergoing assessment. MSC is well-known to consumers in the USA, Canada, UK, Germany, France and Japan and is regarded as the best of the seven organizations certifying sustainable, wild-caught seafood. Nevertheless, consumers deserve better fare than what the MSC currently serves. Despite its potential to promote better fishing, conservationists are becoming increasingly critical of the MSC for certifying fisheries that are not truly sustainable. In an opinion piece in Nature (467, 28-29; 2 September 2010) leading scientists call for "radical reform" of the MSC to protect the environment. Pelagic longline fisheries hook and entangle hundreds of thousands of sea turtles each year, but two of these fisheries in the Northwest Atlantic, the Canadian swordfish fishery and the U.S. yellowfin and bigeye tuna and swordfish fishery, are currently undergoing MSC assessment as sustainable fisheries. These assessments exemplify the way in which economic interests are driving MSC to the detriment of the environment. The small Canadian fleet is estimated to have caught 9,592 loggerheads between 1999 and 2006, with interactions increasing over time to 3,368 in 2006. The majority of these turtles are released alive, but post-release mortality can be as high as 40-50%. This assessment has been severely criticized; it is still in the final assessment phase six months after the final report was due. The larger U.S. fleet undergoing assessment is implicated in hundreds of sea turtle interactions each year; post-hooking mortality in U.S. fisheries, which have numerous mandatory requirements to improve the turtles' chances of survival, are estimated to be 20-25%. Under MSC, each fishery is assessed by independent reviewers using an established step-by-step process and performance indicators with explicit goals. Key elements include information gathering and monitoring, the development of a management strategy, prevention of irreversible harm, species recovery, and minimal levels of mortality in non-target species. Assessments allow for ample time to comment, and MSC assessors accept comments from all stakeholders. A major flaw, however, is that assessors are financially motivated to take fisheries undergoing assessment to the next step in the process. Challenges to final assessments are difficult, and ultimately, the inclusion of more fisheries is lucrative for MSC. As envisioned by its founders, the MSC is valuable, but it is clear significant changes in the assessment process are needed. Information on how the sea turtle community can become more engaged with the MSC and recommendations for MSC reform will be provided.

SEA TURTLE INTERACTIONS WITH SWORDFISH FISHERIES IN CHILE: STAYING ABREAST AS FISHERIES EVOLVE

Miguel Donoso[1] and Peter Dutton[2]

[1] ONG Pacifico Laud
[2] National Marine Fisheries Service

For centuries, artisanal fishers in Chile have caught swordfish (Xiphias gladius), as evidenced by artifacts at indigenous burial grounds at Arauco and Lebu. The traditional harpoon fishing techniques were replaced by gillnets in the 1980's. The gillnet fishery effectively dissappeared by the late 1990's. Since then much attention has been focused on incidental take of sea turtles in longline fisheries, and concern over the potential impacts on declining populations that occur in the southeastern Pacific, however the potentially greater threat from coastal net fisheries that are now growing in the region, has been generally overlooked. We present data on longline and gillnet fisheries in Chile including bycatch of sea turtles caught in the Chilean commercial longline fishery targeting swordfish in international waters off Chile. A total of 10,604,059 hooks from 7,976 sets were observed, representing ca. 95% of the total number of hooks fished between 2001-2005. Leatherbacks and loggerheads were the most common species captured. The loggerheads ocurred in waters with temperatures ranging from 16.8°C - 22.1°C, with a mean of 19.7°C, while leatherbacks were captured in waters ranging in temperature from 15.2°C to 23.4°C, with the majority in 17°C waters. Other significant findings include observations of green turtles larger than oceanic stage juveniles, ranging from 49-73 cm CCL, indicating than green turtles larger than the typical ocean life stage juveniles inhabit open ocean habitat. We evaluate threats to sea turtles from current fisheries operating out of Chile, and present new findings documenting a recent resurgence of artisanal gillnets fisheries and accompanying interactions with sea turtles. Finally we draw attention to cooperative work with artisanal gillnets fishers to reduce impacts to sea turtles.

HIGH MORTALITY OF THE PACIFIC GREEN TURTLE (*CHELONIA MYDAS* AGASSIZZI) IN COSTA RICA

Luis G. Fonseca[1], María M. Chavarría[2], Wilberth N. Villachica[3], Jeffrey A. Seminoff[4], and Roldán A. Valverde[5]

[1] Instituto Internacional en Conservación y Manejo de Vida Silvestre, Universidad Nacional, Heredia, Costa Rica
[2] Área de Conservación Guanacaste, Ministerio de Ambiente, Energía y Telecomunicaciones, San José, Costa Rica
[3] Fundación para el Desarrollo, la Conservación y el Equilibrio, Hojancha, Guanacaste, Costa Rica
[4] National Marine Fisheries Service, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA 92037, USA
[5] Department of Biological Sciences, Southeastern Louisiana University, Hammond, Louisiana 70402 USA

The Pacific green turtle is one of the least studied sea turtle populations. In Costa Rica nesting by this turtle includes the entire Pacific coast, reaching the greatest abundance on the northwest region. Between August 30 and September 3, 2010 our team documented 85 dead turtles on Naranjo, Nancite beaches as well as on the islands of Las Cocineras and Bahia Santa Helena, all in the Gulf of Papagayo. Of the 28 individuals found dead at Naranjo and Nancite beaches only four were males. The mean curved carapace length of the females was 81.9 cm (min: 69.0 cm, max: 89.0 cm) and the mean curved width 75.8 cm (min: 67.0 cm, max: 82.5 cm). The mean curved width for males was 76.2 cm (min: 72.0 cm, max: 79.5 cm) and a mean curved width of 70.5 cm (min: 65.0 cm, max: 73.0 cm). Presumably, only one of the females was a juvenile. Given the advanced decomposition process of all specimens it was not possible to conduct necropsies. We suggest that the cause of such mortality was the high concentration of the dinoflagelate (Pyrodinium bahamense var. compresum), which caused an extensive red tide during the period in which the turtles died. Severe intoxication by the toxins of this dinoflagelate is known to cause cardio-respiratory paralysis and death.

EVALUATION OF A TURTLE EXCLUDER DEVICE (TED) DESIGNED FOR USE IN THE U.S. MID-ATLANTIC ATLANTIC CROAKER FISHERY

Jeff Gearhart

NOAA Fisheries, P.O. Drawer 1207, Pascagoula, Mississippi, 39568, USA

In 1994, the National Marine Fisheries Service (NMFS) Northeast Fisheries Observer Program (NEFOP) documented sea turtle bycatch in the Atlantic croaker (Micropogonias undulatus) and weakfish (Cynoscion regalis) trawl fishery off North Carolina. The fishery utilized a high opening bottom trawl locally known as a "flynet." In 1998, the NMFS Southeast Fisheries Science Center (SEFSC) initiated research to develop a Turtle Excluder Device (TED) for the flynet fishery. Over the next 10 years, numerous prototype designs were trialed in the fishery. In 2007, the Flexible Flatbar Flynet (FFF) TED was developed for the fishery and scheduled for catch retention trials. The specialized "trouser trawl" testing technique was utilized to conduct testing due to the highly variable catch rates of the fishery. The objectives of the study were to quantify the target and bycatch species catch loss associated with TED use in the Atlantic croaker targeted flynet fishery operating off North Carolina. In addition, usability testing was carried out to identify handling problems and specialized handling techniques required when using TEDs in this fishery. The study was carried out aboard contracted commercial vessels operating along the North Carolina coast and originating from Wanchese, NC. Results indicate that catch loss for the primary target species, Atlantic croaker, was not significant, averaging 3.9% (95%CI -15.5 to 7.8%; $p<0.2229$; power 0.996), while catch of other target species and primary bycatch species was significantly reduced. Usability testing proved invaluable during this study providing specialized handling techniques that prevented TED damage and facilitated deployment and retrieval processes.

EVIDENCE OF REGRESSION OF FIBROPAPILLOMAS IN GREEN TURTLES (*CHELONIA MYDAS*) CAPTURED IN ITAIPU COASTAL REGION, NITERÓI, RIO DE JANEIRO STATE, BRAZIL

Suzana Machado Guimarães[1], Humberto Mas Gitirana[2], Amanda Vidal Wanderley[1], and Gisele Lôbo-Hajdu[2]

[1] Programa de Pós-Graduação em Biologia Marinha da Universidade Federal Fluminense. Niterói, Rio de Janeiro - Brasil
[2] Laboratório de Genética Marinha, Departamento de Genética, Universidade do Estado do Rio de Janeiro. Rio de Janeiro, Rio de Janeiro - Brasil

Fibropapillomatosis is a disease characterized by benign cutaneous tumors (fibropapillomas) which display unique or multiples injuries with smooth and verrucoses features beyond a variety of colorations and sizes. These fibropapillomas may affect sea turtles both externally and internally, furthermore, depending on the body part and level of tumor development, also cause death. There are fibropapillomatosis events in all sea turtle species, but the majority is being recorded on green turtles. Despite the presence of tumors being frequently associated to herpesvirus group, even today there are not conclusive studies indicating the cause of this disease. However, several environmental and intrinsic factors from life path of each sea turtle are being pointed as facilitators and stimulators, such as parasitosis, genetic predisposition, viral infections, chronic stress, immune suppression, ultraviolet radiation or toxic exposures to chemicals. As in other regions of the world, most brazilian fibropapillomatosis events are related to turtles that live on coastal marine habitats with high levels of degradation and pollution by human activities. The regression of tumors is poorly documented in scientific literature. This work is the first Brazilian record of regression of fibropapillomatosis in green turtles proven by photographic images. From July 2008 to August 2010 weekly field surveys visits to Itaipu coastal region (Niterói, Rio de Janeiro State, Brazil) were performed to monitor sea turtles occurrences. Data collection was recorded from incidental capture by fisheries, capture-recapture dives and strandings. All captured sea turtles were submitted to physical exams (presence of injuries, apparent tumors and abnormalities), biometric measuring and tagging. In addition, each turtle had its photographs (from head, carapace and plastron) taken to compose an image

library for individual identification. After this, sea turtles were returned into the sea. A total of 131 different green turtles were captured, examined and measured. Approximately 30% (n=39) of individuals had apparent tumors and presented size profile ranging from 31 to 75 cm of curved carapace length. Twenty one percent (n=28) of total captured turtles were recaptured once or twice, from which seven turtles (40%) showed tumor development only at first or second recapture after a minimum interval of 85 days from initial capture. By further image library analysis, we clearly identified two turtles which showed regression of fibropapillomas located on the neck and ventral axillary areas. The first turtle showed clear level of regression of tumor after 188 days and the second showed complete absence of tumor after 164 days from initial capture. An event of complete regression of tumors after approximately 6 months is reported and the prevalence of fibropappilomatosis on juvenile green turtles is endorsed. It is important to stimulate other studies focused on regression of fibropapillomatosis aiming to understand the particular mechanisms of disease regression and whether is possible to predict if a sea turtle affected by this disease have chances to be cured.

EVALUATION OF SCYPHOZOAN JELLYFISH AS BIOLOGICAL INDICATORS FOR COASTAL MARINE POLLUTION AND LEATHERBACK TURTLE HEALTH*

Heather S. Harris[1], Scott R. Benson[2], Gina M. Ylitalo[3], Spencer E. Fire[4], Robert H. Poppenga[5], Christina C. Fahy[6], and Jeffrey A. Seminoff[7]

[1] NOAA, Southwest Fisheries Science Center, Protected Resources Division (contract veterinarian), Morro Bay, California, USA
[2] NOAA, Southwest Fisheries Science Center, Protected Resources Division, Moss Landing, California, USA
[3] NOAA, Northwest Fisheries Science Center, Environmental Assessment Program, Seattle, Washington, USA
[4] NOAA, National Ocean Service, Marine Biotoxins Program, Charleston, South Carolina, USA
[5] University of California, Davis, California Animal Health and Food Safety Laboratory, Davis, California, USA
[6] NOAA, Southwest Regional Office, Protected Resources Division, Long Beach, California, USA
[7] NOAA, Southwest Fisheries Science Center, Protected Resources Division, La Jolla, California, USA

Western Pacific leatherback turtles (*Dermochelys coriacea*) travel long distances from their nesting grounds in Papua Barat, Indonesia and the Solomon Islands to forage seasonally on dense aggregations of scyphozoan jellyfish off the west coast of the United States (Benson *et al*., 2007a; Benson *et al*., 2007b; Dutton *et al*., 2007). Migrations of this magnitude may expose turtles to a diversity of ocean contaminants, most significantly via ingestion of prey. Although leatherbacks are considered largely pelagic and may forage during their long distance migrations along convergence zones and upwelling areas along continental margins, they also spend significant time foraging seasonally in neritic habitat (Benson *et al*., 2007b). A recent proposal by NOAA to designate leatherback critical foraging habitat along the U.S. west coast (proposed rule, 75 FR 319, Jan 5, 2010) specifically identified prey condition as a primary constituent element essential for leatherback turtle conservation. However, a gap in knowledge was identified regarding the potential for jellies to bioaccumulate marine pollutants. Scyphozoan jellies may be excellent indicators of ocean health because of (1) their large scale episodic population blooms that represent a substantial portion of pelagic biomass, (2) their daily vertical migrations through the water column that expose them to a unique and potentially more biologically significant suite of contaminants and biotoxins than filter feeding benthic invertebrates, (3) their unparalleled ability for uptake of dissolved organic material through consumption of zooplankton, and (4) their function as a net sink for these elements (Graham *et al*., 2001; Pitt *et al*., 2009). Jellyfish populations are becoming more prolific and abundant in many marine ecosystems as a result of changing ocean conditions, potentially in response to the cumulative effects of human impact (Mills *et al*., 2001). To assess the potential for scyphozoan jellies to bioaccumulate toxins, we sampled four species in Monterey Bay, California, including the preferred prey of leatherbacks, the brown sea nettle (*Chrysaora fuscescens*, n=15), and the secondary prey moon jelly (*Aurelia labiata*, n=5), egg yolk jelly (*Phacellophora camtschatica*, n=5), and purple-striped jelly (*Chrysaora colorata*, n=1). Concentrations of heavy metals, organochlorines, polybrominated compounds, and the biotoxin domoic acid were measured in whole homogenized jellies and in dissected manubrium, the portion that leatherback turtles preferentially eat. Results of this study provide evidence that jellies may serve as sentinel organisms for marine pollution and act as a bioindicators for the health of leatherback turtles.

DETERMINING THE IMPACTS OF BEACH RESTORATION ON LOGGERHEAD (*CARETTA CARETTA*) AND GREEN TURTLE (*CHELONIA MYDAS*) NESTING AND REPRODUCTIVE SUCCESS ALONG FLORIDA'S ATLANTIC COAST

Allison W. Hays and Llewellyn M. Ehrhart

University of Central Florida, Orlando, Florida, USA

Many beaches are eroding at an accelerated rate. The principal method to combat coastal erosion in the United States and many European countries is soft armoring, or the construction of beaches or structures to absorb wave energy. This shoreline alteration has the potential to impact marine turtles using the sandy beach for nesting as well as their developing hatchlings incubating in the changed substrate. The objective of this study was to determine how different types of engineering affect loggerhead and green turtle nesting and reproductive success. Two types of restoration have occurred along the southern Brevard County, Florida, USA coastline, which supports some of the highest density loggerhead and green turtle nesting in the world. Since 2005, approximately 35 kilometers of shoreline have undergone 1) full-scale restoration (typically referred to as "nourishment" or "renourishment"), where the berm was raised and widened when sand was added above and below the mean high tide line (2005, 2010) or 2) dune restoration, where the berm was narrowed when sand was added only to the dune (2005, 2006, 2008, 2009). We used a Before-After-Control-Impact-Paired Series (BACIPS) model to quantify the effect of these different types of restoration on nesting and reproductive success. The BACIPS design tests for significance between the difference (delta) in the nesting and reproductive success rates at the impact and control sites before and after restoration. The closer the delta is to zero, the more similar the nesting and reproductive success between the two sites. For loggerheads, there was a significant difference in nesting success deltas at the full-scale restoration site during the nesting season immediately following restoration (year of construction) (delta= -0.0029 before; 0.1187 after) and one year post-construction (delta=-0.723 before; 0.1535 after). For green turtles, the significant difference in deltas lasted up to four years post-construction (delta=-0.0605 before; ranged from 0.1483 to 0.2671 after). After dune restoration, there was a significant difference in nesting success deltas for loggerheads during each year of construction (delta=-0.0054 before; ranged from 0.0674-0.1376 after), which was, in one case, still seen one year post-construction. Results of dune restoration on green turtle nesting success were more varied; there was a significant difference in deltas during two of the four years of construction (delta=-0.0320 before; -0.8647 after and delta=-0.0059 before and 0.1424 after) but not during the first year post-construction. These data, combined with results from the analysis of reproductive success data, will provide more insight into how altering the nesting habitat affects the overall value of the beach as a nesting environment and as a suitable substrate for hatchling development. In addition, to our knowledge, this is the first study examining if loggerhead and green turtle nesting and reproductive success are impacted to the same degree on beaches that have undergone full-scale restoration compared to those with dune restoration.

LAND USE, MACROALGAE, AND A TUMOR-FORMING DISEASE IN MARINE TURTLES

Kyle S. Van Houtan, Stacy K. Hargrove, and George H. Balazs

National Oceanic and Atmospheric Administration (NOAA) Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, Hawaii, United States of America

Wildlife diseases are an increasing concern for endangered species conservation, but their occurrence, causes, and human influences are often unknown. We analyzed 3,939 records of stranded Hawaiian green sea turtles (*Chelonia mydas*) over 28 years to understand fibropapillomatosis, a tumor□forming disease linked to a herpesvirus. Turtle size is a consistent risk factor and size□standardized models revealed considerable spatial and temporal variability. The disease peaked in some areas in the 1990s, in some regions rates remained constant, and elsewhere rates increased. Land use, onshore of where the turtles feed, may play a role. Elevated disease rates were clustered in watersheds with high nitrogen-footprints; an index of natural and anthropogenic factors that affect coastal eutrophication. Further analysis shows strong epidemiological links between disease rates, nitrogen-footprints, and invasive macroalgae and points to foraging ecology. These turtles now forage on invasive macroalgae, which can dominate nutrient rich waters and sequester environmental N in the amino acid arginine. Arginine is known to regulate immune activity, promote herpesviruses, and contribute to tumor formation. Our results have implications for understanding diseases in aquatic organisms, eutrophication, herpesviruses, and tumor formation.

