Dear Sea Turtle Symposium Attendees,

As President of the International Sea Turtle Society, I wish to personally extend my warmest welcome to each one of you, as you join me and all of my Organizing Committees for the 42nd Annual International Sea Turtle Symposium here in amazing Thailand. These meetings represent only the second time in the history of the ISTS that the Symposium has been held in Southeast Asia, and the first time to be held in Thailand. This is truly an historic event, and I'm delighted you've chosen to be a part of these meetings.

We've chosen "All In – All Together; Inspiring the Next Generations of Sea Turtle Conservationists" as our Symposium theme to represent the importance of all of us, as a sea turtle conservation community, being connected together from East to West. Our Society is truly a global one, representing the efforts of researchers, community members, government agencies, conservationists, policy makers, and sea turtle enthusiasts. Humanity and all sea turtle species benefit when, as a community, we're all pulling together for the good of sea turtles around the world. Rather than setting aside our differences, we demonstrate that the diversity of cultures and groups, approaches and views among our community strengthen, rather than weaken, the fabric of our collective resolve to see the oceans and beaches of the world continue to support healthy, recovering populations of sea turtles that sustain healthy ecosystems, and bring joy to people everywhere.

The Symposium logo, so elegantly designed by Dr. Sirawich Srisiri (and described above), provides a beautiful representation of the ethos of these meetings, in that my Team and I are seeking to facilitate opportunities for us as local community members, students, researchers, government agencies, and conservation organizations to collaborate across national boundaries, and together represent a truly global community.

No matter what your role is, my Team and I hope that as you spend time here in Pattaya, Thailand at the 42nd ISTS Symposium, you'll enjoy wonderful experiences at these six days of meetings, workshops, presentations, and social events. May you experience new discoveries, find new challenges, engage new colleagues, and develop new life-long friendships that will continue to pique your curiosity, drive your compassion, and fuel your commitment for sea turtles and the people who share their spaces.

When our time together is finished, let's return to our respective places knowing that we're "All In - All Together!"

Cheers,

Stephen G. Dunbar, PhD
President,
International Sea Turtle Society

NOAA Technical Memorandum NMFS-SEFSC-785

doi: 10.25923/b53w-tq22

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

24 to 29 March, 2024

Pattaya, Thailand

Compiled by:

Paul A. Whittock, Emily Hyatt, and Lisa C. Belskis

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

March 2025

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U. S. DEPARTMENT OF COMMERCE

Howard Lutnick, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Vice Admiral Nancy Hann, Deputy Under Secretary for Operations and performing the duties of Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator

NATIONAL MARINE FISHERIES SERVICE

Emily Menashes, Assistant Administrator for Fisheries (Acting)

March 2025

NOTICE

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Technical Editor:

Lisa Belskis

A PDF version is available at the NOAA Institutional Repository,

https://repository.library.noaa.gov

As of the date of this publication, all efforts are made to use "Gulf of America" per Executive Order 14172. However, the abstracts cited herein referred to this water body as the "Gulf of Mexico" as they were presented during the International Sea Turtle Society's Forty-Second Annual Symposium on Sea Turtle Biology and Conservation in March 2024.

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

PRESIDENT'S REPORT

42nd Annual Symposium on Sea Turtle Biology and Conservation

24 – 29 March, 2024, Pattaya, Thailand

Stephen G. Dunbar[1,2,3], Robert Gammariello[2,3], Ingrid Yañez[4], Nantarika Chansue[5], Sirawich Srisiri[5], Nitiwadee Keschumras[5], and Thanida Haetrakul[5]

[1] President, International Sea Turtle Society
[2] Department of Earth and Biological Sciences, School of Medicine, Loma Linda University, Loma Linda, CA 92350
[3] Protective Turtle Ecology Center for Training, Outreach, and Research, Inc. (ProTECTOR, Inc.), Loma Linda, CA 92350
[4] Eastern Pacific Hawksbill Initiative (ICAPO)
[5] Veterinary Medical Aquatic Animal Research Center of Excellence, Faculty of Veterinary Science, Chulalongkorn University, Bangkok, Thailand 10330