GEOSPATIAL ANALYSIS ON IMPACTS OF DEC 2004 TSUNAMI ON SEA TURTLE NESTING BEACHES ALONG THE ANDAMAN AND NICOBAR ISLANDS*

Sujjahad H. Inayath[1] and S. Ramachandran[2]

[1] Institute for Ocean Management, Anna University, Tamil Nadu, Chennai – 600 025
[2] VELS University, Chennai- 600 117

Andaman and Nicobar Islands (A&N) are the summits of a submarine mountain range lying on the great tectonic suture zone that extends from the eastern Himalayas to the Arakan along the Myanmar border and finally to Sumatra and lesser Sundaes. These islands are located between 6°-14° North Latitude and 92°-94° East Longitude. The origin of sand in (A&N) islands involves both fluviomarine and weathering of the parent rock from the land. The presence of sand is noticed as a thin strip all along the coastal region. Majority of the islands have a rocky coast and certain stretches of coastline are important nesting areas for a variety of sea-turtles, all of them endangered or threatened. These include the Leatherback, Hawksbill, Olive Ridley and Green turtles. Some of these nesting sites are of global importance. The earthquake on 26th December 2004 with its epicentre at Sumatra, Indonesia triggered a tsunami, which had a major impact on these islands. Assessment of tsunami inflicted damage to island ecosystems was done using remote sensing and Geographic Information System (GIS) and field surveys for twenty of the Andaman Islands and eleven of the Nicobar Islands viz., Aves, Baratang, Cinque, East, Havelock, Interview, John Lawrence, Little Andaman, Long, Middle Andaman, Neil, North, North Andaman, North Passage, Peel, Rutland, Smith & Ross, South Andaman (part), Stewart and Strait Islands and Bompoka, Car Nicobar, Chowra, Camorta, Katchall, Kondal, Little Nicobar, Nancowry, Pulo Milo, Teressa and Trinkat islands respectively. A comprehensive change detection study of pre and post tsunami satellite data yields evidence of pronounced detrimental effects to the sensitive ecosystems such as mangroves, coral reefs, forests, vegetation, sandy beaches, rock formations, groundwater and biodiversity. The tectonic activity that initiated the tsunami has caused 1- 4 m of subsidence of the Nicobar Islands and 1-2 m uplift of western shorelines of the Andaman Islands. Removal of sandy beaches as well as deposition of sand has been witnessed. The turtle nesting beaches of Nicobar islands (Baratang, Cinque, Little Andaman, North, Peel and South Andaman) and Nicobar islands (Bompoka, Camorta, Kondal, Little Nicobar, Trinket and Nancowry) have almost disappeared and in some beaches the debris is scattered all along the coast and this will affect the reproductive potential of Leatherback, Green Sea, Hawksbill and Olive Ridley turtles which use these islands as nesting sites. Given the importance of this ecosystem, an overall view of the ecological damages caused by the tsunami and changes in sandy beach extent were studied. This knowledge is essential for planning the mitigation, rehabilitation and restoration measures in order to protect the coastal wetlands and the severity of damages and their consequences suggest the need for a definite ecology restoration programme and integrated coastal zone management plan.

BYCATCH STUDY AND MITIGATION ACTIVITY IN COASTAL AND MARINE WATERS OF BANGLADESH*

Mohammad Z. Islam[1], Foysal Ehsan[1], Rafat Adnan[1], and Md. Foysal[2]

[1] Marinelife Alliance, Cox's Bazar, Bangladesh
[2] Chittagong University, Bangladesh

During the last three years we are conducting bycatch study on marine mega fauna and trying to reduce bycatch with the participation of offshore fishermen through awareness, training and actions. Fishermen are the major stakeholders for marine mega fauna conservation in the coast and offshore fisheries area we emphasize the charismatic mega fauna like sea turtle, cetacean and whale sharks bycatch and to reveal the magnitude. we will continue fishermen awareness for bycatch reduction along 160 km coastline from Chittagong to St. Martin Island. Offshore fishermen are being

trained in identifying Sea Turtle, Whale Shark & Cetacean to participate in offshore data collection & improve reduction of bycatch incidence and how to release trapped individuals safely. We developed outreach materials and guideline ID for identification and use in the offshore areas particularly for fishermen. Initially we trained 30 local secondary level students to conduct the survey through interview offshore fishermen. Now we only focus and work with fishermen. Major activities are fishermen training on bycatch reduction and their field actions. So far we trained 355 fishermen head of 245 boat including Gill nets (Drifting & Bottom Set Gill net) Marine set bag net (ESBN), long liners and included in the bycatch awareness program over 2700 fisherman from Cox's Bazar & Chittagong district. Fishermen are collecting Data and releasing live turtles after the motivation program becoming a part and major stakeholder of the efforts.

CAN WE SAVE THEM? SEA TURTLE CONSERVATION ISSUES IN SRI LANKA*

Thushan Kapurusinghe[1,2], Lalith Ekanayake[1,3], M.M. Saman[1], and Saman Rathnakumara[1]

[1] Turtle Conservation Project, 11, Perera Mawatha, Madakumbura, Panadura, Sri Lanka,
[2] Durrell Institute of Conservation Ecology, University of Kent, Canterbury, UK
[3] University of Peradeniya, Sri Lanka

Five species of sea turtles nest in Sri Lanka. They are the Green turtle (*Chelonia mydas*), Leatherback turtle (*Dermochelys coriacea*), Olive ridley turtle (*Lepidochelys olivacea*), Loggerhead turtle (*Caretta caretta*) and the Hawksbill turtle (*Eretmochelys imbricata*). All 5 species are listed by the World Conservation Union (IUCN) as either critically endangered or endangered. Coastal communities of Sri Lanka depend on surrounding natural resources for their survival. In addition, development activities are taking place in many coastal areas of the island. As a result, very important coastal habitats and coastal fauna such as the coral reefs, sea grass beds, mangroves, marine turtles and other coastal vegetation are under serious threat of extinction. After the eradication of terrorism from the island, the government now plans to extend the development activities, which include large scale tourism projects, to the north eastern coast. Domestic travel and tourism have increased after the war, resulting in coastal habitat degradation such as damage to the coral reefs on the Pigeon Islands and Bar Reef of the Kalpitiya peninsula. Large mangrove areas have been cleared in Kalpitiya area to construct luxury hotels, disturbing the Puttlam lagoon system where sea turtles and dolphins are found. Sea turtle hatcheries are still illegally operated in Sri Lanka and the Department of Wildlife Conservation has failed to regulate these hatcheries. There is a great political influence to keep the illegal turtle hatcheries in operation. Although the nesting turtles are protected in National Parks (NP) such as Yala NP, Kumana NP, Wilpattu NP, natural predators account for nearly 100% egg predation in these areas. Sea turtle by-catch seems to be the biggest threat for sea turtles' survival in their aquatic habitat. Thousands of turtles become entangled in fishing nets and drown each year. TCP has recorded several fish hook entanglements associated with long-line fisheries but further research is needed to fully understand this problem. The new harbor which is being constructed in Hambanthota is posing a serious threat to sea turtles in Ussangoda-Godawaya and Rekawa sea turtle sanctuaries. In addition, there is a proposal to remove beach sand from the Ussangoda-Godawaya Sanctuary. The planting of introduced beach pines Casuarina along the beaches of Ussangoda-Godawaya sanctuary disturbs the sand dune formation process and shows negative impact on nesting activities of critically endangered Leatherback turtles. Sea turtles that nest in Kosgoda beach forage in Hikkaduwa Marine Sanctuary and these turtles are being tamed are ridden by children and fed by locals as a tourist attraction. Although there is a wildlife office located in Hikkaduwa Marine Sanctuary, they fail to prevent these illegal activities. Loosing nesting beaches is a serious threat for nesting turtles. Both Kosgoda and Rekawa beaches are currently becoming narrower each year, limiting suitable nesting spaces for sea turtles. The Gulf of Mannar region between Sri Lanka and India provides an important foraging ground and migratory route for sea turtles and the Indian Government's proposal to excavate 'Sethusamudram' canal may seriously disturb the sea turtle activities in the region.

GENETICS INVESTIGATION OF GREEN TURTLE (*CHELONIA MYDAS*) CARCASSES FROM THE 2007 POACHING INCIDENCE IN SABAH WATERS*

Chong Y. Kuen and Joseph Joseph

Faculty of Maritime Studies and Marine Science, Universiti Malaysia Terengganu, Kuala Terengganu, Terengganu, Malaysia

Numerous conservation efforts had been conducted to protect the endangered sea turtles. However in recent years, a bigger and serious threat had emerged, and it is threatening the turtles at their foraging ground. Illegal fishermen, mostly from China and Vietnam had been harvesting sea turtles at foraging ground around Malaysian waters, and it was believed to have occurred since 2003. The biggest poaching incidence was in 2007, where the Malaysian Marine Police confiscated 318 sea turtles, of which only 26 turtles are found to be alive on board of a Chinese fishing vessel near Mantanani Island and Mengalum Island (northern coast of Borneo). Foraging ground normally consists of mix stocks. Therefore, exploitation of sea turtles at foraging ground might affect several nesting colonies in the region. However, very little is known about turtles at foraging grounds in Malaysia. This study aimed to investigate the genetic composition of 20 green turtle carcasses from the poaching incidence at Mantanani and Mengalum in 2007 using mitochondrial DNA (mtDNA) control region. DNA was extracted using quick CTAB protocol and amplified using TCR 5 & TCR 6 primers. Natal origin of these samples were determined by comparing haplotypes obtained from this study with previously published haplotypes from nesting populations around Southeast Asia and Western Pacific. A total of six haplotypes were detected from the 20 green turtle carcasses. These haplotypes (CARU, C8, C4, D2, E2, C3) were previously described by Moritz *et al*. (2002). This study revealed that the samples from the 2007 poaching incidence were consists of stocks from nesting populations of Indonesia, Australia, Sarawak (Malaysia), Sulu Sea (Sabah Turtle Island and Philippines Turtle Islands) and Micronesia. The present study confirmed that sea turtles foraging in the northern coast of Borneo are originated from several nesting populations in Southeast Asia and Western Pacific. Illegal harvesting of sea turtles at foraging ground must be stop, or else it will affect several source populations in this region. Clearly, International collaboration and regulations are urgently needed in order to defeat the illegal harvesting of sea turtles at foraging grounds.

SEA TURTLE SURVEY IN XISHA ARCHIPELAGOS (PARACEL ISLANDS), CHINA

Li Wei[1,2] and Yamin Wang[1]

[1] College of Ocean, Shandong University at Weihai, Shandong, China/ Marine Science Laboratory, The Chinese University of Hong Kong, Hong Kong
[2] Marine Science Laboratory, The Chinese University of Hong Kong, Hong Kong

China's sea turtle resources are historically most abundant in South China Sea, mainly Xisha (Paracel Islands), Nansha Archipelago, Hainan Island and Guangdong coastal area. After decades of directing hunting and egg poaching, along with incidental capture and habitat loss, now only national sea turtle refuge situated in the coastal area of Guangdong Huidong County found green turtles' nesting. Remote Islands of Xisha and Nansha Archipelagos, though have sporadic reports, had not been systematically surveyed. In order to identify remaining sea turtle nesting habitats in Xisha Archipelagos and provide basis for conservation measurements, we conducted seasonal surveys in several Islands of Xisha Archipelagos: Woody Island - the largest island in Xisha, seven-connected coral islands and East Island. Beaches were foot-patrolled for turtle lefts and environmental conditions of each islands noted. In spring survey 14 suspected nesting pits were found in a long and flat fine sandy beach located at northwest corner of Woody Island. However, by autumn large part of this beach was filled for construction of a fishing base. Among seven-connected coral islands, total 31 suspected pits were found in spring, usually locating at wide and low-elevated beach with fine sands, but with preference for neither vegetation zone nor total sandy zone. In summer survey, turtle crawling marks and eggs were spotted in South Shoal and two new nests in North Island, but eggs in North Island have been excavated. East Island, a military restricted also known as "Bird Island" had four suspected nesting pits in spring survey. In summer we found a

deadly stranding green turtle. East Island should have created an ideal habitat for sea turtles for its fine beach and few human disturb. However, construction workers have landed and started to make this island a tourism destination. In summary, fishermen's poaching and coastal development are still the biggest threatening factors for nesting turtles in these remote islands of Xisha Archipelagos, in South China Sea.

SPECTRAL AND RESPONSE ASSESSMENT OF TURTLE-FRIENDLY LIGHTING

Margaret M. Lamont[1], Raymond R. Carthy[2], Christine Thomas[3], Peter Ness[3], and Gilbert M. Defreitas[4]

[1] Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida, USA
[2] U.S. Geological Survey, Florida Cooperative Fish and Wildlife Research Unit, Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida, 32611
[3] EYE Lighting International of North America, Inc. 9150 Hendricks Road, Mentor, OH USA
[4] Progress Energy, 3300 Exchange Place, Lake Mary, FL USA

Artificial lighting disrupts the orientation ability of hatchling sea turtles as they crawl from their nest to the sea. Currently, Low-Pressure Sodium (LPS) and Light-Emitting Diode (LED) lamps are the only lamps to be labeled "turtle friendly" by the Florida Fish and Wildlife Conservation Commission. While useful for residential purposes, these bulbs are not optimal for large-scale use by utility companies due to cost, color output, and disposal requirements. In addition, current methods of defining "turtle-friendly" lamps may not properly assess the visual and behavioral responses of turtles. A research radiometer with a scanning calibration of 10nm increments between 380nm and 740nm was used to conduct a set of lighting trials on four bulbs: LPS, High Pressure Sodium (HPS), an HPS lamp with an amber filter, and a new amber-coated bulb (Test Lamp) developed by Eye Lighting International in partnership with Progress Energy, and control conditions (no lamp). Experimental hatchling arena orientation trials were conducted along Cape San Blas, Florida with 80 loggerhead (*Caretta caretta*) hatchlings in September and October 2009. The results indicate that the LPS Lamp emitted the least amount of light in wavelengths within the non-turtle friendly range (380-560nm). The Test Lamp emitted the second least, followed by Amber lens and HPS. All lamps, including LPS, emitted measurable light below 560nm. In hatchling arena trials, the Test Lamp performed as well as the LPS and Amber lens; however the orientation of hatchlings released under the Amber lens was significantly different than that of hatchlings released under LPS, indicating that, compared to the Amber lens, the effective spectral output of the Test Lamp is closer to that of LPS. Radiometer readings of a red LED bulb will occur in December 2010 and these results will be included in the final presentation. Results of this study demonstrate the limitations of current management techniques used to describe turtle-friendly lighting and highlight four primary areas for improvement: 1. Current standards are based on the belief that LPS light is monochromatic, whereas our results indicate that they produce a peak of intensity at near UV wavelengths which are visible and attractive to hatchlings. These lamps resulted in significant misorientation of hatchlings as compared to a dark sky. 2. Wavelengths in the UV range may result in significant misorientation of sea turtle hatchlings. Criteria for evaluating acceptable beachfront lighting should include reduction of light in these wavelengths. 3. Establishing an acceptable level of misorientation is important in developing criteria for wildlife-friendly lighting. This level most likely differs among beaches. 4. While some characteristics of hatchling light perception are well agreed upon, turtle vision appears complex with varied levels of response throughout the spectrum. Therefore, it is not appropriate to simply assign one wavelength as a cut-off for acceptability. Results of this study indicate that examining the entire spectrum of the lamp, along with the intensity at each wavelength using a research radiometer can provide more useful information.

MARINE TURTLE STRANDINGS ALONG THE U.S. WEST COAST

Robin A. LeRoux[1], Christina Fahy[2], Joseph Cordaro[2], Brent Norberg[3], Erin L. LaCasella[1], Sarah Wilkin[2], Peter H. Dutton[1], and Jeffrey Seminoff[1]

[1] National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, CA, USA
[2] National Marine Fisheries Service, Southwest Region, Long Beach, CA, USA
[3] National Marine Fisheries Service, Northwest Region, Seattle, WA, USA

Leatherbacks, green turtles, loggerheads, and olive ridleys inhabit waters off of the U.S. West Coast and use them as foraging grounds where they regularly face human-induced and natural threats, resulting in both live and dead strandings. Over 350 marine turtle strandings along the entire U.S. West Coast were reported to the National Marine Fisheries Service between 1958 and 2009. Strandings have been recorded from the border of Mexico to as far north as Alaska, although the majority of strandings have occurred along the California coast. Hard-shelled turtles typically strand off of southern California, whereas leatherbacks primarily strand off of the central California coast. Approximately 60% of the animals recorded off of the coasts of Oregon, Washington, and Alaska were a combination of hard-shelled species, 20% were leatherbacks and the remaining were undetermined. The causes of stranding varied, and included illness-related, marine debris (entanglement and ingestion), boat collisions, fisheries interactions and/or power plant entrainments. Approximately one-third of the stranding incidents involved live animals and a majority of these were power plant entrainments that, following entrainment, were subsequently released. The remaining two thirds involved either live animals that were transported to rehabilitation facilities and died or animals found dead; in many cases the direct cause of death was not determined. Life history data have been recorded when possible and will be summarized by species. This presentation will provide the first ever compilation and analysis of stranding data on the U.S. West Coast. In a number of instances genetic samples were taken and analyzed to identify the nesting origin of the stranded animal. Preliminary MtDNA analysis indicates that stranded leatherbacks originate from western Pacific nesting beaches, stranded loggerheads from North Pacific nesting beaches in Japan, and stranded green and olive ridleys from eastern Pacific nesting beaches. The information collected from each event is scientifically valuable and will aid in management of marine turtle populations on the U.S. West Coast.

TESTING THE HYPOTHESIS THAT CLIMATE CHANGE WITH RISING TEMPERATURES WILL FEMINISE MARINE TURTLE POPULATIONS*

Colin J. Limpus[1] and Milani Chaloupka[2]

[1] Queensland Turtle Research, Capalaba, Queensland, Australia
[2] Ecological Modelling Services, P/L, University of Queensland, St. Lucia, Queensland, Australia

Many studies considering potential impacts of climate change on turtles have hypothesised that with rising global temperatures there will be a feminising of marine turtles populations. This has been based on the well established principle that marine turtles exhibit temperature dependent sex determination, with the temperature of the nest determining the sex of the hatchlings. In eastern Australia, there has been systematic sampling of marine turtles foraging in coastal habitats since the 1970s. Determining the sex of these turtles by visual examination of their gonads using laparoscopy has been an integral part of these studies since 1982. Laparoscopically derived sex ratios are available for immature turtles recently recruited into three widely spread coastal foraging areas supporting the southern Great Barrier Reef genetic stock for *Chelonia mydas* over the last three decades. We tested the climate-change-feminising-hypothesis using regional climate data to explore the changing temperature environment of the nesting area for the southern GBR genetic stock and its subsequent impact on the long-term sex ratio trends for immature green turtles in the 3 coastal foraging areas. Our results provide little empirical support for the climate-change-feminisation-hypothesis. Given the irrefutable nature of temperature dependent sex determination in marine turtles, this study leads us to re-examine the complexity of the multiplicity of environmental and biological factors that influence nest location and nest temperature and hence resulting sex ratios.