The 42 nd International Sea Turtle Symposium (ISTS42) took place from March 24 – 29, 2024 at Dusit Thani Hotel, in Pattaya, Thailand. It was decided early by the President and Thai Organizing Committee that Pattaya would serve as an ideal host city due to its location on one of the largest beach areas in the country, as well as the many features on offer to visiting attendees to the Symposium. For the 42 nd ISTS, the Organizing Committee planned several new initiatives, including having three concurrent oral sessions, a student-only social event, and introducing an 'Origin Stories and Stories from the Field' special session. For the first time in the Symposium's history, the meetings were hosted in Thailand, making the ISTS more accessible to communities, researchers, government agencies, and students from throughout the SE Asia and Indian Ocean regions. To facilitate a sense of integrating attendees from both the East and West, as well as the Global North and South, the theme of the Symposium was "**All In – All Together; Inspiring the Next Generations of Global of Sea Turtle Conservationists.**" This theme set the inclusive tone of the meetings, with the warm and welcoming staff of the Dusit Thani Pattaya Hotel, and the international inclusiveness of the city providing the perfect backdrop for all attendees to feel they were part of a truly historic and memorable ISTS gathering. There were 558 attendees representing 66 countries from around the world. The symposium logo incorporated elements of the Thai culture, architecture, and art, in which the Kranok cradles a water body, a Thai cityscape, and the three species of sea turtles (green, hawksbill, and leatherback) found in Thai waters. Attendees who arrived prior to the official start of the Symposium took part in 14 workshops facilitated on Sunday, March 24, covering topics as varied as GIS, sea turtle rehabilitation and medicine, drones and turtles, photo-based citizen science, and a workshop organized by the Student Committee. Workshops provided a total of 76 hours of interactions, among 384 attendees, while seven regional meetings were carried out on Monday, March 25, and provided a total of 36 hours of reporting, discussion, and planning time involving 350 registered participants The Travel Grants Committee received 144 travel grant applications to review, of which 114 (79.2%) were approved, with 47 allocated to South Asia, 19 to North America, 10 to Europe, 10 to Mexico and Central America, 10 to South America, 7 to Africa, 5 to Oceania and Polynesia, 3 to the Caribbean, and 3 to the Middle East and North Africa. The Symposium social media campaign resulted in 164 total social media posts, increasing engagements in Facebook by 306.8%, while engagements through Instagram increased by a staggering 4,500%. Honored guests for the Opening Ceremonies included Mr.

Poramese Ngampiches, Mayor of Pattaya City; Mr. Pinsak Surasawadee, Director General of the Department of Marine and Coastal Resources (DMCR); Mr. Autthaphon Chatroenchansa, Director General of the Department of National Parks (DNP); the representative of Mr. Bancha Sukkaew, Director General of the Department of Fisheries; Ms. Preeyaporn Suwannakes, Director General of the Department of Pollution; Admiral Suwin Jaengyodsuk, Deputy Commander of the Royal Thai Navy; and very special guest, Mr. Jatuporn Buruspat, Permanent Secretary of the Ministry of Natural Resources and the Environment, and Representative for Her Highness, Princess Sirivannavari. The business meeting reviewed Society business for the 2023 – 2024 year. Essentially all business-related items, including the Treasurer's, Secretary's, Awards Committee, Travel Grant Committee, and Student Awards reports were adopted by Society members without extensive discussion. The proposal for the restructuring of the Society's administration initiated much discussion among the members present, with members being reassured that the proposal for restructuring was in the discussion phase with a request for members to provide their feedback on the proposal over the coming year. The Nominations Committee Chair presented the 2024 Elections results: Alexander Gaos was elected President-Elect; Seh Ling Long and Richard Reina were elected to the Board of Directors; Connie Ka Yan and Kellie Pendoley were elected Nominations Committee members; and Ryan Welsh, Rod Mast, Earl Possardt, and Jacques Fretey were elected Awards Committee members. Overall, the 42 nd International Sea Turtle Society Symposium was a huge success that reminded everyone who attended, that if we are to be effective at the global conservation of sea turtles and the habitats they rely on, we must continue to work in intimate collaboration with coastal communities, and be committed to being 'all in – all together!''

The President's Report may be found in its entirety in the Marine Turtle Newsletter Issue 168, entitled, "President's Report for the 42 nd Annual Symposium on Sea Turtle Biology and Conservation, Pattaya, Thailand, 24 – 29 March, 2024" by Stephen G. Dunbar, Robert Gammariello, Ingrid Yañez, Nantarika Chansue, Sirawich Srisiri, Nitiwadee Keschumras, Thanida Haetrakul.

WELCOME LETTER FROM MAYOR OF PATTAYA CITY

Poramase Ngampiches, Mayor of Pattaya City

Dear esteemed attendees of the 42nd International Sea Turtle Symposium,

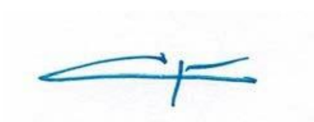
As the Mayor of Pattaya City, it is with great pleasure that I extend a warm welcome to all of you as guests to our vibrant Pattaya MICE City in Thailand!