IMPACTS OF SMALL SCALE FISHERY ON MARINE TURTLES IN FWI

Laurent Louis-Jean[1], Eric Delcroix[2], Baptiste Logeais[3], Philippe Lenfant[4], René Galzin[4], and Jean-Philippe Maréchal[3]

[1] EPHE-CNRS / OMMM, Fort de France, Martinique
[2] ONCFS, Basse Terre, Guadeloupe
[3] OMMM, Fort de France, Martinique
[4] EPHE-CNRS, Perpignan, France

In the early nineteen's, marine turtles populations decreased to a critical level. This situation was followed by a fully protection policy of the species living in the French West Indies (FWI) in 1991 for the Guadeloupe archipelago and 1993 for Martinique. The conservation plan for marine turtles in the FWI has been approved by the National Council for Nature Conservation in 2006. A major objective was to identify the main threats on marine turtles. Local fishing gears kill hundreds of turtles every year through by-catch. Fisheries in the region are mostly artisanal. Most fishing is done by fishers using 6-8m boats fitted with outboard motors, employing a variety of techniques and gears. There are 2600 fishermen for about 2300 boats. Fisheries are concentrated on the continental shelf because of its accessibility and the presence of numerous species of commercial interest. The green turtle, *Chelonia mydas*, and the hawksbill turtle, *Eretmochelys imbricata*, are the main species living and impacted in these waters. Small scale fisheries in FWI are an important social and economic sector, its management is a local priority concern to limit coastal resources decline. Bottom gillnets (one layer), trammel nets (three layers) and "folle" nets (one layer) targeting fish, lobsters and conch are first concerned by the by-catch. Their number and use have increased in the past few years. It is believed that their impact on marine resources is not compatible with long term management. The net fishery account for 20% of the fishing techniques used and causes serious ecological problems as well as for species selectivity. Experimental fishing, targeting lobster (80 trials), fish (78 trials) and queen conch (74 trials), has been conducted to determine the impact of these techniques and to compare species selectivity between new designed nets and the current gears. For the fish technique, the trammel net caused 68% of discards (0.41 g.h-1.m-2). The non commercial species represent most of the catches (59%). The lobster fishing showed that bottom net is quite selective with 22% of discards. The lobster counted for 47% (0.63 g.h-1.m-2). The conch technique showed a better selectivity of the "folle" net with 83% of conch captured. Trammel nets have a significant impact on benthic coral communities. Among the major problems, bycatches of protected species is a reality difficult to assess. About sixty marine turtles have been caught, and about 90% were dead by drowning and entanglement. Trammel and "folle" nets caught and killed more turtles than the gill nets. A policy (ban, no fishing area, fishing period…) in order to limit the impact of trammel nets is required and prepared for more sustainable small scale fisheries and the protection of these protected marine reptiles.

SEA TURTLE STRANDINGS AND HUMAN INTERACTIONS IN SARASOTA COUNTY, FLORIDA

Gretchen N. Lovewell and Amelia R. Jugovich

Mote Marine Laboratory

Mote Marine Laboratory's Stranding Investigations Program (SIP) has been responding to reports of injured living and dead sea turtles in Sarasota County, FL, since 2003; prior to that time another Mote program responded to such reports. From 2000-November, 2010, more than 620 sea turtles of four species were recovered by Mote staff in Sarasota County waters and beaches. Due to undocumented deaths of hatchlings and other unrecovered carcasses, the number of turtles we recovered under-represents the actual number of deaths and serious injuries. Of the turtles recovered, more than 120 had indications of a boat strike, fisheries interactions (gear ingestion or entanglement), mutilation, or some other form of human interaction (HI). Thus, HI was documented in approximately 20% of sea turtle strandings. Environmental factors such as elevated red tide/brevetoxin levels (2005-2006) and prolonged periods of abnormally low temperatures (2010) tend to alter turtle behavior potentially resulting in an increase risk of HI. There was an

increase in the number of HI cases between June and August when (a) summer boating events were most common, and (b) turtle nesting frequency, and thus turtle density in coastal areas with high boat traffic was greatest. The increased chances of injurious human interaction during peak nesting season could have long-term implications for sea turtle conservation.

BUOYLESS GILLNETS SIGNIFICANTLY REDUCE LOGGERHEAD BYCATCH MORTALITY AT BAJA CALIFORNIA SUR, MEXICO*

David Maldonado-Diaz[1], S. Hoyt Peckham[1], Jesus Lucero-Romero[1], Alejandro Rodriguez[1], and Maria Wojakowski[2]

[1] ProCaguama/Grupo Tortuguero
[2] Duke University

Incidental capture or bycatch in coastal gillnets results in high mortality of many vulnerable and endangered megafauna including cetaceans, pinnipeds, seabirds and sea turtles. The overlap of intense gillnet fisheries with high-density foraging grounds of loggerhead (*Caretta caretta*) turtles at Baja California Sur, Mexico (BCS) causes some of the highest bycatch rates recorded worldwide and likely threatens the persistence of the endangered North Pacific loggerhead population. To address this problem, we have partnered with BCS gillnet fishers since 2004 to develop, test and implement gillnet bycatch solutions. The west coast of BCS represents one of Mexico's most productive fishing grounds. Grouper (Mycteroperca sp.) among other valuable fish are targeted by local small-scale fisheries using bottom-set gillnets. Gillnets used to fish for these species have a stretch mesh size ranging from 20-30cm and are deployed with tiedowns in near-shore habitat of 5-40m depths during summer months. We initiated a community-based conservation campaign in 2004 to engage local fishers in mitigating and eliminating their bycatch. Through workshops conducted each fishing season, fishermen proposed modifications to their traditional gillnets that could maintain or increase the profitability of commercially viable target species while reducing or eliminating loggerhead bycatch. Between 2004 and 2008 we conducted controlled experiments to test reductions in net height and net tiedown length, and buoy removal. In our trials, modifications of net height and net tiedown length did not reduce turtle bycatch. In 2007-9 we conducted controlled experiments to compare bycatch rates and landings between traditional (control) nets and buoyless nets (with buoys removed from float line). Buoyless nets were set adjacent to control nets. In 136 controlled sets of gillnet pairs, 66% fewer turtles were caught in buoyless nets (9 turtles) than in control nets (27 turtles). Mean bycatch rates were significantly lower in buoyless nets (0.06±0.3 turtles set-1; mean ± SD) than in control nets (0.19±0.7 turtles set-1; pairwise bootstrap resampling, $p=0.002$). Catch of target fish was similar in species composition and quantity between the two designs, with 1554 and 1926 kg of fish landed in buoyless and control nets, respectively. Daily catch volume was lower in buoyless (11.4±18.6kg set-1) than in control nets (14.2±21.6kg set-1), but this difference was not significant (pairwise bootstrap resampling, $N=136$ $p=0.078$). Based on our results, buoyless gillnets catch significantly fewer turtles while maintaining target catch, representing a potential partial solution to local bycatch mortality. Given the endangered status of the North Pacific Loggerhead turtle and the size of the BCS gillnet fleets, a 60% reduction in bycatch mortality is unlikely to ensure persistence of the north Pacific loggerhead population, let alone recovery. While buoyless gillnets tested at BCS did not eliminate turtle bycatch completely, they may offer an important partial solution for reducing turtle bycatch while comprehensive alternatives are developed, both at BCS and around the world.

USE OF RAPID ASSESSMENTS TO DETERMINE GILLNET BYCATCH MITIGATION PRIORITIES IN THE SOUTHEAST PACIFIC OCEAN

Jeffrey C. Mangel[1,2], Joanna Alfaro-Shigueto[1,2], Natalia Ortiz[1], Nadia Balducci[1], Jodie Darquea[3], Andres Baquero[3,4], Miguel Donoso[5], and Brendan J. Godley[6]

[1] Pro Delphinus, Lima, Peru
[2] University of Exeter, Penyrn, Cornwall, UK
[3] Equilibrio Azul, Quito, Ecuador
[4] Universidad San Francisco de Quito, Quito, Ecuador
[5] Pacifico Laud, Valparaiso, Chile
[6] University of Exeter, Penyrn, Cornwall, UK

The use of rapid assessment surveys has been shown to be useful at gathering and prioritizing information on sea turtle bycatch at a regional scale. In the southeast Pacific Ocean, bycatch has been documented in longline fisheries but there is little information on the effect of gillnet fisheries and the threats they may pose to sea turtle populations. Moreover, it is challenging to scale-up existing findings to allow the identification of priority areas for gillnet bycatch mitigation efforts. To address this, we administered a rapid assessment survey from September to December 2010 in twelve index ports from Ecuador (n= 7 ports, n= 250 fishermen) and Chile (n=5 ports, n= 60 fishermen). Surveys were conducted only with gillnet vessel captains to enhance the reliability and representativeness of the work. A related project was also conducted in Peru (n= 30 ports, n= 500 fishermen). Here we report on survey findings and discuss the regional implications for sea turtle bycatch research.

EFFECTS OF ROCK ARMORING STRUCTURES AND DUNE QUALITY ON THE NESTING PATTERNS OF THE LOGGERHEAD SEA TURTLE ON JEKYLL ISLAND, GEORGIA

Christina Ann Martin

Georgia Sea Turtle Center, Jekyll Island, Georgia, USA

Caretta caretta (loggerhead sea turtle) nesting activities from 1999-2009 were mapped and analyzed against dune quality on Jekyll Island, Georgia to determine if the presence of rock armoring structures have a significant impact on successful nesting attempts. The beach was separated into three sections of equal length based on level of erosion: Moderate erosion section one encompasses the entire length of rock wall, non-erosion section two representing prime nesting habitat, and slight erosion section three included driftwood beach and accretion areas. Nesting activities were distributed respectively into these sections based on their GPS coordinates. Beach success (nests/false emergences), nesting success (nests/(nests + false emergences above mean high tide)), and nesting density (nests/kilometer) were all found to have a negative correlation (r= -0.623, r= -0.632, r= -0.706 respectively) when compared against dune quality. Non-erosional section two displayed significantly higher patterns of nesting success during the eleven year study when compared to sections one and three. Additionally, section two provided suitable nesting habitat for 362 more nests than erosional sections over the eleven year study. These patterns suggest that the presence of rock armoring structures and dune quality affects the nesting behavior of loggerhead sea turtles when selecting nest sites.

A BAYESIAN APPROACH TO PREDICTING LEATHERBACK BYCATCH IN THE CALIFORNIA DRIFT GILLNET FISHERY*

Summer L. Martin[1] and Stephen M. Stohs[2]

[1] Scripps Institution of Oceanography, La Jolla, California, USA
[2] Southwest Fisheries Science Center, NOAA Fisheries, La Jolla, California, USA

The unintentional bycatch of non-target species is a problem in fisheries around the world. Of particular concern is bycatch of endangered and legally protected species, such as leatherback sea turtles. Quantifying bycatch is critical for understanding how this source of mortality affects the dynamics of impacted species. In the U.S., the Magnuson-Stevens Fishery Conservation and Management Act authorizes the use of onboard observers to monitor commercial fisheries catch and bycatch. Observer coverage levels in U.S. federally managed fisheries vary by fishery; for example, the California Drift Gillnet Fishery, which targets swordfish and thresher shark, employs an observer coverage level near 20 percent of effort, while the Hawaii Shallow-Set Longline Fishery requires a 100 percent coverage level to implement a sea turtle quota with a shut-down provision requiring the season to end once either sixteen leatherback or seventeen loggerhead gear interactions have been observed. Many other federally managed fisheries require no observer coverage based on the presumption that bycatch is not a serious concern. A higher level of observer coverage costs more but yields greater certainty for bycatch estimates, which are often used to determine acceptable bycatch levels and therefore limits on the amount of fishing allowed. The existence of observer programs with less than 100 percent observer coverage creates the need to estimate bycatch in the unobserved portion of fishing effort. The traditional approach to this problem has been to calculate deterministic point estimates of bycatch by linearly extrapolating from observed effort to unobserved effort. In order to better characterize the uncertainty in the rare event bycatch process, we have developed a Bayesian approach to predicting the amount of bycatch in unobserved effort. Our approach utilizes previous data to infer a predictive distribution and provide a range of bycatch estimates with associated probabilities. We demonstrate the methodology using 20 years of data (1990-2009) from the California Drift Gillnet Fishery, including the observed fishing effort for swordfish and sharks, the number of leatherback interactions and mortalities, and the number of unobserved fishing sets. This methodology can potentially be applied to other fisheries in which incomplete observer coverage is used to estimate the number of protected species interactions or mortalities.

EGG PREDATIONS OF JAPANESE LOGGERHEAD TURTLES BY AMERICAN RACCOONS?

Yoshimasa Matsuzawa, Takafumi Sugiyama, and Kiyoshi Goto

Sea Turtle Association of Japan, Hirakata, Osaka, Japan

Loggerhead sea turtles (*Caretta caretta*) in the Pacific are endangered and listed above the Top Ten Burning Issues in Global Sea Turtle Conservation by IUCN Marine Turtle Specialist Group. In this sense, sea turtle conservation and census in Japan, which is the sole nesting ground for this species in the north pacific, is of importance and receive much attention. In the past we have noticed and addressed variety of anthropogenic threats such as over exploitation, fishery bycatch, degradation of beach environment, releasing hatchlings after prolonged retention. However, we did not yet pay much attention to egg predation by wild animals in Japan. In this paper we would report that egg predation most probably by American raccoon dogs (*Procyon lotor*) are rapidly increasing and will expand in the future. We located and monitored almost all loggerhead nests in Minabe-Senri beach, which is the greatest loggerhead nesting ground in Honyshu Island, the main land of Japan, since 1996. There few nests were excavated by animals until recent years. But thirty-three clutches were predated in 2008. In 2009 fifty-three clutches, which correspond to one-third of the year total, were excavated. Most of the predations were occurred from the end of July to the middle of August, when we did not cover the surface of the nests by bamboo grids yet. Most other nests also might be predated without such emergency measure. Feral raccoon increase their number and got to have a great impact even on agricultural crops anywhere in Japan. We also got to find increasing number of raccoons on the beach and adjacent farm ground in 2000s. We did not shoot photos of raccoons predating eggs and hatchlings on the beach yet. But raccoons are thought to be the

predators in the most cases. Considering a continual struggle with raccoons in the Atlantic coast of US, we have to now address this issue intensively with cooperation of communities and governments.

WHICH WAY DO WE GO? SHIFTING TRENDS IN DISORIENTATIONS AFFECT LIGHT MANAGEMENT STRATEGIES

Kristen Mazzarella[1], Keri Ferenc-Nelson[2], Sarah Hirsch[1], Paula Clark[3], and Tony Tucker[1]

[1] Mote Marine Laboratory, Sarasota, Florida, U.S.A.
[2] Sarasota County, Sarasota, Florida, U.S.A.
[3] Town of Longboat Key, Longboat Key, Florida, U.S.A.

Light pollution is an ongoing contemporary threat to nesting sea turtles and hatchlings. Light management plans and ordinances for coastal properties have been implemented to reduce the amount of artificial light visible on nesting beaches. Federal and state agencies require the documentation of disorientations to study the causes and effects while local code enforcement identify and rectify lighting issues during turtle nesting season. Biologists, lighting owners, and code enforcement officers are discouraged by a lack of immediate improvement in disorientation rates after substantial efforts have been put forth to reduce beachfront lighting (e.g., light retrofitting, shielding, and changes in enforcement with local lighting ordinances). Such results may not indicate failure, but rather a change in the source of disorientations and a need to adjust current strategies for light reduction. As beachfront lighting problems decline, hatchlings emerging on darker beaches may become more vulnerable to sky glow or the increased the effect of one forgotten light. On the developed coastline of Sarasota County, Florida, the number of turtles disorienting from nests, the proportions of disorientations from viable nests, and the causes of disorientations were investigated to determine whether they were changing over time. There is increasing evidence that disorientations are shifting from individual properties and point sources of light and trending more toward diffuse sky glow or unknown causes. As lighting issues in the immediate vicinity of a coastal strip are addressed, there is a transition as the battle for dark coastal beaches shifts focus inland towards distant sources of sky glow. Therefore, adaptive light management strategies should be considered if a continued decline in disorientation events is intended.

SEA TURTLES AND OCEAN ENERGY TECHNOLOGY

Erin McMichael and Jeanette Wyneken

Florida Atlantic University, Boca Raton, Florida, USA

The introduction of structures in the ocean have the potential to impact marine organisms, including all sea turtle species. These marine turtles are protected under the Endangered Species Act. As such, they require additional attention when assessing human impacts that may disrupt the species' and their habitats. The impacts of ocean energy technology may vary across species and life-history stage as they may utilize coastal waters and currents in different ways. A challenge for any in-water technology is evaluating potential impacts to animals or structures because our understanding of in-water animal distributions and behavior is limited. All marine turtles are migratory specialists that utilize multiple habitats, (nearshore and offshore), traveling to or from nursery areas, feeding grounds, or breeding grounds and nesting beaches. Although sea turtles primarily use the upper 300m of ocean waters, some species are known to dive up to 1250 m. Thus, different ocean energy technologies which are located at various depths may impact sea turtles. Specific concerns will vary according to project location, but are likely to include attraction of sea turtles with structures or devices, interactions with structures, alteration key regions of currents that are used during migration, impacts on currents boundaries that serve as foraging areas, addition of underwater noise, changes in magnetic properties at sites, and alteration of foraging grounds used by juveniles and adults. In addition, sea turtles and some of their prey species are known to be attracted to offshore structures, increasing the likelihood of equipment-turtle interactions. Here, we report on the process and progress on instituting a monitoring and research program aimed at minimizing impacts of ocean energy technology on sea turtles within the Florida Current off southeast Florida. Our approach outlines the process of initiating this project and assessing available information, and criteria to establish

baselines to identify likely sea turtle impacts. Our specific focus is to identify and estimate annual and seasonal density of marine turtles throughout the area.

SETTING DEEPER, CATCHING FEWER? SEA TURTLE BYCATCH ON DEEP SET PELAGIC LONGLINES IN URUGUAYAN WATERS

Philip Miller[1], Maite Pons[1], and Andres Domingo[2]

[1] CICMAR, El Pinar, Canelones, Uruguay
[2] DINARA, Montevideo, Uruguay

It has been suggested that deep set (>100m hook depth) pelagic longlines have substantially lower rates of sea turtle bycatch than shallow set longlines. The Uruguayan pelagic longliners have been exclusively using shallow longlines during the last 25 years. During the years 2009 and 2010, the government of Uruguay granted scientific prospective fishing permits to a Japanese company to assess the abundance and economic feasibility of targeting big eye tuna within the country's EEZ, where it has not been targeted for the last 15 years. These boats operated with 100% observer coverage of the National Program of Observers Onboard the Tuna Fleet (PNOFA), managed by the National Direction of Aquatic Resources (DINARA). During the periods March-September 2009 and May-August 2010, 689 sets were deployed. The observers obtained information of the fishing gear and operative, recorded the whole capture and identified the species of each captured individual, including all sea turtles. Hook depth was measured using TDRs, and averaged 133m ranging between 75 and 210 m (n=92 measurements). Most of the turtle captures corresponded to loggerheads, but leatherback, green and olive ridley turtles were also captured. The turtle's CPUE was found to be similar to that of the traditionally employed shallow set longlines operating in the region. Thus, the idea that pelagic longliners targeting tuna with deep set longlines do catch fewer turtles, needs to be considered with caution.

A MODEL-BASED TOOL FOR SETTING CUMULATIVE INTERACTION LIMITS FOR MARINE TURTLES*

Jeff E. Moore[1] and K. Alexandra Curtis[2]

[1] Protected Resources Division, Southwest Fisheries Science Center, National Oceanic and Atmospheric Administration, La Jolla, California, USA
[2] Center for Marine Conservation, Nicholas School of the Environment, Duke University Marine Laboratory, Beaufort, North Carolina, USA

Incidental take in fisheries is a primary cause for global population declines of marine turtles. Scientific review panels and international fisheries management meetings are calling for effective assessment of population impacts of fisheries bycatch, but as yet, no consistent, life-history-based decision tools are in place for estimating how much incidental take can be sustained by marine turtle populations without impeding recovery or leading to decline. Instead, incidental take limits are set *ad hoc* and may not offer adequate protection, or in some cases may result in unjustifiably restrictive regulations for fishermen. We have developed a robust, quantitative, matrix-population-model-based approach to setting total incidental take limits, analogous to the Potential Biological Removal tool used for marine mammals under the U.S. Marine Mammal Protection Act (MMPA). We demonstrate the effectiveness of this approach in principle with simulations that compare recovery of hypothetical turtle populations subjected to managed bycatch mortality to those without anthropogenic mortality. Performance tests include varying age at first reproduction, type of density-dependence, level and correlation of stochasticity in survival and fertility rates, and levels of uncertainty in estimation of population size and bycatch mortality. Additional proof of concept simulations assess performance (and management modifications needed) in the cases of biased information for survival and fertility rates, population size or estimation uncertainty, mortality or estimation uncertainty, strength and type of density dependence, and variation in starting age distribution. The approach described here could be applied to marine turtles under the Endangered Species Act in the U.S. or under Regional Fisheries Management Organizations internationally.

BEACH RESTORATION AND ITS EFFECT ON LOGGERHEAD SEA TURTLE HATCHLING FITNESS IN FLORIDA*

Mario J. Mota

University of Central Florida, Orlando, Florida, USA

Beach restoration projects create coastal habitats that can differ from native coastlines in many physical properties such as sand grain composition, sand compaction, sand calcium carbonate, and moisture content. Data show that these engineered beaches impact nesting and hatching successes, but a question often asked is whether they affect hatchling quality. Sea turtle nests in these engineered beaches are subjected to a microenvironment that can impact incubation by restricting normal incubating cycles of CO2 and O2. Previous research has shown that hatchlings emerging from clutches incubated under these conditions are physiologically stressed, as measured by morphological and hematological data. An experiment was designed to test how these hatchlings behave during the first hour of their swimming frenzy. Three incubators were buried in Melbourne Beach and filled with experimental sand with relatively high total CaCO3 (10-12 %). This concentration was based on the mean value measured from engineered beaches with high sand compaction. Each incubator had forty eggs that were randomly collected from three loggerhead sea turtle nests. These nests were marked and sampled as controls for native beaches with low sand compaction. Weekly 2 ml air samples were collected from each incubator and beach nest and CO2 and O2 concentrations analyzed by gas chromatography. All clutches were monitored for hatching and after emergence, they were excavated and their fertility rates calculated. A subset of hatchlings (n=30, each) was collected from incubators and beach nests, and assessed for physical and hematological (PCV, total proteins, triglycerides, glucose, cholesterol, and lactate) differences. Hatchlings from each treatment were harnessed, tethered to an event recorder/force transducer and placed in a circular pool. Their swimming activity was recorded for one hour. Observers collected data on total number of breaths, long breaths, swimming strokes, and time floating/resting. Results show that clutches incubated in high concentrations of sand carbonate were exposed to elevated CO2 levels during the second half of incubation, when compared to clutches from soft native sand. Statistically significant differences ($p < 0.05$) between sand treatments were found in hatchling morphological and hematological data. Hatchlings emerging from incubators with high CO2 levels were smaller (body weight, straight-line carapace width and length) and also had higher blood triglycerides and lactate values. These differences were reflected in swimming behavior. After an initial 30 minute burst of energy, hatchlings from the experimental incubators progressively swam slower while controls stabilized and swam at a constant speed. High blood lactate, a byproduct of anaerobic muscle metabolism, substantiates the slower speed of incubator hatchlings. Their higher triglycerides indicate that yolk lipids are being utilized as energy source. These hatchlings also took more long breaths and had a higher swim/breath ratio than controls. Although beach restoration regulations aim to minimize impacts on sea turtle nesting, data show that hatchlings emerging from incubation environments with high sand CaCO3 and restricted CO2 flux are physiologically stressed. This effect can hinder the ability of hatchlings to swim and disperse from their natal beach.

INTERACTIONS BETWEEN SEA TURTLES AND DREDGE GEAR IN THE U.S. SEA SCALLOP FISHERY, 2001-2008*

Kimberly T. Murray

NOAA Fisheries, Woods Hole, MA, USA

Since 2006, the National Marine Fisheries Service (NMFS) has mandated gear modifications (“chain mats”) and fishing effort reductions in the U.S. Mid-Atlantic sea scallop dredge fishery to alleviate or minimize interactions with sea turtles. Turtle interactions with gear can be defined as those that are “observable” based on standard fishery observer protocols, plus unobserved interactions, which include both quantifiable and unquantifiable interactions. Once a gear modification is in place, a turtle interaction that was once observable may become unobservable, because the gear modification successfully prevented the turtle from being captured. This presentation describes turtle interactions

in scallop dredge gear from 2001 to 2008, identifies gear and environmental correlates with observable interaction rates, and reports the average annual number of interactions and adult-equivalent interactions before and after chain mats were mandated in the fishery. Fisheries observer data were used to develop a Generalized Additive Model (GAM) to estimate rates of observable interactions of hard-shelled turtles. These rates were applied to commercial dredge fishing effort to estimate the total number of observable interactions, and to infer the number of unobservable, yet quantifiable interactions after chain mats were implemented. Interaction rates of hard-shelled turtles were correlated with sea surface temperature, depth, and use of a chain mat. The average number of annual observable interactions of hard-shelled turtles in the Mid-Atlantic scallop dredge fishery prior to the implementation of chain mats (1 Jan 2001 through 25 September 2006) was estimated to be 288 turtles (CV = 0.14, 95% CI: 221 – 376), which is equivalent to 49 adults. After implementation of chain mats, the average annual number of observable interactions was estimated to be 20 turtles (CV = 0.48, 95% CI: 8 – 49), equivalent to 4 adults. If the rate of observable interactions from dredges without chain mats had been applied to trips with chain mats, the estimated number of observable and inferred interactions of hard-shelled species after chain mats were implemented would have been 125 turtles per year (CV = 0.51, 95% CI: 49 – 318). Results from this analysis suggest that chain mats and fishing effort reductions contributed to the decline in estimated turtle interactions after 2006.

ASSESSMENT OF THE HUMAN IMPACT ON SEA TURTLES NESTING ALONG THE COASTLINE OF MUANDA, DEMOCRATIC REPUBLIC OF THE CONGO

Samuel Mbungu N.[1] and Alain Gibudi[2]

[1] ACODES ONG, Muanda/ République Démocratique du Congo
[2] PROTOMAC ONG, BP 14 533 Libreville, Gabon

Three of the seven species of sea turtles nest along the coastline of Muanda, in the Democratic Republic of the Congo. These nesting sites were virtually unknown until recently. The first effective monitoring campaign focused on sea turtles on Muanda’s coasts began in 2005 with funding from WWF / DRC. Since then, three consecutive seasons of sea turtle monitoring have been conducted. These monitoring reveal that 80% of sea turtles are victims of bycatch by artisanal fisheries, and 54.5% of nesting females are subject to poaching. In addition to this, the nests themselves also undergo considerable anthropogenic pressure. This work tirelessly conducted by teams from the NGO ACODES during three seasons has clearly demonstrated that increasing anthropogenic impacts in any form are the main threat to sea turtles and other species in this region. Hence the importance of increasing conservation efforts to fight against these scourges in order to ensure the survival of these endangered species!

ELIMINATING THE CAPTURE OF MARINE TURTLES AND REDUCING BYCATCH : THE FRENCH GUIANA SHRIMP FISHERMEN AND THE WWF HAVE COMMAN GOALS!

Michel A. Nalovic[1] and Laurent Kelle[2]

[1] CRPMEM Guyane (Comiter Régional Des Peche Marines et Elevage Marins de Guyane)
[2] WWF France

In French Guiana tropical shrimp trawl fisheries represent a major source of bycatch since shrimp represents only 10% of the total catch. Though the amount of interaction is not well quantified the strong presence of marine turtles in French Guiana indicates that there capture might be frequent. With this in mind the WWF-France proposed to allow the fishers to develop and improve there own fishing technique. For eliminating the accidental capture of marine turtles there exists a system called the TED (Turtle Excluder Device) which is widely used in the Americas but not in French Guiana. The system consists of a grill that is inserted in the trawl at a 45 degrees angle with an opening toward the top or bottom. Its use eliminates the capture of 97% of marine turtle. Thanks to European funds the WWF in 2006 ordered a study by IFREMER to test different selective gear on shrimp trawlers off the coast of French Guiana. Fallowing this work the industry members expressed the need to continue experimenting. To accomplish this the WWF and the CRPMEM began collaborative research partnership. With technical support from NOAA (National Oceanic and

Atmospheric Administration) and IFREMER (Institue Française de Recherché pour l'Exploitation de la Mer), the CRPMEM Guyane executed at sea trials. Parameters such as the shape and the spacing between the bars where tested. These trials allowed crews onboard to appreciate the advantages associated with the use of selective fishing gear. After ample testing a prototype bringing together the advantages of different systems was identified. This model re-baptised TTED, shows one particular advantage over the regular TED. On average the TTED reduces bycatch by 25-40% in French Guiana. It competently eliminated the capture of elasmobranches. The use of the TTED reduces workload and also the risks of injury due to sharks and rays that are frequently include in the Bycatch. Fallowing the restitution of the at sea trial and the recommendations from the captains and scientific community the TTED was included in the EU regulation guidelines for trawling in French Guiana as of January 2010. In waiting for this new law to come into effect the WWF-France and the CRPM Guyane partnered up again and, with funds from the European Union, the Fisheries Ministry and the French Guiana Region, bought TTED's for the industry. Also the CRPMEM Guyane invited NOAA technicians for a workshop to teach the captains how to install and maintain the new TTED. Today others have heard about the TTED and both the Departments of Fisheries of Neighbouring Suriname and Guyana have expressed the desire to test the TTED in their shrimp fisheries. This is a good sign for the turtles of the Guiana's shield. This collaborative research program is the result of bringing all stake holders together and determining common objectives. This type of open consultation is the ideal way to get things moving effectively. As a result the TTED was developed in French Guiana for the welfare of both marine organisms and the fishing sector.

SUBSTITUTING HOOK AND LINE FOR GILLNET FISHING: A POTENTIAL MARKET-BASED SOLUTION TO REDUCING BYCATCH MORTALITY AT BAJA CALIFORNIA SUR, MÉXICO*

S. Hoyt Peckham[1], D. Maldonado-Diaz[1], J. Lucero-Romero[2], A. Rodriguez[1], A. Esliman-Salgado[2], M. Wojakowski[3], and E. Caballero[2]

[1] Proyecto Caguama
[2] Grupo Tortuguero de las Californias
[3] Duke University

Coastal gillnet fisheries are among the leading sources of overfishing and bycatch worldwide. Gillnets have proliferated over the past 30 years because they are inexpensive, lucrative as well as easy to fish, build and repair. Though gillnets are inherently non-selective, modifications of net characteristics can reduce bycatch. Where gillnet fisheries overlap with important juvenile foraging habitat of loggerhead turtles at Baja California Sur, Mexico (BCS), gillnet modifications result in substantial decreases in bycatch rates. However, given the endangered status of the North Pacific loggerhead and their extremely high annual mortality in local gillnet fleets, bycatch decreases achievable through gillnet modification are unlikely to ensure population persistence. In partnership with local master fishermen we began investigating the economic viability and biological effects of substituting hook for gillnet fishing of grouper (Mycteroperca sp.) and other valuable groundfish in 2007. Pilot trials conducted in 2009 and informal fisher interviews suggested that hook fishing was lucrative prior to the introduction of gillnets in the 1980s, that it results in zero turtle bycatch, and that fishers have interest in returning to hook fishing. Semi-structured interviews of local grouper fishing captains (N=27) suggested that 58% would be willing to switch to hook fishing under current market and fishery conditions. The principal concern of all fishers regarding switching was the viability of a preferential market for hook-caught fish. We conducted a market study to evaluate the viability of hook fishing by combining a) catch volume and composition for local gillnet fleets from our 2004-2009 observer database and b) fisher interviews to identify fish product, handling, and infrastructure and compared these with expert assessment of market demand in NW Mexico and the USA. We concluded that ex-vessel value could be augmented by in excess of 100% by improving handling and refrigeration of hook-caught fish. Achieving these added values would require vessel conversion, fisher training, and added infrastructure. Preliminary evaluation of these costs suggested they would be modest given available private and public funding. In summer 2010 we equipped 18 crews with gear for bottom trolling and jigging, each of whom received onboard training from master fishermen. We conducted onboard observations of 61 hook trips and compared landings with 267 gillnet trips. Both gears were fished over rocky bottom for grouper. Mean catch volume and value per trip were not substantially different between hook and gillnet trips. Hook landings were more selective, reducing fish bycatch and eliminating turtle bycatch. Cultivation of demand for hook caught, turtle friendly groundfish is underway for BCS. Opposition was encountered from local fisheries intermediaries, and efforts are underway to explore how best to accommodate their roles in the emerging preferential market. The combination of observed hook fishing performance and market viability for the substitution of hook fishing constitutes a potential market-based

solution to local gillnet bycatch and perhaps overfishing, representing an opportunity with broad potential in similar fisheries worldwide. Implementation of this market-based solution will require complementary enhancement of local fisheries management and evaluation of ecosystem effects and sustainability.

A HAZARD ASSESSMENT OF COASTAL POLLUTION ON ENDANGERED LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*)

Christopher A. Pincetich, Teri Shore, and Todd Steiner

Sea Turtle Restoration Project, Forest Knolls, California, USA

Critically endangered leatherback sea turtles (*Dermochelys coriacea*) migrate across the Pacific Ocean to forage on scyphomedusae populations off the Coast of California, Oregon, and Washington, exposing them to municipal, industrial, and non-point source coastal pollution. Maintaining good water quality in coastal marine environments is essential to the normal health and development of leatherback sea turtles, their scyphomedusae prey, and the planktonic life that supports scyphomedusae populations. Stormwater and nonpoint-source runoff is recognized by EPA as the leading sources of contaminants and marine plastics along the west coast of the U.S. Polluted discharges cause direct toxic impacts to marine species and can impact coastal ecosystems through delivery of heavy metals, chlorinated pesticides, disease causing pathogens, debris, and plastics. Global sea turtle research indicates poor coastal water quality results in increased disease, accumulation of heavy metals and organochlorine contaminants, and death from ingestion of plastic pollution. Warm, point-source discharges have attracted greater densities of marine life and sea turtles, putting them at increased risk from toxicity, and is sea turtles, increased risk of fibropapilomas believed to be caused by water quality impacts. Emerging water quality contaminants of concern in the marine environment include pharmaceutical drugs, anti-microbial agents, fire retardants, nanoparticles and plasticizers. A hazard assessment approach is presented to evaluate the effects of coastal pollution on the endangered western Pacific leatherback sea turtles.

INGESTION OF PLASTIC BY SEA TURTLES IN THE STATE OF PARAIBA, NORTHEAST BRAZIL

Camila Poli, Cinthia Saska, and Rita Mascarenhas

Universidade Federal da Paraíba ,João Pessoa, Paraíba, Brazil and Associação Guajiru - Projeto Tartarugas Urbanas, Cabedelo, Paraíba, Brazil

After 12 months of daily monitoring (August 2009 to July 2010) of beaches between the municipalities of João Pessoa (7º08'S and 34º48'W) and Cabedelo (7º01'S and 34º49'W), 124 sea turtle strandings were recorded. The curvilinear carapace length (CCL) and curvilinear carapace width (CCW) were measured. During necropsy, the gastrointestinal tract was removed and the organs were analyzed separately (esophagus, stomach and intestine). The gastrointestinal contents were washed and the plastic residues were distinguished from the other food items, which were later quantified, weighed and qualified according to their structure and color. The items were separated into the categories malleable or rigid plastic and colored, white or transparent plastic. A total of 98 gastrointestinal tracts were obtained from sea turtles found stranded in the study area. Of these, 20 (20.4%) contained plastic residues, where 13 (65%) were *Chelonia mydas*, five (25%) *Eretmochelys imbricata* and two (10%) *Lepidochelys olivacea*. CCL varied between 29.1 and 89.3 cm, with a mean of 46.03, although only one individual could be considered adult. In 13 (65%) individuals, a hardened mass of feces and plastic was found blocking the gut, making it possible to affirm that death was caused by the ingestion of plastic. The total number of items ingested was 361 items and per organism varied between 1 and 87, with a mean of 18.05 items. The total weight of the items found was 114.92 g, varying between 0.01 and 63.53 g/individual, with a mean of 5.74 g/individual. There was no positive correlation between CCL and number of items ($r = 0.15$, $p>0.05$) and between CCL and weight of the items ($r = 0.01$, $p>0.05$). The majority of the items ingested belonged to the category of malleable plastic, totaling 310 (85.87%) items, with a mean of 15.5 items. The category rigid plastic totaled 51 items (14.12%), with a mean of 2.55 items. There was a significant difference in the ingestion of

malleable plastic versus rigid plastic (ANOVA $F(1,38) = 21.61$, $p = 0.0001$). In the categories of color, transparent plastic was more abundant, totaling 178 (49.31%) items, with mean of 8.9 items, followed by colored plastic with 103 items, mean of 5.1 items, and white plastic with 80 items, mean of 4 items. There was no significant difference in the ingestion of plastic by color category (ANOVA $F(2,57) = 1.34$, $p = 0.2671$). The frequency of occurrence of the items collected was 85% in the intestine and 40% in the stomach. No items were found in the esophagus. In this study, it was possible to see that the sea turtles along the coast of Paraiba showed a growing incidence of ingestion of plastic, as demonstrated in studies in other parts of the world, and that the juvenile individuals, which do not have feeding specializations, are more susceptible to ingestion of these marine residues.