Over the past two years, meticulous preparations have been underway to ensure that every detail has been thoughtfully planned to enhance your comfort and enjoyment during both the Symposium and your stay in Pattaya City. It has been a delightful experience collaborating closely with your ISTS President, Dr. Stephen Dunbar, and his dedicated Thai Team to make arrangements for this Symposium. We are truly excited to have you here to immerse yourselves in our rich Thai culture.

The impact of the ISTS Symposium on Southeast Asia is profound, and we believe that the knowledge shared and connections made during this event will have a positive and far-reaching influence on sea turtle conservation in the region.

We hope that each of you will not only benefit from engaging with colleagues, networking, and advancing sea turtle research and conservation efforts, but will also relish the warm and hospitable atmosphere of our city.

Once again, I extend a heartfelt welcome and express our sincere appreciation for choosing to host the 42nd International Sea Turtle Symposium here in Pattaya City, Thailand. We eagerly anticipate sharing the beauty and charm of Pattaya with all of you, and hope that your time here will be filled with unforgettable memories.



Poramase Ngampiches, Mayor of Pattaya City

COMMITTES, CHAIRS, AND KEY ORGANIZERS

EXECUTIVE COMMITTEE

Executive Committee Role	Member
President	Stephen Dunbar
Secretary	Manjula Tiwari
Treasurer	Nicholas Blume
President Elect	Andrews Agyekumhene
Past President	Diego Amorocho

ORGANIZING COMMITTEE

Organizing Committee Role	Member
Assistant to the President	Robert Gammariello
Treasurer / Bookkeeper	Nicholas Blume and Terry Meyer
Registrar	Naty Teryda, Sophie Mills, and Sittikorn Kamalas
Logistics Coordinators	Nantarika Chansue, Thanida Haetrakul, and Sirawich Srisiri
Symposium Coordinator	Ingrid Yañez
Webmaster / I.T. Liaison	Paul Whittock
Fundraising Officer	Ingrid Yañez
Exhibitor/Vendor Chair	Yonat Swimmer, Kara Dodge, and Nantarika Chansue
Speed Chatting Coordinators	Alexandra Fireman, Gabi Arango, Matthew Ramirez, and Renato Saragoça Bruno
Nomination Committee Chair	Mustapha Aksissou
Nomination Committee Members	Ryan Welsh, Imed Jribi, Nicholas Pilcher, and Jeanette Wyneken
ISTS Awards Committee	Mariluz Parga, Michael Salmon, Ana Liria Loza, and Jesús Tomás
Student Committee	Janie Reavis and Rangsima Sujittsakul ('Orn')
Student Awards Committee	Andrea Phillott and Natalie Wildermann
Grassroots Conservation Award Committee	Ingrid Yañez
Workshops Committee	Dustin Baumbach, Claire Jean, Thanida Haetrakul, and Ingrid Yañez
Silent and Live Auction Team	Marina Zucchini and Rod Mast
Volunteer Coordination Team	Itzel-Sifuentes-Romero, Adriana Cortes, and Ormmy Parinda Awpituk ('Orm')
Video Night Coordinator	Seh-Ling Long
Stories Committee	Sabrina Mashburn, Lynn Massey, and Suzie Graham
Communications and Social Media Support	Stephanie Molina, Laura Prosdocimi, Ingrid Yañez, and Paul Whittock
Travel Grants Committee	Alexander Gaos (Chair), Andrew Maurer (Chair), Angela Formia (Africa), Karen Eckert (Caribbean), Jose Urteaga (Mexico, Central America & Caribbean), ALan Rees (North Africa & Middle East), Daniela Freggi (Europe), Alejandro Fallabrino (South America), Andrea Phillott (South Asia),

	Mark Hamann (Southeast Asia/Pacific), and Kelly Stewart (USA & Canada)
Sea Turtle Trading Post	Kate Mansfield
ISTS Art Competition Committee	Chanyanis Daochi, Chandana Pusapati, Shanthasiri Jayaweera, Mohd Uzair Rusali, and Betty Delali Dordzi
Photography and Videography	Michael Dunbar
Organizers Image Collection	Sean Richards
Workshop Organizers	Pablo Antonio Trujillo Susunaga, Georgina Zamora Quílez, Amalia María Cano-Castaño, Diana del Pilar Ramírez Acosta, Anjelika Abou Issa, ALan Rees, Ray Carthy, Nerine Constant, Natalia Teryda, Thane Wibbells, Andrew DiMatteo, Laura Sparks, Brendan Hurley, Zachary Posnik, Daniela Freggi, Mariluz Parga, Antonio di Bello, Janie Reavis, Gabriela Arango, Marco García Cruz, Renato Bruno, Stephanie Koehnk, Jane Lloyd, Mtalii Ochieng, Christine Hof, Nicolas Pilcher, Irene Kelly, Michel Nalovic, John Wang, Harris Wei-Khang Heng, Jaime Restrepo, Kartik Shanker, Jarina Mohd Jani, Hector Barrios-Garrido, Jose Urteaga, Manjula Tiwari, Michelle Maria Early Capistran, Cathi Campbell, Jack Frazier, Bryan Wallace, Roderic Mast, Rachel Smith, Brian Hutchinson, Ashleigh Bandimere, Kelley Anderson, Lindsay Mosher, Marc Girondot, Sabrina Mashburn, Aiyana Reissman, Kosatas Papafitsoros, Daphne Hoh, Chialing Fong, Manjula Tiwari, Steve Dunbar, Sea Williamson, Hiltrud Crodes, and Andrea Phillott