RAPID ASSESSMENTS OF THE BYCATCH OF SEA TURTLES IN ARTISANAL FISHERIES IN THE WESTERN INDIAN OCEAN ISLANDS*

Chris Poonian[1], Eleanor Cunningham[2], and Tara Whitty[3]

[1] Community Centred Conservation (C3), London
[2] C3 Madagascar and Indian Ocean Islands Programme
[3] Scripps Institution of Oceanography, San Diego

Bycatch is a global threat to sea turtles with artisanal fisheries posing particular challenges in terms of data collection, monitoring and mitigation strategies. Due to the decentralized nature of artisanal fisheries, limited infrastructure for research and monitoring in developing countries, and logistical obstacles to establishing observer programs, collecting data on bycatch through interviews is recognized as a practical method for estimating the magnitude of bycatch in artisanal fisheries We conducted rapid assessments of sea turtle bycatch in artisanal fisheries of the Union of the Comoros (n=409), Mauritius (n=110) and Madagascar (n=573) in the Western Indian Ocean using semi-structured interviews of fishers. Bycatch was found to pose a serious threat to sea turtle populations. It was reported as a routine occurrence by fishers in Madagascar and Comoros in a variety of fishing gears, particularly gillnets in Madagascar and longlines in Comoros and Mauritius. Although turtles were often released alive, mortality was generally high and turtles were often killed and eaten or sold in Comoros and Madagascar. Various local traditions and taboos were also found to influence artisanal fishers' interactions with sea turtles at all study sites. The heterogeneity of gears used by artisanal fishers, and the potential for sea turtle bycatch in a variety of gear types indicated by this work suggests that mitigating turtle bycatch in artisanal fisheries in the western Indian Ocean requires close collaboration with fishing communities including capacity-building and awareness raising to ensure that management actions are implemented effectively. Addressing the impacts of these fisheries on sea turtles will require examination of the potential for alternative livelihoods and locally- enforced regulations. These results demonstrate the deep human roots of fisheries interactions with sea turtles that must be understood for effective management and conservation.

HEALTH STATUS OF SEA TURTLES FROM THE CENTRAL-NORTH COAST OF RIO DE JANEIRO STATE, BRAZIL

Estéfane C. Reis[1], Dália dos P. Rodrigues[2], Christiane S. Pereira[2], and Salvatore Siciliano[3]

[1] Universidade do Estado do Rio de Janeiro (UERJ), Laboratório de Genética Marinha (LGMar), Rio de Janeiro, RJ, Brazil
[2] Fundação Oswaldo Cruz (FIOCRUZ), Laboratório de Referência Nacional de Cólera e outras Enteroinfecções Bacterianas (LRNCEB), Rio de Janeiro, RJ, Brazil
[3] Fundação Oswaldo Cruz (FIOCRUZ), Grupo de Estudos de Mamíferos Marinhos da Região dos Lagos (GEMM-Lagos), Rio de Janeiro, RJ, Brazil

In Brazil, there are five species of sea turtles, commonly known as loggerhead, green turtle, hawksbill, olive ridley and leatherback turtle. All are considered endangered under national and international criteria. Human action has caused many impacts on marine ecosystem and threatened its biodiversity. Several microorganisms inhabit this ecosystem and

are able to cause infectious diseases. Therefore, marine environment changes contribute to the emergence of diseases, such as fibropapillomatosis in sea turtles. The ingestion of solid anthropogenic debris is another important menace to many marine organisms. In this context, the present study aims to investigate the presence of bacterial agents of the Vibrionaceae and Aeromonadaceae Families, the occurrence of fibropapillomatosis, and the interaction with anthropogenic debris in stranded sea turtles found along the central-north coast of Rio de Janeiro state, and thus assess the health status of these organisms and their environment. For this, beach monitoring was made at intervals of 15 days along the study area by GEMM-Lagos staff in 2009. Sea turtles were identified at species level and checked for the presence of external tumors. Specimens, when fresh, were necropsied and gastrointestinal contents screened to evaluate the presence of anthropogenic debris. Swabs were also collected for bacteriological analysis conducted by LRNCEB/FIOCRUZ – an innovative survey for sea turtles in Brazil. 143 sea turtles were found stranded in the study area and only four had tumors. This low incidence may be explained by the advanced state of decomposition of most of the specimens. 43.7% of the gastrointestinal contents screened had anthropogenic debris, indicating a potential cause of sea turtles' death in the region, specially of *C. mydas*. 88.2% of swabs were positive for Vibrio and 52.9% for Aeromonas. Thus, sea turtles, as sentinels of marine ecosystem health, indicate the environmental degradation of the central-north coast of Rio de Janeiro state, prompting the need for urgent mitigation actions.

QUANTUM LIGHT MEASUREMENT TO AID ASSESSMENT OF ANTHROPOGENIC AND NATURAL LIGHT INFLUENCES ON SEA TURTLE NESTING, TYBEE ISLAND, GA

Ana N. Reyes and Christopher J. Hintz

Savannah State University, Savannah, Georgia, USA

Tybee Island, GA has extremely low sea turtle nesting density; although highest in 20 years, only eleven nests were laid along the three-mile shoreline during the 2010 nesting season (2.2 nests km-1). One proposed reason for low nesting density is light pollution along the developed beachfront. To assess potential light pollution, we developed a technique to quantify light levels emanating or reflected from seaward and shoreward surfaces using a Licor LI-1400 Data Logger/Light Meter with two LI-190 Quantum Sensors. Simultaneous measurement of seaward and shoreward light intensities, normal to the shoreline and collected 20 cm above the ground, provided ratiometric light level measurements relevant to sea turtle hatchlings and nesting females. Initially, we measured the light field along Tybee Island during summer 2010 to identify areas subject to light pollution along the nighttime beach. In a second but related study, we investigated the influence of moonlight on beach light field. A single site adjacent to a known sea turtle nest was measured during new, first-quarter, full, and third-quarter moon to observe the change in light field as the ambient moonlight changed. Further, the effect of moon elevation angle (seaward and shoreward) had on the lightfield was investigated during a single full-moon night. The moon when gibbous to full substantially reduces the effect anthropogenic light has on the ambient light field. The effect is reinforced soon after moonrise until its zenith, when this bright nighttime light source is over the ocean. These data will be useful for sea turtle conservationists to use in awareness campaigns for Tybee Island, encouraging the reduction of light pollution by commercial, residential, and municipal sources.

PRELIMINARY RESULTS OF THE EFFECTS OF SIMULATED PILE DRIVING VIBRATIONS ON SEA TURTLE EMBRYOGENESIS

M. Ripcke, M. Guinea, and K. McGuinness

Charles Darwin University, Darwin, NT, Australia

The effects of low frequency, high amplitude vibrations on the embryonic development of sea turtles were investigated using the eggs of the flatback sea turtle, *Natator depressus*, as model species. The experimental design incorporated three stages of embryonic development, each of which was treated with six simulated pile driving vibrations of 440 Hz. Amplitudes varied from 1.24 m/s2 to 3.81 m/s2 vertical acceleration (86.6 dB(A) to 110.8 dB(A) re 20 µPa @ 0.05 m sound level). A control group was not vibrated at any stage and subjected only to background acceleration (-0.01m/s2)

and sound (63.2 dB). Each treatment group incorporated three replicates of 10 eggs each. The major findings were: 1. High amplitude vibration significantly decreased hatching success in the sea turtle N. depressus. 2. The lethal vibration 50 (LV50) for N. depressus at 440 Hz is suspected to lie between 1.67 m/s2 and 3.7 m/s2 vertical acceleration (or 94.4 to 110.3 dBA re 20 µPa @ 0.05m sound level). 3. There was no detectible effect of the developmental stage at which vibrations were administered on the hatching success of turtle eggs. A complimentary study was performed to assess the suitability of the common chicken (Gallus gallus) to replace sea turtle eggs in future vibration experiments. The study design was replicated and the major outcome was: 4. Chicken eggs are not suitable surrogates for sea turtle eggs as neither the administrated vibrations, nor the developmental stage at which they were administered affected chicken hatching success. This study will be used to develop sea turtle friendly strategies for port development by incorporating these results into safe approach distance modelling of pile driving to nesting beaches.

CLIMATE CHANGE IMPACTS ON NESTING LEATHERBACK TURTLES IN THE EASTERN PACIFIC OCEAN*

Nathan J. Robinson[1], Sara Valentine[2], and Frank V. Paladino[2]

[1] Department of Biological Sciences. Purdue University. West Lafayette. IN 47907. USA
[2] Department of Biology, Indiana-Purdue University. Fort Wayne. IN 46805. USA

The number of leatherback turtles, *Dermochelys coriacea*, nesting at Playa Grande beach in northwest Costa Rica exceeded 1,000 individuals per year prior to 1990. This number has subsequently declined, although this decline has been characterized by large inter-annual fluctuations. In this long-term study of leatherback nesting data, it is demonstrated that over the past 16 years the peak median day (PMD) of nesting has shown a general trend towards occurring later in the nesting season (PMD varied from Julian day 346.5 to 366). It is also evident that the relative ratio of successful nesting events declines towards the end of the nesting season. Part of the variability in PMD can be explained by the El Niño-Southern Oscillation, which alternates between a warm El Niño phase and a cooler La Niña event every few years in the eastern tropical Pacific. ENSO events could be affected by future scenarios of climate change with warmer SST's (Sea Surface Temperatures) resulting in more frequent and stronger El Niño events. This study predicts if SSTs continue to rise, by delaying the arrival of the leatherback turtles to the nesting beach, the PMD could continue to shift to later in the season. This scenario would result in a continual decrease in the ratio of successful nesting attempts per season and thus a decline in potential reproductive output of the population.

USING GIS TO DETERMINE THE EFFECT OF SKYGLOW ON NESTING SEA TURTLES OVER A TEN YEAR PERIOD*

Kirt W. Rusenko, Rick Newman, Cody Mott, Juan Duarte, Trevor Tyner, Heather Iannozzi, and David Anderson

Gumbo Limbo Nature Center, 1801. N. Ocean Blvd., Boca Raton, FL, 33432, USA

The Boca Raton Sea Turtle Conservation and Research Program has recorded Global Satellite Positioning (GPS) for all sea turtle crawls over the five miles of nesting beach in Boca Raton, FL since 2001. During this time period shifts in sea turtle nesting from dark City Park areas to beachfront condominiums have been recorded with the majority of the crawl activity located in front of the taller and wider condominiums as first reported by Salmon, *et al*., 1995. South Beach Park in Boca Raton has a low and even dune line and a portion of the area was renourished in 2004 and 2005 which apparently exacerbated the sky glow apparent to emerging female sea turtles. During the 2004 nesting season a 70% decline in crawl activity was noted in a two kilometer area known as South Beach Park. Since crawl activity dropped a similar amount in the area of South Beach Park that was not renourished, the reason for the decline in crawl activity is largely due to sky glow. Using ESRI ArcGIS 9.x with Spatial Analyst to demonstrate crawl density, persistent crawl activity predominated in one area near the south end of the park. This area was characterized by three 80 foot tall Australian Pine Trees indicating that female sea turtles were seeking shaded areas of the beach to nest.

Following the 2006 sea turtle nesting season in Boca Raton there no longer remained an area of persistent crawl activity in South Beach Park. This was largely due to the fact that the previous fall, Hurricane Wilma had destroyed the three Australian pine trees. The trees never recovered from the hurricane damage and two of them were removed in 2008 leaving the area with no shade from the city glow. Areas of South Beach Park with a low dune profile demonstrate concentrations of below the high tide line false crawls indicating that many of the female sea turtles are making a decision to avoid the area before they emerge from the ocean. Another Park area in Boca Raton is also seeing shifts in crawl activity that seems to be influenced by removal of Australian pines. The number of hatchling disorientation events attributed to or influenced by sky glow has increased over the last 14 years. In the past, these disorientations have rarely been lethal but recently sky glow disorientations in dark park areas have resulted in the death of more than half of the hatchlings. In 2010, the majority of recorded hatchling disorientations have occurred in the days nearest a new moon and hatchling disorientations show a decrease during a full moon.

MAMMALIAN PREDATION OF SEA TURTLE NESTS IN BOCA RATON, FL- FIFTEEN YEARS OF STUDY AND THE EFFECTIVENESS OF USING HABENERO PEPPER POWDER FOR CONTROL

Kirt Rusenko, Rick Newman, Cody Mott, David Anderson, Trevor Tyner, Juan Duarte, and Heather Ianozzi

Gumbo Limbo Naure Center, 1801 N. Ocean Blvd., Boca Raton, FL 33432, USA

The Boca Raton Sea Turtle Conservation and Research Program has recorded detailed information on successful and unsuccessful attacks by mammalian predators on sea turtle nests on five miles of beach in Boca Raton, FL since 1996. This data collection was begun as a student research project which demonstrated that the 20 year practice of caging nests in Boca Raton was an ineffective method of nest protection (Mroziak, *et al*., 2000). As a result of this study, cages were no longer used routinely as protection from mammalian predators. The two prominent predators in Boca Raton are the raccoon (*Procyon lotor*) and the gray fox (*Urocyon cinereoargenteus*). From 1997 to 2000, no physical method of protection was used and the predation rates averaged 16.0%. Each year during this time period the number of attacks increased as the predators relearned how to find in situ sea turtle nests. Beginning late in the 2000 nesting season we began to use hot pepper sauce as a deterrent with variable success. In 2001 and 2002 the overall predation rate slightly increased to 16.4%. Because hot pepper sauce would attract fire ants, it could not be used near nests. Chicken eggs were injected with hot pepper sauce and placed on predator trails and dune accesses. This was not effective as the predators did not seem to associate the hot eggs with sea turtle eggs, and the fact that the shore birds would often eat the eggs did not help. In 2003, we started using habanero pepper powder in combination with screening in areas of high predator activity such as city park areas, which had high populations of raccoons. The habanero powder has a Scoville rating of 250,000 compared to a rating of 5,000 for common Tabasco sauce which makes the powder an effective deterrent. The powder is only used in response to a dig on a sea turtle nest by a mammalian predator. Approximately 2-4 grams of powder are sprinkled in each dig. When the predator returns to the nest, sniffing the peppered dig hole effectively removes the predator from foraging that night. From 1996 to 2002, there were an average number of 505 fox attacks each season. From 2003 to 2010, the average number of fox attacks decreased to 167. The average number of raccoon attacks per season actually increased slightly during those time periods from 310 to 373. More significantly, the percentage of successful attacks on sea turtle nests decreased nearly two-fold to 6.79%, indicating the habenero pepper was an effective deterrent from 2003 to 2010. Successful predations were defined as either total predation (less than 50 whole eggs in nest at excavation) or partial predation (more than 50 whole eggs in the successfully predated nest at excavation). In the past 8 years, predation has moved out of city park areas to condominium areas where residents have begun feeding foxes.

PROJECTING THE RESPONSE OF EASTERN PACIFIC LEATHERBACK TURTLES TO CLIMATE CHANGE*

Vincent S. Saba[1], Charles A. Stock[2], James R. Spotila[3], and Pilar Santidrián-Tomillo[3]

[1] Princeton University, Princeton, NJ, USA
[2] NOAA Geophysical Fluid Dynamics Laboratory, Princeton, NJ, USA
[3] Drexel University, Philadelphia, PA, USA

The impacts of anthropogenic induced climate change on ecosystems and biodiversity is one of the key topics for the upcoming fifth assessment report from the Intergovernmental Panel on Climate Change (IPCC). Sea turtles are excellent candidates for this assessment because their response to climate change can be driven by both terrestrial and oceanic dynamics. The nesting population of eastern Pacific leatherbacks at Playa Grande, Costa Rica has been extensively studied in terms of its sensitivity to present-day climate variability in the ocean and beach. Therefore, these turtles are an ideal species for a climate change impacts study. Fisheries and historic egg poaching have rendered this population critically endangered yet even if these threats are reduced or eliminated, the population still faces the challenge of recovery in a rapidly changing climate. Here we used IPCC-class climate models to force a nesting population model based on empirical climate sensitivity data. We designed a population model that estimates nesting recruitment and remigration as a function of mature female foraging success determined by El Niño Southern Oscillation (ENSO) variability. Nest success and hatchling sex ratios were determined by air temperature and precipitation. Monthly precipitation/air temperature data and sea surface temperature data were extracted from 14 IPCC climate models from 1975-2100 such that the period from 2000-2100 represented the projected CO2 trends under the IPCC A2 scenario. All modeled data was bias-corrected based on empirical data from 1975-1999. We assumed no significant effect of sea level rise on the nesting beach, eliminated fisheries mortality, and only considered models that resolved the empirical relationship between ENSO, precipitation, and air temperature. This resulted in the use of 7 models. Considering the mean projection from these 7 climate models, the nesting population remains stable until the decade beginning in 2030 when the population begins to decline. By the year 2100, the nesting population is reduced by 75%. Although the beach is projected to become warmer and dryer, the primary driver of the decline was increasing air temperature that reduced hatching success and emergence rate. Hatchling sex ratios became increasingly female-biased due to the warmer, dryer conditions but never reached a mean of 100% female over a decadal time period. Changes in ENSO variability from 1975 to 2100 had a minimal effect on the population trend when compared to the effect of beach conditions. Therefore, decreased neonate recruitment was due to warmer, dryer conditions in Costa Rica and thus caused the nesting population to decline by 2100. This suggests that sea turtle populations in a changing climate may be more sensitive to nesting beach conditions than to oceanic conditions. Finally, we projected the population trend assuming that a climate-controlled hatchery program begins in 2001 and thus maintaining present-day hatching success/emergence rates and sex ratios. These projections resulted in no decline and stabilized the population. If a significant warming and drying over multiple decades becomes evident at eastern Pacific leatherback nesting beaches, climate controlled hatchery programs may be able to offset the negative impacts of rapid climate change.

COLLECTION OF PRE-EMERGENT LOGGERHEAD HATCHLINGS FOR RESEARCH HAS NO ADVERSE IMPACTS

Mike Salmon[1], Cody R. Mott[2], Kirt W. Rusenko[2], Rick Newman[2], Michael D. Anderson[2], Juan P. Duarte[2], Trevor J. Tyner[2], and Heather Iannozzi[2]

[1] Department of Biological Sciences, Florida Atlantic University, Boca Raton, Florida, USA
[2] Gumbo Limbo Nature Center, Boca Raton, Florida, USA

Over the last 30 years, many behavioral studies on marine turtles have been done using hatchlings as subjects. These studies have ranged topically from mechanisms underlying orientation and navigation, to sensory biology, feeding and predator avoidance responses. Hatchlings were usually taken from nests during the afternoon or early evening, typically within hours before a nocturnal emergence initiated by the turtles was scheduled to occur. Taking hatchlings early was

advantageous for several reasons: to start studies sooner in the evening so the turtles could be released on the same night; to run many hatchings from different nests and meet sampling requirements; and to maintain consistent treatment protocols. However, disturbing the nest before an emergence might compromise the survival of the remaining turtles by introducing odors to the surface sand that could attract predators, by stimulating a premature emergence of the turtles that remained, by altering the physical environment within the nest, or by some combination of these effects. These possibilities so worried current personnel at the Florida Fish and Wildlife Conservation Commission that they banned the practice of an early take, even in the absence of evidence from Florida beaches indicating that the procedure posed a threat. We initiated this study to determine whether that policy could be justified by experimental data. We compared the fates of 68 experimental nests (from which 10 hatchlings/nest had been removed on the day of an expected emergence) with 113 control (undisturbed) nests at a beach in Boca Raton, Florida. All nests were deposited between early May and mid-August. Screens were used to protect nests in the few areas where predators (raccoon, fox, skunk) were a threat. Three days after an emergence, nests were excavated and inventoried. Control and experimental groups did not differ in clutch size, mean number of live or dead hatchlings left in the nest, or in mean number of hatchlings that emerged from the nest and presumably crawled to the sea. There was no evidence that any turtles emerged during the day. We conclude that at our location the removal of < 10 hatchlings/nest, if done with care, has no statistical effect on nest productivity.

ENTANGLEMENT OF SEA TURTLES IN VERTICAL LINES OF FIXED GEAR FISHERIES: A SUMMARY OF THE GEOGRAPHIC RANGE, SEASONALITY, INVOLVED SPECIES AND NATURE OF REPORTED ENTANGLEMENT EVENTS IN THE NORTHEAST REGION OF THE UNITED STATES

Katherine A. Sampson

NOAA Fisheries Service Northeast Region, Gloucester, MA, USA

In 2002, NOAA Fisheries Service Northeast Region formed the Sea Turtle Disentanglement Network (STDN) in response to reports of sea turtle entanglements. The STDN is made up of federal and state agencies and stranding response organizations from Maine through Virginia. NOAA Fisheries Service administers the STDN, as well as maintains the northeast region sea turtle disentanglement database. Since its inception, the STDN has received 182 confirmed reports of entangled sea turtles, though it must be acknowledged that this represents significant under-reporting of entanglement events. Of these reports, 125 were of sea turtles entangled in the vertical line of fixed gear fisheries. Vertical line entanglements occurred throughout the Northeast Region, with the highest incidence in Massachusetts (70 cases, 56.0%). Entanglements were reported in the region from May through December, but peak months were July (37 cases, 29.6%) and August (50 cases, 40.0%). The vast majority of vertical line entanglements involved leatherback sea turtles (*Dermochelys coriacea*; 115 cases, 92.0%), but loggerhead (*Caretta caretta*; 9 cases, 7.2%) and green (*Chelonia mydas*; 1 case, 0.8%) sea turtles were also documented. All but one loggerhead entanglement occurred south of New Jersey, likely due to a higher abundance of hard shell turtles in the southern states of the region. Leatherback entanglements occurred throughout the region, but the highest incidence was in Massachusetts. In 63 cases, gear was identified to fishery through gear analysis and/or fisherman interviews; in these cases, 34 (54.0%) were identified as lobster, 15 (23.8%) as whelk, 10 (15.9%) as sea bass and four (6.3%) as crab pot gear. Lobster and whelk gear entanglements were widely distributed; lobster gear entanglements occurred throughout New England and whelk gear entanglements occurred in states ranging from Massachusetts to Virginia. Crab and sea bass gear entanglements were more localized, with the former occurring only in Virginia and the latter only in Massachusetts. The configuration of gear on the turtle was noted in 113 cases. The number of wraps and exact entanglement configuration varied widely between animals; however the location of entanglement was relatively consistent. The front flippers were involved in almost all (104 cases, 92.0%) and the head / neck in the majority (70 cases, 61.9%) of entanglements. Configurations involving the rear flippers or carapace were much less common (5 cases, 4.4% and 4 cases, 3.5%, respectively). Sea turtle entanglement in vertical lines of fixed fishing gear is not well understood. Many questions such as whether turtles are attracted to some aspect of the gear, whether there are environmental correlates to vertical line entanglements and how turtles interact with the gear in their environment all remain to be answered. Further analysis of the data collected by the STDN during disentanglement response may elucidate potential mitigation measures for the threat of vertical line entanglement.

EFFECTS OF LIGHT POLLUTION BY CAR HEADLIGHTS IN LOGGERHEAD HATCHLING BEHAVIOUR IN CAPE VERDE

Vanesa Santos-García[1], Adolfo Marco[1], Elena Abella[1], and Luis F. López-Jurado[2]

[1] Estación Biológica de Doñana, CSIC, Seville, Spain
[2] Department of Biology, Universidad de Las Palmas de Gran Canaria, Spain

Many sea turtle nesting areas are experiencing a tremendous growth in tourism during the last decades that will likely continue in the near future. Many touristic activities involve light pollution by the increasing presence of vehicles close or even over the beaches. Vehicles can drive towards or along the beaches and even stay with the lights turned on illuminating during prolonged periods of time significant zones with sea turtle nesting activity. Thus, it is important to evaluate the impact of car light pollution on both nesting females and newborns in their search of the sea. Unlike other pollution sources, the artificial light in these animals causes behavioral effects, such as abandonment of the nesting activity on the part of females or the disorientation of the hatchlings on the beaches. The impact of car lights over hatchlings can have a profound influence on their chance of survival. We have assessed the exposure of sea turtles to light pollution and tested the influence of car headlights on hatchling behavior and orientation on pristine undisturbed beaches from Boavista Island (Cape Verde). This eastern Atlantic archipelago hosts the third worldwide most important nesting population of loggerhead turtles (*Caretta caretta*). 90 % of nesting activity occurs on Boavista, an island that is experiencing a fast tourist development over the last five years. During the 2010 nesting season we experimentally studied on the beach the behavioral impact o car headlights on 120 loggerhead hatchlings from different nests incubated in a beach hatchery. Hatchlings were tested once to one of the three types of illumination: white headlights without filter, white headlights fully covered by a red gel filter, natural nocturnal conditions (dark or moon light). This was the only source of artificial light on several kilometers around. Hatchlings were randomly assigned to each of the light treatments. We recorded the first orientation of the turtle, time to arrive to the limit of the circular arena and direction of the turtle when crossing the limit of the arena. We also recorded hatchling behavior and calculated their speed. Several highly significant differences were found among treatments. In the presence of white light virtually all the hatchlings moved quickly toward it. The attraction and speed of hatchlings toward car lights was significantly reduced by red filters. At dark conditions all hatchlings went directly to the sea. Full moon light slightly attracted hatchlings under the dark and red treatments but had no influence under the white treatment. These results are interpreted as a great threat of car lights to hatchlings that move inland, away from the sea, seriously endangering their survival through predation, exhaustion, dehydration, etc. As a preventive measure, during the 2010 season the main turtle watching operator of the island (NATURALIA) covered the headlights of all tourist cars with gel red filters when they approached to the beaches at night. This measure was very well accepted by tourists, tour operators and local drivers at a very low cost.

FUSARIUM SOLANI IS RESPONSIBLE FOR MASS MORTALITIES IN NESTS OF LOGGERHEAD SEA TURTLE, *CARETTA CARETTA*, IN BOAVISTA, CAPEVERDE

Jullie M. Sarmiento-Ramírez[1], Elena Abella[2], María P. Martín[1], María T. Tellería[1], Luis F. López-Jurado[3], Adolfo Marco[2], and Javier Diéguez-Uribeondo[1]

[1] Real Jardín Botánico CSIC,Madrid, Spain
[2] Estación Biológica de Doñana, CSIC, Sevilla, Spain
[3] Universidad de las Palmas de Gran Canaria. Las Palmas, Spain

The fungus *Fusarium solani* (Mart.) Saccardo (1881) was found to be the cause of infections in the eggs of the sea turtle species *Caretta caretta* in Boavista Island,Cape Verde. Egg shells with early and severe symptoms of infection, as well as diseased embryos were sampled from infected nests. Twenty-five isolates with similar morphological characteristics were obtained. Their ITS rRNA gene sequences were similar to the GenBank sequences corresponding to *F. solani* and their maximum identity ranged from 95% to 100%. Phylogenetic parsimony and Bayesian analyses of these isolates showed that they belong to a single *F. solani* clade and that they are distributed in two subclades named

A and C (the latter containing 23 out of 25). A representative isolate of subclade C was used in challenge inoculation experiments to test Koch postulates. Mortality rates were c. 83.3% in challenged eggs and 8.3% in the control. Inoculated challenged eggs exhibited the same symptoms as infected eggs found in the field. Thus, this work demonstrates that a group of strains of *F. solani* are responsible for the symptoms observed on turtle-nesting beaches, and that they represent a risk for the survival of this endangered species.

TO EAT OR NOT TO EAT? THE ROLES OF CHOICE AND VISION IN INGESTION OF MARINE DEBRIS BY SEA TURTLES*

Qamar A. Schuyler, Kathy A. Townsend, and Justin Marshall

University of Queensland, Brisbane, Queensland, Australia

Marine debris ingestion is a major problem for sea turtles, resulting in both lethal and sublethal impacts. Necropsies of 100 turtles stranded in the Moreton Bay region of Australia between 2006-2010 show that over 30% were killed due to ingestion of marine debris (Townsend, in press). In other parts of the world, up to 100% of stranded turtles have been found to contain plastic within their digestive system (Tourinho *et al*., 2010; Bugoni *et al*, 2001). However, these figures may not adequately represent the true magnitude of the problem. In order accurately assess the risks to turtles we need a better understanding of the dynamics of the interaction between sea turtles and the debris that they consume. We investigate the selectivity of sea turtles with regard to the ingestion of marine rubbish, particularly focusing on plastics. We compare the distribution of plastics found within the gut of 34 stranded sea turtles sourced from the Moreton Bay region to that “available” in the environment. We analyse the colour, consistency, distribution and buoyancy of ingested plastics in comparison to debris found during regular monitoring of a beach on North Stradbroke Island. Results indicate that turtles do exhibit a preference for particular types of debris. To understand why this might be the case, we discuss results in relation to the visual anatomy of sea turtles, and we make preliminary recommendations for ways to reduce the impact of marine debris on sea turtle populations.

INCIDENTAL HOOK-AND-LINE CAPTURE OF SEA TURTLES ALONG THE UPPER TEXAS COAST DURING 2004-2008

Erin E. Seney[1,2], Andre M. Landry, Jr.[1], Benjamin M. Higgins[3], and Shanna L. Kethan[3,4]

[1] Texas A&M University at Galveston, Galveston, Texas, USA
[2] Current: AAAS Science & Technology Policy Fellow at NOAA/NMFS Office of Science & Technology, Silver Spring, Maryland, USA
[3] NOAA/NMFS Sea Turtle Facility, Southeast Fisheries Science Center, Galveston, Texas, USA
[4] Current: Lee High School, Baytown, Texas, USA

Five species of federally-protected sea turtles occur seasonally in the northwestern Gulf of Mexico, putting them at risk for interactions with commercial and recreational fisheries. We examined the incidental capture of sea turtles on recreational hook-and-line gear along the upper Texas coast in 2004-2008. Fishing pier operators were contacted annually to promote reporting of all sea turtles captured on hook-and-line gear. Additionally, informational posters were placed at fishing piers, bait shops, parks, refuges, and other appropriate venues in Brazoria, Galveston, Chambers, and Jefferson Counties. Reported turtles were rescued as quickly as possible and transported to the NOAA/NMFS Sea Turtle Facility in Galveston for holding, removal of easily accessible hooks, and collection of morphometric data. All turtles were subsequently examined and radiographed at the Houston Zoo Veterinary Clinic. Hooks visible from the oral cavity were removed non-surgically through the mouth, whereas those in the esophagus were removed either orally or surgically by a veterinarian. Hooks located in the stomach or intestinal tract were allowed to pass naturally. After examination and necessary procedures, each turtle was returned to Galveston, held for treatment as prescribed, and ultimately released. Forty Kemp’s ridleys (*Lepidochelys kempii*), four loggerheads (*Caretta caretta*), and one green sea turtle (*Chelonia mydas*) were retrieved after capture on recreational hook-and-line gear in Galveston and Jefferson Counties during 2004-2008. Eight Kemp’s ridleys were caught by surf fishermen, one ridley was caught from a

nearshore boat, and the remaining turtles were retrieved from three privately-owned piers in Galveston County. Twenty Kemp's ridleys were hooked in the mouth or jaw, whereas 18 ridleys and 3 loggerheads were throat-hooked or swallowed the hook. Two Kemp's ridleys and one loggerhead were flipper-hooked, and the green turtle was hooked in the back of the neck. One Kemp's ridley died after hook-removal surgery, and the remaining 44 turtles were released following necessary treatment. Kolmogorov-Smirnov tests comparing the hook-and-line-caught Kemp's ridleys to 94 stranded conspecifics from the Gulf side of Galveston and Jefferson Counties indicated the two groups differed significantly in straight carapace length and geographical distribution, but not in temporal distribution (year and day of year). Although captures by surf fishermen were probably under-reported, incidental hook-and-line captures represented 28% of documented non-nesting encounters of Kemp's ridleys in Galveston and Jefferson Counties during 2004-2008. Public outreach efforts should be expanded to target not only pier-based fishing, but all recreational anglers, in order to facilitate hook removal and determine the full extent of these potentially lethal interactions on protected sea turtle species.

COMPARATIVE STUDY ON MORTALITY OF SEA TURTLES DUE TO ACCIDENTAL BYCATCH IN VARIOUS FISHING GEARS (2009-2011) ALONG THE CHENNAI COAST

Azra Shakir, Sabha Natesen, and Supraja Dharini

TREE Foundation Chennai, India

Short Speed Paper Presentation - Others COMPARATIVE STUDY ON MORTALITY OF SEA TURTLES DUE TO ACCIDENTAL BYCATCH IN VARIOUS FISHING GEARS (2009-2011) ALONG THE CHENNAI COAST Azra Shakir 1, Sabha Natesen2 and Dr. Supraja Dharini3 1. Researcher TREE Foundation sea turtle stranding network 2. Researcher TREE Foundation sea turtle research team member 3. Founder Chairperson of TREE Foundation, Tamil Nadu Tamil Nadu with its 910 km coastline. Considerable amount of sporadic nesting beaches of olive ridleys are available along Tamil Nadu coast and in particular along the Chennai area, which is present on the Southern parts of the Chennai coast. A survey will be conducted during December 2010 to April 2011 with the following objectives in order to know the number of dead olive Ridley, along the beach in Chennai. STUDY AREA: Studies were conducted along 13 km stretch in Chennai coastal area from Periya Neelankarai to Reddy Kuppam. These are nesing beachs of olive ridley and also the area where intense fishing activites take place during the nesting season form decmber to March. TURTLES AS BY CATCH: Large marine turtles especially the female turtles during the breeding season become victims of the modern fishing gear. Well over 5000 turtles are entangled annually in floating and bottom set gill nets . Shrimp trawling and fishing hooks with baits cause serious damages to marine turtles and result in death due to injuries. But some artisanal fishing gear also pose a threat to nesting turtles. Incidental catch will also be recorded .This study will document the morphology of dead stranded sea turtles and record visible external injuries. This presentation will highlight the above. A questionaire will be used to assess the sea turtles as by catch in various fishing practices. A Compartive study will be done on the data obtained during the year 2009-2010 with that of the data obtained during the year 2010-2011 and the results will be tabulated.

SEAFOOD CARDS AND CERTIFICATION – SUSTAINABLE FOR SEA TURTLES AND THE OCEANS?

Teri Shore[1], Buffy Martin Tarbox[2], and Chris Pincetich[1]

[1] Turtle Island Restoration Network, Forest Knolls, California, USA
[2] GotMercury.org, Forest Knolls, California, USA

The proliferation of seafood cards and certification schemes that attempt to provide advice to fish eaters about choosing the most "sustainable" fish may be unintentionally undermining conservation efforts to reduce bycatch of sea turtles and other protected species such as whales and dolphins. These programs are well-intended and based on solid fishery research. However, ranking wild capture fish species from commercial fisheries known for killing or injuring sea turtles

and marine mammals as "good alternatives" or "green" or "certified sustainable" does a disservice to conscientious fish buyers, endangered species and fisheries. For example, at least one prominent seafood card lists U.S. longline-caught swordfish as a good alternative even though the fishery continues to capture and kill sea turtles, primarily endangered leatherbacks and loggerheads. Two Atlantic pelagic longline fisheries are now seeking green eco-labels from a well-established international certification body. A highly regarded ocean organization gives a good "green fish" symbol to all U.S. wild-caught shrimp, even while acknowledging that "shrimp trawling damages the seafloor and can result in large bycatch." While U.S. fisheries may be managed better than foreign fleets, shrimp trawling in the U.S. remains one of the biggest threats to the survival and recovery of sea turtles, capturing an estimated 25,000 or more per year – more than a decade after Turtle Excluder Devices were required. Futhermore, the seafood cards and certification programs often do not take into effect high-mercury fish and the impact of mercury exposure on human health when classifying a species as a "good choice" for consumers. While it is not clear whether these seafood card or certification programs have had any significant impact on fish choices, fisheries or sustainability, they do have the potential to create a demand for fish species that harm endangered marine life. Scientists have proven that the loss of even one adult sea turtle or whale can be detrimental to an endangered population. The authors remain concerned that bycatch of endangered or protected marine animals is not given adequate priority and should be given greater weighting in sustainable seafood and certification schemes. This poster will compare the sustainability ranking given to fish species from commercial fisheries with sea turtle and marine mammal bycatch from several of most prominent seafood card and certification programs. It will estimate the sea turtle and marine mammal bycatch from those highlighted fisheries. And then it will make recommendation for reforming the sustainable cards and certification programs to better incorporate levels of sea turtle and marine mammal bycatch including: 1. flagging levels of bycatch protected species on the seafood cards with color-coded icons of green, yellow, red sea turtles or whales, 2. revising the criteria for seafood sustainability and certification schemes to better incorporate bycatch of endangered and protected species, and 3. not awarding green or sustainability rankings to fisheries with high bycatch of sea turtle and marine mammals.

THE IMPACT OF HUMAN TRAFFIC ON LOGGERHEAD HATCHLING EMERGENCE AT THE SOS TARTARUGAS HATCHERY, SAL, CAPE VERDE

Janice Smith

ADTMA, SOS Tartarugas, Cape Verde

Cape Verde is known to be the 3rd largest nesting site for Loggerhead turtles in the world. SOS Tartarugas was set up on Sal in 2008 to protect Loggerhead turtles from being killed by poachers when coming on land to lay their nests. Due to the increase in tourism and development on Sal the need to relocate nests to a safer location is increasing. In 2008 one hatchery was set up to relocate any nests perceived to be in danger. The number of hatcheries rose to two in 2009 and 2010. Due to increased threats noted in 2010, 2011 will see more nests needing to be relocated and the greater need for a further hatchery. Observations from previous nesting seasons has shown trickle emergence amongst nests situated in our main hatchery. Frequently nests would hatch whilst public excavations were occurring suggesting that human traffic could affect the emergence of the nests. The long-term effects of this are unknown; however, the results of this study will help update hatchery protocol to ensure the process can be kept as natural as possible. A 'no go area' was created to prevent people walking to close to the nests in an attempt to decrease the impact human traffic may be having on emerging nests. A 1 m area was left around the entire diameter of the nest. The study was carried out over the 2010 nesting season, nests were moved between June and September and hatching was monitored from September through to November in the hatcheries. Results showed 20.5% of hatching nests emerging over 2 days in comparison to the 79.5% hatching during 1 evening. In our smaller less frequently visited hatchery 13.6 % of all nests hatched over 2 days in comparison to the 86.4% of nests hatching in one evening.