PROGRAM COMMITTEE

Program Committee Role	Member
Program Chairs	Kelly Stewart, Michael Jenssen, Makayla Kelso, and Katrina Phillips
Poster Session Chairs	Chelsea Clyde-Brockway and Sean Richards
Session Chairs	Summer L. Martin, Matthew David Ramirez, Gabriela Manuela Velez-Rubio, Michael G. White, Sarah Milton, David William Owens, Justin Randall Perrault, Roldan Valverde, Jeanette Wyneken, Heidrun Frisch-Nwakanma, Stacy Hargrove, Michael Joseph Liles, Mario Jorge Mota, Aliki Panagopoulou, Kirah Ishelle Forman-Castillo, Tomoko Hamabata, Hielim Kim, Robin LeRoux, Erin McMichael, Claudio Quesada-Rodríguez, Ryan Welsh, Seh Ling Long, Sabrina Caitlin Mashburn, Kathy Zagzebski, Thushan Jayalath Kapurusinghe, Deasy Natalia Lontoh, Jarina Mohd Jani, Isabel Marques Silva, Tina Fahy, Irene Kelly, Liyana Izwin Khalid, Tony (Michel Anthony) Nalovic, Nicolas Pilcher, Juan Manuel Rguez-Baron, Brad Nahill, Matthew Godfrey, Shaleyla Kelez, Ray Carthy, Lalith Ekanayake, Jeanne A Mortimer, Ana Rita Patrício, Daniela Freggi, Annie Page-Karjian, Maria Luz Parga, Maximilian Polyak, Kara Dodge, Sandra Hochscheid, Nathan Jack Robinson, and Natalie Wildermann
Proceedings Coordinator	Joseph Pfaller
Proceedings Compilers	Paul A. Whittock, Emily Hyatt, and Lisa C. Belskis

TRAVEL GRANT COMMITTEE AND REGIONAL MEETING ORGANIZERS

Travel Grant Committee Role	**Member**
Chair	Alexander Gaos, Andrew Maurer
Regional Chair - Africa	Angela Formia
Regional Chair – Caribbean	Karen Eckert
Regional Chair – Mexico, Central America & Caribbean	Jose Urteaga
Regional Chair – North Africa & Middle East	ALan Rees
Regional Chair – Europe	Daniela Freggi
Regional Chair – South America	Alejandro Fallabrino
Regional Chair – South Asia	Andrea Phillott
Regional Chair – Southeast Asia/Pacific	Mark Hamann
Regional Chair – USA & Canada	Kelly Stewart

Regional Meeting	**Member**
Africa	Manjula Tiwari
East Asia	Connie Ka-yan NG, Takashi Ishihara
IUCN Marine Turtle Specialist Group (MTSG)	Roderic B. Mast, Paolo Casale
Indian Ocean & Southeast Asia (IOSEA)	Lalith Ekanayake
Latin America Meeting (RETOMALA)	Jimena Gutiérrez-Lince, Daniela Rojas-Cañizales, Gabriela Vélez-Rubio, Georgina Zamora-Quílez
Mediterranean	Imed Jribi, Aliki Panagopoulou
Oceania/Pacific Islands	Irene Kelly

BOARD OF DIRECTORS AND THEIR END OF TERM

Neca Marcovaldi	2024
Sandra Hochscheid	2025
Amanda Williard	2025
Daniela Freggi	2025
Mariana Fuentes	2026
Andrea Phillott	2026
Itzel Sifuentes	2027
Joe Pfaller	2027

Kellie Pendoley (past President 2022)	2024
Diego Amorocho (past President 2023)	2025

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Telonics Inc.
Thai Story Tours
The Leatherback Trust
TurtleSpot Taiwan
Wildlife Computers

ISTS AWARDS

Chair: Mariluz Parga

Members: Michael Salmon, Ana Liria Loza, and Jesús Tomás

Lifetime Achievement Award

Kellie Pendoley

Anders Rhodin

Champions Award

Scott Eanes

Turtle Watch Egypt 2.0

President's Award

Poramese Ngampiches (Pattaya City Mayor)

Nantarika Chansue

Thanida Haetrakul

Sirawich Srisiri

Nitiwadee Keschumras

Sahang Supamas

Kelly Stewart

Ingrid Yanez

Sabine Dunbar

Grassroots Conservation Award

Campamento Tortuguero Ayotlcalli A.C., and "Warriors of the Rainbow" Program. Guerrero, Mexico: "Warriors of the Rainbow" educating future leaders and decision makers.