THINK GLOBALLY, ACT REGIONALLY: PREDICTING FUTURE FISHING EFFORT TO REDUCE BYCATCH INTERACTIONS

Candan U. Soykan, Tomo Eguchi, and Suzanne Kohin

NOAA, NMFS, Southwest Fisheries Science Center

As sea turtle bycatch receives greater attention, novel approaches to mitigation have arisen. One of the more practical ideas to emerge of late is the use of data on fishing effort and sea turtle distribution patterns to identify areas of potential overlap for targeted conservation efforts. Since this approach does not require observer data on bycatch, it is being proposed as a possible method for use in data-poor regions or with little-studied species. However, investigators have yet to consider the proper scale and method to best predict fishing effort. I address these shortcomings by exploring the effects of scale on prediction accuracy using a variety of different datasets on fishing effort. Moreover, I consider the influence of various predictor variables on prediction accuracy, including past fishing effort and oceanographic variables. Preliminary results suggest that fishing effort predictions are most accurate at intermediate spatial scales, and that certain environmental factors enhance prediction accuracy. The implications for conservation are that overlap between sea turtles and fishing effort should be addressed at the regional, rather than global scale.

MARINE DEBRIS INGESTION BY *CHELONIA MYDAS* IN SANTA CATARINA COAST, SOUTHERN BRAZIL

Gustavo D. Stahelin[1], Mariana C. Hennemann[2], Daphne W. Goldberg[1], Camila T. Cegoni[1], and Juçara Wanderlinde[1]

[1] Fundação Pró-Tamar, Florianópolis, Santa Catarina, Brazil
[2] Universidade Federal de Santa Catarina (UFSC) - Núcleo de Estudos do Mar (NEMAR), Florianópolis, Santa Catarina, Brazil

In all continents, marine debris ingestion by sea turtles has become a major concern, especially in levels that can lead the animals to death. Since 2005, Projeto Tamar has been monitoring Florianópolis Island and most of the coastal area of the state of Santa Catarina, southern Brazil, receiving and rehabilitating stranded and incidentally captured sea turtles. Santa Catarina coast is an important foraging ground for juvenile green turtles (*Chelonia mydas*), a globally endangered species. The present study shows preliminary data on anthropogenic debris found in the digestive tract of 19 carcasses of *C. mydas* washed ashore on the coastal area of Santa Catarina between October 2009 and July 2010. Necropsies were performed in the rehabilitation facilities of the Tamar station in Florianópolis. All anthropogenic debris found in the esophagus, stomach, small and large intestines during necropsy were separated, washed and dried at 50°C. After that, all litter items from each part of the gastrointestinal tract of the turtles were separated into six categories (soft plastics, hard plastics, nylon, other plastics, latex, textile and other/unknown), counted and weighed. The individuals' sex and probable cause of death were also determined. Out of the 19 turtles analysed, 10 were females, 9 were males, and 17 (89%) presented marine debris in at least one portion of their digestive tract. If only esophagus and stomach had been analysed, marine debris would be found in 13 (68%) individuals. The mean + standard deviation CCL of the studied animals was 0.369 ± 0.082 meters (range: 0.250 – 0.665 m). Mean number of items found in the 17 turtles analysed was 367 ± 850 items (range: 7 – 3593 items) and mean weight was 25 ± 64 grams (range: 0.13 – 269.60 g) per animal. In terms of number of debris items found, 98% were plastic (70% hard plastics; 16% soft plastics; 8% nylon; 4% other plastics) and only 2% belonged to the other three categories. Plastics accounted for 96% (89% hard plastics; 4% soft plastics; 2% nylon; 1% other plastics) of the overall weight of the debris found in the turtles, followed by latex (2%), textile (1%) and other/unknown (1%). No significant differences were found in litter quantities and weight between males and females (except for the male that presented 3593 debris items weighting almost 270 g), nor correlation among CCL and litter quantities and weight. Concerning the portions of the digestive tract, large intestine showed higher litter content than esophagus (t-test; $p<0.04$) and small intestine (t-test; $p<0.04$). Five of the necropsied turtles (26%) probably died as a result of the debris ingestion. The results obtained in this study are compatible with data in the literature. Based on the results found, it is important to notice that research papers

which only evaluate the contents from esophagus and stomach may be underestimating the amount of debris ingested and the proportion of sea turtles contaminated.

HOOKING POSITION AS A FUNCTION OF HOOK SIZE, BAIT TYPE, AND TURTLE SIZE IN LOGGERHEAD TURTLES (*CARETTA CARETTA*) INCIDENTALLY CAPTURED IN THE U.S. ATLANTIC PELAGIC LONGLINE FISHERY

Lesley W. Stokes and Sheryan P. Epperly

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

Pelagic longline fisheries target large pelagic fish including swordfish, tunas, and sharks throughout the world's oceans. Incidental bycatch in pelagic longline fisheries is known as an important source of sea turtle injury and mortality. In July 2004, the National Marine Fisheries Service (NMFS) issued a Final Rule mandating increased reporting of bycatch, instituting careful handling and release gear requirements and outreach programs, and requiring changes in fishing gear in the U.S. Pelagic Longline Fleet. Most notably, the fishery was required to use circle hooks (size 16/0 no offset, or 18/0 maximum 10° offset outside the Northeast Distant Waters (NED); 18/0 or larger, maximum 10° offset inside the NED) after August 2004. The previous industry standard was a smaller (9/0) J-hook baited with squid. Reductions in bycatch rate and hooking position were expected due to hook shape and increased size based on results from experimental studies conducted in the NED fishing area (Watson *et al*. 2005). Specifically, a reduction in the number of deeply ingested hooks was targeted with the required gear changes. This investigation examines the hooking positions of incidentally hooked loggerhead turtles observed in the U.S. Pelagic Longline Fleet since January 2005. Specifically, we are interested in whether loggerheads deeply ingest a significant proportion of large circle hooks, or whether, as expected, more hookings occur in the beak or mouth. Hooking position may have implications for gear removal success and subsequent survival. Deeply ingested hooks cannot be removed using the required careful release gear, but external hooks and those in the mouth or beak are accessible for removal. We investigate whether there are patterns in hooking position as a function of circle hook size and bait type (squid or finfish). We also investigate whether the potential for deep ingestion increases as turtle size increases using observer data encompassing a large geographic area where a wide size range of turtles was encountered. Data collected by highly trained fishery observers are used to characterize the fishing gear used and hooking position. The fishery has a Pelagic Observer Program (POP), in place since 1992, to document finfish bycatch and quantify interactions with protected species (Beerkeircher *et al*. 2004). The observers document the nature of the hooking interaction, including specific hooking position and amount and type of gear remaining at release. Once the observer determines that the turtle has been hooked, they designate the hooking position as hooked location unknown; internal, unknown; swallowed, visible to insertion point, partial hook visible, or not visible; beak/mouth, upper, lower, side, if mouth: tongue, glottis, roof of mouth, jaw joint, other; external, unknown; beak/head/neck; carapace/plastron; front flipper/shoulder/'armpit'; and rear flipper/groin/tail. Data from these categories are pooled where appropriate and summarized considering hook size, bait type, and turtle size.

LESSONS LEARNED FROM 10 YEARS OF FISHERIES BYCATCH RESEARCH*

Yonat Swimmer[1], Amanda Southwood Williard[2], and John Wang[3]

[1] NOAA Pacific Islands Fisheries Science Center, Honolulu, Hawaii, USA
[2] Department of Biology and Marine Biology University of North Carolina Wilmington
[3] Joint Institute for Marine and Atmospheric Research, University of Hawaii

Incidental capture of unwanted species, or bycatch, in artisanal and commercial fishing operations has been shown to result in population-level impacts on threatened and endangered marine animals. In response to high interaction rates with sea turtles, the Hawaii-based longline shallow-set (swordfish) fishery was closed for two years and is now subject to strict management measures. Given the ecological concerns, as well as the enormous economic toll such a closure placed on U.S. commercial activities, NOAA was highly motivated to seek solutions to identify mitigation measures that would allow fishing operations to continue while simultaneously not posing a risk to sea turtle populations. Thus

NOAA prioritized the funding of diverse research aimed to understand how to modify fishing gear so that it attracts targeted fish species while being repulsive or at least not attractive to sea turtles. In the past decade, our research group funded, collaborated with, and field-tested various projects to improve our understanding of these dynamics. Our collaborative research furthered the understanding of turtle and fish ecology, biomechanics, and sensory systems, which we've applied in our at-sea field trials in both gillnet and longline fishing gear modifications. Additionally, we've aided the development and adoption of fishing gear that reduces sea turtles' probability of capture, such as modifications in the hook. In this overview of research in the past decade, we illustrate some of our successes and discuss our failures in identifying means to improve on fisheries' abilities to be truly ecologically sustainable.

HEAVY METALS IN BLOOD AND CARAPACE SAMPLES OF NESTING GREEN TURTLES (*CHELONIA MYDAS*) FROM THE CENTRAL COAST OF QUINTANA ROO, MEXICO

Ana L. Talavera[1], Maria C. Ortiz[1], and Julio C. Zurita[2]

[1] El Colegio de la Frontera Sur, Chetumal, Quintana Roo, Mexico
[2] CONCENZU, Distrito Federal, Mexico

As part of the marine turtle conservation, it is necessary to know the health conditions of the populations. Heavy metals pollution may cause some diseases in marine turtles. Although some elements are essential for the organism, they can be toxic over a certain threshold. Biological process like age, sex, migration and reproduction may cause variation in heavy metals concentrations. Hence, it is necessary to establish the relationship between this process and heavy metals in sea turtles. The objective of this study was to assess the metals levels in blood and carapace of nesting green turtles from four beaches along Quintana Roo, Mexico. In addition, we explore how heavy metals vary according to a "relative age" given to the turtles to determine bioaccumulation with age. Blood and carapace samples were taken from 30 nesting females during 2009. Heavy metals (Cd, Pb, Zn) levels were higher in carapace than in blood samples. Highest Zn levels were between 76.91 ppm (carapace, dry weight) and 2.14 ppm (blood, wet weight); for Cd 0.86 ppm (carapace, dry weight) and 0.09 (blood, wet weight); and for Pb 4.07 ppm (carapace, dry weight) and 0.67 ppm (blood, wet weight). The "relative age" of females vary between 0 (neophytes) to 18 years. There was no correlation between "relative age" and female size or between "relative age" and metals concentrations in blood or carapace. A positive correlation between carapace size and concentrations of Zn in blood, were found. Also, a negative correlation between carapace size and Pb concentrations in carapace were found. Levels reported in the present work are considered low and are not a threat for the green turtle population from the central cost of Quintana Roo. Higher carapace levels indicate long-term exposure, while blood levels are affected by recent metals intake. Blood Zn increase may be in function of the nutriments requirements for the largest females. Carapace Pb decrease may reflect mobilization from bones associated with Ca requirements for eggs formation. We recommended identifying migration paths and foraging areas for future studies about possible pollutant sources. To the International Sea Turtle Society, Western Pacific Regional Fishery Management Council, U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service and the International Sea Turtle Symposium for the grant support.

CLIMATIC EFFECTS ON HATCHING SUCCESS AND EMERGENCE RATE OF LEATHERBACK TURTLE NESTS AT PLAYA GRANDE, COSTA RICA*

Pilar Santidrian Tomillo[1], Vincent S. Saba[2], Gabriela S. Blanco[1], Charles A. Stock[3], Frank V. Paladino[4], and James R. Spotila[1]

[1] Drexel University, Philadelphia, PA, USA
[2] Princeton University, Princeton, NJ, USA
[3] NOAA, Princeton, NJ, USA
[4] IPFW University, Fort Wayne, IN, USA

The weather in the Northwest coast of Costa Rica is characterized by a rainy season (May – October; ~232 mm/month) followed by a pronounced dry season (December – April; ~8 mm/month). The local conditions in the area are strongly

affected by the El Niño Southern Oscillation (ENSO). During El Niño years, the weather conditions are hot, dry, and frequently result in droughts. Sea turtles nests need stable conditions of humidity and temperature for egg development and hatchling emergence. We analyzed the effect of local weather conditions (precipitation and ambient temperature) on egg development and hatchling emergence of leatherback turtle (*Dermochelys coriacea*) nests between seasons 2004-2005 and 2009-2010 at Playa Grande, Costa Rica. Hatching success and emergence rate were negatively affected by El Niño conditions because of low levels of rain and high temperatures. Additionally, we used the ensemble of global climate model simulations contributed to the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) to project annual hatching success and emergence rate over the next 100 years. Our projections show that hatchling output will dramatically decline throughout the 21st century because of dryer and warmer conditions predicted for the area of Central America where the leatherbacks nest. Our results suggest that similar effects can be expected on other sea turtle nesting beaches around the world where climate is likely to change to dryer and warmer conditions as a result of climate change.

A FISHERIES RELATED SEA TURTLE UNUSUAL MORTALITY EVENT IN NORTHAMPTON COUNTY, VIRGINIA, USA: A REPORT OF STRANDING ACTIVITY, NECROPSY FINDINGS AND FISHING EFFORTS

Christina M. Trapani[1], Brian A. Stacy[2], and Susan G. Barco[1]

[1] Virginia Aquarium Stranding Response Program, Virginia Beach, Virginia, USA
[2] National Marine Fisheries Service, Office of Protected Resources, Gainesville, Florida, USA

The Virginia Aquarium responds to high numbers (Avg. 262 per year, 2001-2009) of sea turtle strandings during the late-spring, summer and early fall months. Approximately 78% of strandings occur on the bay and ocean facing beaches of lower Chesapeake Bay in Virginia, USA. The majority of strandings are loggerhead (*Caretta caretta*; 79.5%) and Kemp's ridley (*Lepidochelys kempii*; 13%) followed by green (*Chelonia mydas*; 3%) and leatherback (*Dermochelys coriacea*; 3%) sea turtles. The shoreline of lower Chesapeake Bay is an area heavily fished using pound nets (fixed gear). In response to high numbers of sea turtle strandings in Northampton County, NOAA Fisheries first issued a rule prohibiting the use of offshore pound net leaders (defined as "the leader with the inland end set greater than 10 horizontal feet (3 m) from the mean low water tide line1") from May 6th through July 15th, a time frame during which sea turtle strandings peaked. After conducting research on modified net designs, with cooperation from local pound net fishermen, an exception to the rule was enacted in 2006, allowing pound net fishermen to fish their offshore nets using a modified leader. After the change in regulations, the number of strandings in the area, particularly the Chesapeake Bay beaches of Cape Charles to Fisherman Island dropped significantly. The modified leaders were only required through July 15th, after which time, the traditional leaders could be used again. In 2009, an increase in strandings in this area was considered an "Unusual Mortality Event." From 2005-2008, 33% of the annual strandings occurred after July 15th. In 2009, post-July 15 strandings increased to 80%, with most of the strandings occurring between July 24th and September 30th. The 2009 event involved a four-fold increase in the number of stranded sea turtles documented on or floating off of the area between Cape Charles and Fisherman Island in Virginia, USA. A total of 36 stranded turtles, including 30 loggerhead and six Kemp's ridley turtles were associated with the event. Although postmortem examination (necropsy) of many turtles was limited by the state of decomposition, findings were consistent with mortality due to fishery interaction. Of the turtles in suitable condition for necropsy (n=21), most were characterized as nutritionally robust with no evidence of significant underlying disease. Four turtles had clear evidence of prior entanglement or impingement that included ligature wounds or net marks consistent with those documented in known pound net-related interactions. Once VAQS alerted Sea Turtle Stranding Managers of the increase in strandings, NOAA took quick action to increase observer coverage in the area and to assist VAQS by providing an on-site pathologist (Stacy). With NOAA's assistance, the investigation into the event proceeded quickly and efficiently and resulted in conclusive cause of death determinations for several of the fresher carcasses. NOAA observers were able to interview fishers and help the investigators solidify the timeline of events and develop appropriate mitigating regulations.

MASSIVE MORTALITY OF BLACK SEA TURTLE (*CHELONIA MYDAS AGASSIZII*) ON MICHOACÁN COAST, MÉXICO

Carlos Delgado Trejo[1], Gerardo Ceballos Corona[2], and Ricardo Lemus Fernández[3]

[1] Instituto de Investigaciones sobre los recursos Natuarales, Universidad Michoacana de San Nicolas de Hidalgo
[2] Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo
[3] Pronatura, A.C.

In Michoacán, one of the important nesting population of *Chelonia*, the pacific oriental one, the black sea turtle (*Chelonia mydas agassizii*) nests in a band of approximately 80 km from Michoacán's littoral centering most of the nesting in a band of 12 km that corresponds to the Natural Reserve Zone Colola - Maruata, also selected as sites RAMSAR The events of mortality of black turtle in Michoacán have been slightly common and more even the events of massive mortality. At the end of October and during the first five days of November they were brought mortality of black tortoise along Michoacán's coast and in some adjacent beaches to the Warrior's coast with Michoacán. The stranded black turtles were identified mostly as juvenile black turtles of CCL between 58 and 62 cm, and in minor proportion adult males between 70 and 76 cm (CCL). Most stranded dead on the beach and in outpost been of decomposition though some moribund turtles were identified in the beach and floating in the sea to approximately 500 m of the coastal line which I capture and there were realized stomach washes and collection of samples of blood. I observe in the sea one unusually and abundant presence of ascidians pelagic in chain (presumably *Pegea confederata*) and small jellyfish of which they found remains in the stomach contents of the moribund tortoises. I determine the presence in the water of armored dinoflagellates toxins like *Piridinium bahamensis* and *Alexandrium* sp themselves that were brought in a similar event in waters opposite to El Salvador Central America and that caused the massive mortality and 200 black adult tortoises between November, 2009 and May, 2010. This event of massive mortality in the geographical range that occupies black tortoise in the pacific oriental one it represents a new threat for the recovery of his population. The small heights of the tortoises died in Michoacán and the outpost been of decomposition of the corpses suggest that the mortality happened in a zone near to Michoacán's coast for ingestion of dinoflagellates toxins (Saxitoxina) similar to the happened in El Salvador in Centralmerica.

EVALUATING SEA TURTLE INJURIES IN NORTHEAST REGION FISHING GEAR, USA

Carrie M. Upite[1], Sara E. Wetmore[2], and Heather L. Haas[2]

[1] National Marine Fisheries Service, Northeast Regional Office, Gloucester, Massachusetts, USA
[2] National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts, USA

Sea turtles are incidentally taken as bycatch in Federally managed fisheries, and are observed alive, dead, and with varying levels of injuries. Previously, the National Marine Fisheries Service (NMFS) Northeast Region developed working guidance in order to make serious injury determinations for sea turtles taken in the Atlantic sea scallop dredge fishery. This working guidance was used in Endangered Species Act Section 7 consultations to help determine if a sea turtle caught (with varying types of injuries) in scallop dredge gear should be considered a lethal or non-lethal interaction. NMFS recognized the need to revisit the working guidance to attempt to encompass other Northeast Region gear types (e.g., gillnet, trawl, pound nets, pot/trap) and a wide range of sea turtle injuries. As such, a November 2009 workshop gathered various experts in sea turtle veterinary medicine, anatomy, and/or rehabilitation to: (1) discuss case studies of sea turtles caught in fishing gear with varying levels of injuries; (2) critique the NMFS draft working guidance and approach for evaluating post-release survival; and (3) comment on the level of information collected by observers. Workshop participants discussed types of sea turtle injuries and associated survivability, turtle behavior, and resuscitation issues, as well as the specific information that should be collected by observers to better assess sea turtle injury. The information gathered by individual participants at this workshop was then used by NMFS to develop technical guidelines for assessing sea turtle injuries in Northeast fishing gear. The technical guidelines will be presented and their applicability to sea turtle conservation discussed.

LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) INTERACTIONS WITH U.S. MID-ATLANTIC BOTTOM TRAWL GEAR FOR FISH AND SCALLOPS, 2005–2008

Melissa L. Warden

Integrated Statistics, Woods Hole, MA, USA

Interactions between sea turtles and northwestern Atlantic trawl fisheries are of global concern, and the National Marine Fisheries Service (NMFS) is considering expanding bycatch reduction regulations, including deployment of turtle excluder devices (TEDs). In order to inform bycatch mitigation strategies, the number of loggerhead sea turtle (*Caretta caretta*) interactions was estimated for U.S. Mid-Atlantic bottom trawl fisheries for fish and scallops. A generalized additive model of interactions was developed using 1994-2008 Northeast Fisheries Observer Program (NEFOP) data from trawl fisheries that were not required to deploy TEDs. Predicted loggerhead interaction rates were applied to 2005-2008 commercial fishing data to extrapolate the number of interactions for the trawl fleet. For those trawl fisheries in which TEDs were required, an experimentally-determined TED exclusion rate (97%) was applied to estimate the number of loggerheads that would have been excluded by TEDs. Factors that were associated with the interaction rate were latitude, depth, and sea surface temperature (SST). Estimated interactions for 2005–2008 averaged 292 (CV 0.13, 95% CI 221–369) loggerheads annually, with an additional 61 (CV 0.17, 95% CI 41–83) excluded by TEDs. The interaction rate was highest at latitude ≤37°N, depth 15 °C; interaction magnitude in terms of adult equivalents was highest at latitude 37–39°N, depth 15 °C. Predicted average annual loggerhead interactions decreased compared to 1996–2004, due to decreased commercial fishing effort in high interaction areas. Additional sea turtle conservation measures can be informed by the high interaction rate and high interaction magnitude areas identified through this analysis.

SEA TURTLE BYCATCH IN SOUTHERN AFRICA

Anje de Wet and Ronel Nel

Nelson Mandela Metopolitan University, Port Elizabeth, South Africa

Incidental capture in fisheries poses a major threat to sea turtle populations globally. Pelagic longline, shrimp trawl and the anti-shark gill-nets have been identified as the fisheries likely to have the greatest impact on sea turtles in South Africa. Leatherback, *Dermochelys coriacea*, and loggerhead, *Caretta caretta*, turtles nest along the northeastern beaches of South Africa, where they have been protected since 1963. The loggerhead population has responded well to these conservation actions and has increased, while the leatherback population has remained relatively stable. This contrast in response may be due to higher offshore mortality of leatherbacks, particularly because there are currently no turtle bycatch mitigation measures in place in South Africa. Incidental capture of turtles in two of the major South African fisheries was quantified. A total of 65 turtles were caught on observed sets of the pelagic longline fishery between 2006 and 2009 at a rate of 0.008 turtles per 1000 hooks. Basic extrapolation of turtle catch suggests that a total of 107 turtles were caught during this time period. Leatherbacks and loggerheads were caught in equal numbers (n=19). GIS-based spatial analyses of satellite-tagged leatherbacks showed that there is substantial overlap between leatherback migration routes and longline fishing activity. Tag returns of loggerheads also suggest a high degree of overlap between their migration routes and longline fishing activity as well as the shark nets. Between 1981 and 2008, a total of 1730 turtles were caught in the shark nets with a catch rate of 1.7 turtles.km-1.net-1.yr-1. Loggerheads were the most commonly caught species which is consistent with their inshore foraging habits. Leatherbacks are pelagic species but have a higher catch rate from October to February. This coincides with their seasonal inshore movement for breeding and nesting. Previous studies suggest that, in isolation, these fisheries do not have a significant impact on the leatherback and loggerhead populations. Further research is required to better understand the interaction between sea turtles and fisheries as well as to determine the combined impact of fisheries on the turtle populations that nest in South Africa.

INTEGRATION OF SATELLITE TELEMETRY WITH RISK MATRIX ASSESSMENTS: A NOVEL APPROACH TO EVALUATE THE LIKELIHOOD OF IMPACT FROM OFFSHORE CONSTRUCTION ON MARINE TURTLE POPULATIONS AND HABITAT*

Paul A. Whittock and Kellie L. Pendoley

Pendoley Environmental Pty Ltd, Locked Bag 13, Canning Bridge, WA 6153, Australia

In Western Australia, a fundamental component of an industrial development's Environmental Impact Assessment (EIA) process involves assessing the potential risk of impact each development related activity may have on baseline populations of marine turtles, and their habitats. Risk assessments typically use a matrix to identify the overall inherent risk of impact by combining both the likelihood of an activity causing a significant impact and the consequence of each activity on marine turtles or their habitats. Once the risk score has been established management actions can be designed to prevent, reduce and offset the likelihood or consequence of a development's activity and a new residual risk of impact identified. Knowledge of the threat of industrial activities to offshore populations of marine turtles in Western Australia is limited. Industrial activities that are considered to have the potential to threaten offshore marine turtle populations include dredging, dredge spoil disposal, vessel movement, seismic disturbance, and accidental oil spills. These potential threats have increased in frequency and intensity over time as a result of the growing industry sector, and this is expected to continue and rise. Marine turtles offer a particularly complex case when identifying risk. For the EIA process to be effective in adequately assessing risk, sufficient baseline data on offshore marine turtle populations needs to be gathered. This information is essential to determine any thresholds of concern, enable an accurate assessment of the impacts, and improve the design of effective management actions. Fastloc® GPS satellite tracking units fitted with time-depth recorders (TDRs) have been used to gather baseline information on the offshore movement, behaviour and distribution of internesting marine turtles in proximity to a number of industrial developments in Western Australia. We outline how these baseline data have been integrated with offshore bathymetric and tidal data to allow a data based assessment of the likelihood of impact from industrial activities including dredging, vessel movement, and seismic disturbance, on internesting populations of marine turtles. The implications for improved analysis and interpretation of the baseline telemetry data on the management actions to prevent, reduce and offset the risk to marine turtles from industry are discussed.

ARTISANAL TRAWLING AND SEA TURTLE BY-CATCH IN THE VENEZUELAN MID-GUAJIRA

Natalie Wildermann[1], Gabriela Delgado-Ortega[2], Jhonny Reverol[1], Luis Montiel[2], Jordano Palmar[1], and Héctor Barrios-Garrido[1]

[1] Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV)
[2] Laboratorio de Ecología General, Departamento de Biología, Facultad Experimental de Ciencias. La Universidad del Zulia (LUZ)

The Venezuelan Guajira presents great coastal habitat diversity that favors the presence of sea turtles, such as sea grass beds. There are several reports of green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*)turtles foraging in these areas. The indigenous Wayúu communities depend mainly of the fishermen's work, being artisanal trawling one of the most common fishing arts during rain-seasons (winter). Therefore, our objective was to describe the artisanal trawling of Kazuzai and Poitchia communities located in the mid-Guajira, in order to evaluate its impact on sea turtle populations that use these zones. During a 5-month period (June-November 2010) we performed semi-structured interviews and direct observations to register the characteristics of the fishing art and its interaction with MT. The rain-season in 2010 was extensive due to the influence of tropical storms such as "Tomás" resulting from "La Niña-South Oscillation", leading to a raise of the fishing pressure originated by artisanal trawling in the study zone. This fishing art is developed by near 40 vessels distributed along 6 ports, involving almost 30 people per fishing trip (between fishermen, divers and collectors). The trawling gillnet is compounded of three united portions: two lateral polypropilene gillnets (each 400 mts long) and one central monofilament gillnet (100 mts long); it is situated to an

initial depth of approximately 8 mts, and then trawled towards the coast. In general, gillnets are placed on mixed marine grounds (sea grass beds, sand, stones), negatively impacting the benthic fauna (Starfish, sponges, mollusks) as they get trawled. Therefore it is necessary the presence of divers that are constantly moving up the inferior boarders of the net when they get entangled in stones, corals and/or bigger organisms. The target species are principally Northern red snapper (*Lutjanus campechanus*), King mackerel (*Scomberomorus cavalla*), Grouper (*Epinephelus sp.*) and Grunt (*Haemulon sp.*), catching between 400-800 Kg per fishing trip. The fishing collection turns into a social activity, in which the community member (men, women and kids) can pick up all by-catch organisms, finding species such as sea turtles, stingrays (*Dasyatis gutata*), Puffers (*Sphoeroides sp.*) and Halfbeacks (*Hemiramphus sp.*). Between 1 and 6 sea turtles are catched accidentally weekly (24-144 turtles/season), mainly *C. mydas* and *E. imbricata* juveniles and subadults. During this research a total of 51 trawled sea turtles (*C. mydas* = 49 ind.; *E. imbricata* = 2 ind.) were rescued and released, suggesting that the environmental education activities in the studied communities are being effective. Upcoming activities to promote the sea turtle's protection are the training of the fishermen in turtle's first aids, the continuous sensibilization of the communities and the search of alternative sustainable economical activities, in order that sea turtles no longer represent a life necessity, but an opportunity of conservation.

USING A SPATIALLY-EXPLICIT PREDATOR-PREY MODEL TO INVESTIGATE BYCATCH RISK OF TERRAPINS IN CRAB POTS

Amanda S. Williard

University of North Carolina Wilmington

Traditionally, long-lived marine vertebrates such as sharks, marine mammals, and sea turtles have been the focus of studies on mortality due to incidental entanglement in fishing gear. Research on diamondback terrapins (Malaclemys terrapin) indicates that bycatch mortality, specifically due to entrapment in coastal crabbing gear, may be a major cause of population decline for this species as well. Diamondback terrapins inhabit marshes and estuaries along the east and gulf coasts of North America, often times exploiting full-strength seawater habitats. Recent trends in terrapin abundance and demography suggest that fisheries-related mortalities due to crab pot bycatch may be contributing to population declines. The 2004 North Carolina Blue Crab Fishery Management Plan states that data on terrapin population distribution and habitat utilization is necessary in order to design effective regulations to minimize interactions between terrapins and crab pots. The primary goals of our study were to 1) identify spatial and temporal aspects of terrapin-crab pot overlap and 2) assess the likelihood of encounters (i.e. relative bycatch risk) based on densities and distribution of crab pots and terrapins as well as behavior of terrapins in southeastern North Carolina. From June 2008 to June 2009, we used radio telemetry to track the movements and activity patterns of 29 terrapins in Middle and Masonboro Sounds, NC. We also documented location of commercial crab fishing gear in these regions during the same time frame. These waters serve as important habitat for both terrapins and blue crabs and there have been reports of incidental captures and mortalities of terrapins in crab pots set in these regions. To investigate and predict spatial and temporal interactions between terrapins and crab pots, terrapin and crab pot location data for each field site were combined and analyzed using a spatially-explicit predator-prey model. Predator-prey models (e.g. the Williamson spatial overlap index) have been used to predict areas of high bycatch by comparing the density and distribution of fishing effort (predator) to that of the bycatch species (prey) in previous studies with sea turtles and marine mammals. This spatial overlap index (SOI) model describes the degree to which the spatial correlation of predator and prey deviates from the random expectation under uniform spatial distributions. Preliminary results show that although site-specific, spatial overlap is greater in the spring and summer when active, philopatric terrapins are utilizing the same near shore, shallow water habitat as blue crabs. Our data is further corroborated by local crab fisherman catch and bycatch data.

ALTERNATIVE APPROACHES FOR INVESTIGATING TOXICANT EXPOSURE AND EFFECTS IN SEA TURTLES*

Gregory V. Zychowski[1], Sandy L. Wiggins[1], Jennifer M. Cole[1], Benjamin M. Higgins[2], Joseph P. Flanagan[3], James Olson[4], Jean Strahlendorf[5], and Céline A.J. Godard-Codding[1]

[1] Department of Environmental Toxicology, The Institute of Environmental and Human Health (TIEHH), Texas Tech University, Lubbock, Texas, USA
[2] NOAA/NMFS, Galveston, Texas, USA
[3] Veterinary Services, Houston Zoo, Houston, Texas, USA
[4] University at Buffalo SUNY, Buffalo, New York, USA
[5] Department of Cell Physiology and Biophysics, Texas Tech University Health Sciences Center, Lubbock, Texas, USA

Sea turtles are currently protected under the Endangered Species Act. They face many risks, including entanglement in fishing gear, habitat degradation, and environmental pollution. Because of the turtles' protected status, scientists have limited access to the biological samples required for investigating the impact of pollution in this taxon. Here, we describe three novel alternative approaches for sea turtle toxicology: 1) the creation and characterization of loggerhead (*Caretta caretta*) sea turtle primary skin cultures, 2) the identification and sequencing of the CYP1A gene in three species of sea turtles, and 3) the development of an organotypic culture methodology for Kemp's ridley (*Lepidochelys kempii*) sea turtle skin and liver tissues. All samples were permitted appropriately. Cell culture work has potential to describe exposure-effect scenarios in an in vitro context and may offer insight on risks to whole organisms. Characterization of primary skin fibroblast cultures included the determination of optimal growth conditions (temperature, medium, serum concentration, and coating/substrate), observations of morphology, and immunocytochemistry for vimentin, a cytoskeletal protein. Following characterization, loggerhead skin cultures were used to investigate the cytotoxicity of benzo[a]pyrene (B[a]P), a polycyclic aromatic hydrocarbon (PAH) and known marine contaminant associated with fuel combustion and oil. Simultaneously, cytochrome P450 research was undertaken for the loggerhead, Kemp's ridley, and green turtle (*Chelonia mydas*). In mammals, the cytochrome P450 1A1 (CYP1A1) enzyme plays a key role in the metabolism and activation of PAHs to their carcinogenic metabolites and is widely used as a biomarker of exposure to PAHs and related toxicants. The CYP1A protein has been identified in some terrestrial reptiles but whether it is also involved in the bioactivation of PAHs and can be used as a biomarker in this taxon is currently unknown. Here, we report on the first sequencing of the CYP1A gene in reptiles. CYP1A sequencing involved using degenerate CYP1A primers, designed within regions highly conserved in birds and amphibians, in a reverse transcription polymerase chain reaction (RT-PCR). Both ends of the gene were sequenced using Rapid Amplification of cDNA Ends (RACE), and a total of 1556 base pairs or 522 amino acids were identified. Each of the sea turtle CYP1A genes has approximately 70% nucleotide sequence identity with the human and amphibian CYP1A sequences and between 73-80% nucleotide sequence identity with avian CYP1A sequences. Studies investigating CYP1A expression and inducibility in primary sea turtle cell lines upon exposure to PAHs by quantitative PCR are underway. In our third approach, following the evaluation of tissue viability using Flame Atomic Absorption Spectrometry, organotypic tissue culture slices of skin and liver tissue dosed with B[a]P (0.01 μM-10 μM) were evaluated for cytochrome P450 activity using 7-Ethoxyresorufin, 7-Methoxyresorufin, 7-Pentoxyresorufin and 7-Benzyloxyresorufin dealkylation assays. Findings suggest time-dependent and dose-dependent cytochrome P450 activity in Kemp's Ridley organotypic cultures. In sum, all three approaches represent minimally invasive strategies for studying marine turtle exposure to contaminants. In light of the recent oil spill in the Gulf of Mexico and the restricted access to the organisms of concern, we encourage the further exploration and implementation of these methods.

REVIEW: REPTILIAN EXPOSURE TO POLYCYCLIC AROMATIC HYDROCARBONS

Gregory V. Zychowski and Céline A.J. Godard-Codding

Department of Environmental Toxicology, The Institute of Environmental and Human Health (TIEHH), Texas Tech University, Lubbock, Texas, USA

Reptiles have been the subjects of limited toxicological research, and they remain largely understudied for their exposure to polycyclic aromatic hydrocarbons (PAHs). PAHs have demonstrated toxicity in humans and wildlife, and their exposure is associated with cancer, developmental abnormalities, adverse respiratory effects, and immunotoxicity. A systematic survey of literature on reptiles and PAH exposure was conducted for the purposes of identifying specific research areas within this topic, and to identify the level of knowledge accumulated within each. Relevant criteria were applied to ISI Web of Knowledge(SM) searches, and sources for review were selected by rigorous examination of titles, abstracts, article content, and through citation mapping. Additional sources were obtained from the United States Environmental Protection Agency, the Agency for Toxic Substances and Disease Registry, and the National Oceanic and Atmospheric Administration. Based on this survey, additional knowledge might prove useful to conservation efforts and the preservation of population health. Over 25 directly relevant sources were collected, though at least 30 others were used for supplementary purposes. The majority of existing literature has focused on Testudines, followed by Squamata, Crocodylia, and Rhynchocephalia/Sphenodontia (no sources found for that later group). A number of sources that discuss oil or hydrocarbon exposure without specific reference to PAHs have been included in the review. The presence of these sources underlines the importance of studying both specific compounds and mixtures. Additionally, while a few studies have addressed toxic effects after exposure, the majority have been concerned primarily with exposure or indicators of exposure. Many studies have been associated with significant contamination events, including oil spills. Increases in contaminant burdens in organisms from contaminated sites have been demonstrated in several cases. In the existing literature, some correlations have been drawn between contaminant exposure and putative effects (direct or indirect), which collectively include cytochrome P450 induction, inflammation, necrosis, acanthosis, hyperkeratosis, dermal hemorrhaging, catabolic abnormalities, genotoxicity, developmental abnormalities, and mortality. In particular scenarios, especially where threatened and endangered species are concerned, in vitro techniques are perhaps the more promising means by which knowledge gaps may be filled.

Author Index