The Ed Drane Award for Volunteerism

Laura Bruce

STUDENT AWARDS

There were 78 oral presentations and 34 poster presentations nominated by students in the Archie Carr Student Awards during the 42nd Annual Symposium. Presentations were assessed under one of four award categories (nominated by the student presenter): Biology Poster, Conservation Poster, Biology Oral, Conservation Oral. Judges for each category were asked to select a winner and a runner-up. Seven student presentations were selected for awards, with only a winner selected in the category of Conservation Poster. The majority of student award winners came from universities in the USA (six) with one each from universities in Japan and Australia. Award amounts were: Winners = US$500 each, Runners-up = US$250 each. The total for all awards = US$2,750. Winners also received an APC waiver for any Peer J journal.

Chairs: Andrea Phillott and Natalie Wildermann

Members: ALan Rees, Aliki Panagopoulou, Cali Turner, Christopher Long, Connie Ng, Gabriela Velez-Rubio, Jarina Mohd Jani, Joseph Pfaller, Kostas Papafitsoros, Mariela Pajuelo, Matthew Ramirez, Matthew Ware, Ray Carthy, Samir Patel, Sandra Hochscheid, Seh Ling Long, Stephanie Köhnk, and Uzair Rusli

<u>Student Awards for Poster and Oral Presentations at ISTS42, Pattaya, Thailand:</u>

Category	Prize	Student	Institution	Presentation Title
Biology Poster (n=20)	Winner	Tiffany Dawson	University of Central Florida, USA	Evaluating the relationship between immune function and reproductive success in nesting turtles
	Runner up	Megumi Kawai	The University of Tokyo, Japan	Foraging patterns of more nourished green sea turtles migrating to high latitudes in Japan
Conservation Poster (n=14)	Winner	Gustavo David Stahelin	University of Central Florida, USA	Size matters: how sample size and molecular marker choice affect mixed stock analysis
	Runner up	NA	NA	NA
Biology Oral (n=39)	Winner	Emily Turla	Florida Atlantic University, USA	A novel approach to assessing fertility rates of leatherback sea turtle (*Dermochelys coriacea*) eggs
	Runner up	Taylor Brunson	University of the Virgin Islands, USA	Active selection of native seagrass in Halophila stipulacea-dominated meadows among juvenile green sea turtles identified using fine-scale acoustic telemetry in U.S.V.I.
Conservation Oral (n=39)	Winner	Anna Antonia Ortega	University of Western Australia, Australia	Estimating annual leatherback bycatch in the Pacific Ocean by fishery and country to inform targeted conservation strategies
	Runner up	Cindy Vargas	Arizona State University, USA	Incorporating fisher metrics in assessments of sea turtle and other marine megafauna bycatch reduction technologies

SPECIAL FEATURES

SPEED CHATTING WITH THE EXPERTS

Chairs: Alexandra Fireman, Gabi Arango, Matthew Ramirez, and Renato Saragoça Bruno

Eight experts shared their knowledge and experience in 10-minute slots. Experts included: Mohd Uzair Rusli, Jesse Senko, Enas Mohamed Riyaz (Tonti), Juanita Joseph, Gavin Jolis, Sean Williamson, Kimberly Finlayson, John H. Wang. We had over 35 students participate.

VIDEO NIGHT

Chair: Seh Ling Long

Committee members: Seh Ling Long, Azrin Asyikin BMohd Shukor, Nur Isandra Shazlynn, Shamsul Azmil, Audrey Simplicius, Rushan Abdul Rahman, Tze Ning Cheok

Sea Turtle Conservation in Cambodia. Koh Polou Wai, Outer Island, Cambodia by Chandara Tak, Flora & Fauna International, Cambodia

Care for Hedland OUR TOWN. Port Hedland, Western Australia by Kelly Howlett, Care for Hedland Environmental Association Inc (Australia)

Can Sea Turtle Breeding Patterns Buffer Impacts from Climate Change? Fernando de Noronha, Brazil by Armando J.B. Santos, Marine Turtle Research, Ecology, and Conservation Group from Florida State University

Ramblin' Kind. Bhanga Nek, KwaZulu-Natal, South Africa by Amanda Robbins, Nelson Mandela University

Mi Kasa- Su kasa (Our Turtles your Turtles). Watamu, Kenya by Ochieng Odhiambo, Bahari Hai Conservation

STORM: Sea Turtle for Ocean and Research Monitoring in the Indian Ocean. Southwest Indian Ocean by Olivier Bousquet, LACy(Laboratoire de l'Atmosphere et des Cyclones – University of La Réunion

Marine Turtle Tagging in APAIPS. Primeiras and Segundas Islands Environmental Protection Area in Mozambique by WWF- Mozambique

Introducing ShellBank, the World's First Traceability Toolkit and Marine Turtle DNA Database. Region: Global by ShellBank Project (Under WWF)

Rumaki. Tanzania by WWF-Tanzania

Saving Malaysia's Marine Turtles: A Glimpse into Conservation Efforts with WWF- Malaysia. Terengganu, Melaka and Sabah, Malaysia by Gavin Jolis, WWF-Malaysia

The Loggerhead Lost Years. USA and Azores, Portugal by Upwell Turtles

Moheli, 25 years of Cooperation for Sea Turtle Conservation. Moheli, Comoros – South West Indian Ocean by Katia Balloraine, CEDTM (La Réunion – France). A joint project with National Park of Moheli, ADSEI, KELONIA, IFREMER, University of La Réunion

Holistic Approach to Marine Turtle Conservation. Papua, Indonesia by Science for Conservation Program of the Research and Community Service Institute of the State university of Papua (LPPM UNIPA)

Olive Ridley Project: Protecting Sea Turtles & Their Habitats. Maldives, Kenya, Seychelles, Pakistan, Oman, and United Kingdom by Olive Ridley Project

Guidelines for Safe Handling and Release of Marine Turtles in Gillnet Fisheries. By WWF-Pakistan

Why Turtles Love Lampedusa. Lampedusa, Italy, Mediterranean Sea by Daniela Freggi and Marina Zucchini, Lampedusa Turtle Rescue, Italy

Te mana o te moana Sea Turtle Nesting Survey on Tetiaroa Atoll in French Polynesia. French Polynesia, Tetiaroa Atoll by Cécile Gaspar, DVM, founder NGO Te mana o te moana

Protecting Our SEAS. Mabul Island, Sabah, Malaysia by Linda Rainbow, Scuba Junkie SEAS

Sea Turtle Conservation in Sri Lanka. Rekawa, Sri Lanka by Thushan Kapurusinghe, The Sri Lanka Turtle Conservation Project

Saving Sea Turtles of Borneo, Malaysia. Sabah Malaysia by Associate Professor Dr. Juanita Joseph, Sea Turtle Research Group, Borneo Marine Research Institute, Universiti Malaysia Sabah

COPRA Expeditions: Towards a Sustainable Management of the Glorieuses Marine Nature Park Seagrasses. Glorieuses Archipelago – South West Indian Ocean by Katia Ballorian, CEDTM (La Réunion – France). A joint project with PNMG/OFB, KELONIA, TAAF & University of La Réunion

Taking a Deeper Dive into Leatherback Health. Florida, USA by Upwell Turtles

Turtle Point Filicudi. Sea Turtles First Aid, Pecorini Mare Filicudi, 98055 Lipari (ME), Italy by Monica Francesca Blasi, Filicudi Wildlife Conservation

Tides of Transformation. East Coast of India, India, Asia by Supraja Dharini, TREE Foundation

The Tunisian Turtle. Gulf of Gabes, Tunisia by Hamed Mallat, Life Medturtles Project

Virtopsy-led Aquatic Animal Stranding and Salvage Programme in Hong Kong and Adjacent Waters. Hong Kong SAR by Brian Chin Wing Kot, Tabris Yik To Chung, and Henry Chun Lok Tsui, Aquatic Animal Lab, City University of Hong Kong

Cronicas Tortugueras. Venezuela by Gilberto Borges Guzman, Audiovisual Master Pro

Proyecto Macuro. Venezuela, by Clemente Balladares and Gilberto Borges

PULIHARA's Dedication to Conserving the Endangered Sea Turtles. Terengganu, Malaysia by Azrin Asyikin, PULIHARA

WORKSHOPS

Chairs: Dustin Baumbach, Claire Jean, Thanida Haetrakul, and Ingrid Yañez

4TH INTERNATIONAL WORKSHOP ON ENVIRONMENTAL EDUCATION ART AS AN ENVIRONMENTAL EDUCATION TOOL FOR CHILDREN IN SEA TURTLE PROJECTS
Organizers: Pablo Antonio Trujillo Susunaga, Georgina Zamora Quílez, Amalia María, Cano-Castaño, Diana del Pilar Ramírez Acosta, and Anjelika Abou Issa

5TH ISTS DRONES AND TURTLES WORKSHOP
Organizers: ALan Rees, Ray Carthy, Nerine Constant, Natalia Teryda, and Thane Wibbells

GIS WORKSHOP
Organizers: Andrew DiMatteo, Laura Sparks, Brendan Hurley, and Zachary Posnik

SEA TURTLE REHABILITATION AND MEDICINE WORKSHOP
Organizers: Daniela Freggi, Mariluz Parga, and Antonio di Bello

STUDENT WORKSHOP: CAREER PATHS IN SEA TURTLE CONSERVATION
Organizers: Janie Reavis and Gabriela Arango

THE GLOBAL MALE SEA TURTLE INITIATIVE: NEXT STEPS
Organizers: Marco García Cruz and Renato Bruno

PHOTO ID - APPLICATIONS, CHALLENGES AND TECHNICAL SOLUTIONS
Organizers: Stephanie Koehnk, Jane Lloyd, and Mtalii Ochieng

BYCATCH ASSESSMENT AND MITIGATION IN DEVELOPING WORLD FISHERIES: CURRENT STATE OF AFFAIRS, PRIORITIES, OPPORTUNITIES, AND NEXT STEPS
Organizers: Christine Hof, Nicolas Pilcher, Irene Kelly, Michel Nalovic, and John Wang

OVERCOMING BARRIERS TO KNOWLEDGE: SEA TURTLE MOVEMENT AND HABITAT CONNECTIVITY IN SOUTHEAST ASIA
Organizers: Harris Wei-Khang Heng and Jaime Restrepo

DECOLONISING SEA TURTLE CONSERVATION: WALKING THE TALK
Organizers: Jarina Mohd Jani, Hector Barrios-Garrido, Jose Urteaga, Manjula Tiwari, Michelle Maria Early Capistran, Cathi Campbell, Jack Frazier, and Bryan Wallace

DEVELOPING BEHAVIOR CHANGE CAMPAIGNS FOR SEA TURTLE CONSERVATION
Organizers: Roderic Mast, Rachel Smith, Brian Hutchinson, and Ashleigh Bandimere

TEMPERATURE-DEPENDENT SEX DETERMINATION
Organizer: Marc Girondot

GLOBAL PERSPECTIVES ON SEA TURTLE AND MARINE CONSERVATION EDUCATION
Organizers: Sabrina Mashburn and Aiyana Reissman

OPENING REMARKS AND PLENARY PRESENTATIONS

OPENING REMARKS: WELCOME TO THE 42ND ANNUAL SEA TURTLE SYMPOSIUM

Stephen G. Dunbar
President, International Sea Turtle Society

REFLECTIONS FROM A SEA TURTLE LIFER

Guest Speaker: Jeffrey A. Seminoff
NOAA Southwest Marine Fisheries Science Center

SEA TURTLE CONSERVATION IN SOUTHEAST ASIA: A TALE OF TWO BEACHES, AND SOME OF THOSE IN BETWEEN

Guest Speaker: Jarina Mohd Jani
Faculty of Science and Marine Environment, University of Malaysia, Terengganu, Malaysia

ANATOMY, PHYSIOLOGY AND HEALTH

INCREASING HYPOXIA PROGRESSIVELY SLOWS EARLY EMBRYONIC DEVELOPMENT IN THE GREEN TURTLE

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Green turtle (Chelonia mydas) embryos are in an arrested state of development when the eggs are laid, but in the presence of oxygen (generally 19-21% in new nests), arrest is broken and development resumes within 12-16 hours. However, the precise oxygen level at which embryos break arrest and continue development is not known. To better understand the impact of oxygen concentration on breaking of arrest and early embryonic development, we incubated freshly-laid eggs of the green sea turtle for three days at each of six different oxygen concentrations (≤1%, 3%, 5%, 7%, 9%, and 21%) and monitored the appearance and growth of white spots on the shell, typically indicative of embryonic development. As reported previously, white spots did not develop on eggs incubated in anoxia (≤1% oxygen). For all other treatments, mean time to white spot detection varied inversely with oxygen concentration and white spot growth rate increased with oxygen concentration. In nearly all cases the difference in time to white spot appearance and growth rate between eggs at different oxygen levels was statistically significant ($p \leq 0.05$). This suggests that sea turtle embryonic development may respond to oxygen in a dose-dependent manner. Our results indicate that the development of green turtle embryos may be slowed if they are exposed to the most hypoxic conditions reported in mature natural nests. This work also has significant implications for conservation efforts, indicating that to ensure the safe transportation of eggs necessitates that oxygen availability be maintained at or below 1% if the eggs are to be in transit for 12 hours or more.

FIRST HEALTH ASSESSMENTS OF JUVENILE HAWKSBILL SEA TURTLES (ERETMOCHELYS IMBRICATA) IN THE MALDIVES: CLINICAL BLOOD ANALYTES, PHYSICAL EXAMINATIONS, ULTRASONIC STUDIES AND GUT MICROBIOME CHARACTERIZATION*

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The health status of critically endangered hawksbill sea turtles from the Indian Ocean area is largely unknown as few studies have been performed on this population. We evaluated clinical indices of health in juvenile hawksbill sea turtles (n=36) from Maldivian waters in order to 1) establish reference intervals

for plasma biochemical and haematological analytes, 2) perform physical and neurological examinations, 3) assess anatomically available structures by ultrasonic study, and 4) collect colonic and cloacal samples for gut microbial evaluation. All work was subjected to independent animal welfare review and all work was performed under permit from the Maldivian government. Blood analytes included complete blood counts with manual differentiation, PCV, TS, Glucose, SDMA, Creatinine, BUN, Uric Acid, Phosphorus, Calcium, Total Protein, Albumin, Globulin, Albumin:Globulin, ALT, ALP, GGT, Total Bilirubin, Cholesterol, Amylase, Lipase, and BHB. Full physical examinations were performed on each animal, including neurological examination and heart rate measurement by doppler. Ultrasonic examinations were performed using pre-femoral fossa access and renal and lower intestinal features were evaluated. Samples were collected from the cloaca and distal colon using a specialized technique validated for this project. Gut samples were preserved and stored for subsequent microbial analysis. All animals were returned to the wild without incident. This is the first comprehensive health assessment of a population of critically endangered hawksbill sea turtles in the Maldives.

EXPOSURE TO HYPOXIA FINE-TUNES MITOCHONDRIAL FUNCTION IN PRIMARY DERMAL FIBROBLASTS DERIVED FROM LOGGERHEAD SEA TURTLES*

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Sea turtles are constantly exposed to changes in oxygen tension derived from extended breath-hold diving, but the cellular-level response to such changes is not completely understood. Most studies in hypoxia-tolerant reptiles have focused on the freshwater turtle *Trachemys scripta*, which responds to anoxia by inducing metabolic rewiring and preserving mitochondrial integrity, facilitating efficient mitochondrial respiration during reoxygenation. Here, we derived primary dermal fibroblasts from loggerhead sea turtles and western fence lizards to study the bioenergetic cellular response to hypoxia exposure in diving and non-diving reptiles. Cells from both species stained positive for the fibroblast markers vimentin and PDGFRb and responded to hypoxia exposure (0.1% O_2) by accumulating HIF-1α. We measured oxygen consumption rates (OCR) in intact cells using Seahorse technology. We found that basal, maximal, and spare respiratory capacity was lower in lizard than in loggerhead cells at 26°C under normoxic (room air) conditions ($p < 0.0001$). Exposure to short- (1h) and long-term hypoxia (24h) altered mitochondrial function in both species. Maximal and spare respiratory capacity were lower in loggerhead than in lizard cells ($p < 0.01$) after 1h hypoxia followed by 1h reoxygenation. In contrast, basal and maximal respiratory capacity was higher in loggerhead compared to lizard cells after 24h hypoxia ($p < 0.04$). Nonetheless, the overall OCR after 24h hypoxia in both species was lower than that observed after 1h hypoxia. Overall, there was a significant reduction in cellular respiration in both species from short-term to long-term hypoxia exposure. In lizard cells, basal OCR decreased by a factor of three while maximal OCR decreased by a factor of 4.5. In loggerhead cells, both the basal and maximal OCR decreased by a factor of two. Our results demonstrate species-specific regulation of cellular respiration after hypoxia exposure. Remarkably, loggerhead cells show a steady downregulation of cellular respiration in response to hypoxia exposure and faster recovery after extended hypoxia (24h) than lizard cells, aligning with the remarkable hypoxic tolerance exhibited by sea turtles, which can endure up to 7 hours of breath-holding underwater. Understanding the cellular mechanisms that drive hypoxic tolerance in diving animals can provide insights for treating human conditions characterized by hypoxia signaling.

PHYSIOLOGICAL CHANGES IN BLOOD PARAMETERS OF SEA TURTLES ACROSS NESTING EPISODES

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Sea turtles are capital breeders, where the accumulation of energy and resources is necessary to go through an extended period of breeding season. An adult individual does not provide any maternal care to the incubated hatchlings, thus, justifying the necessity of providing sufficient resources for the developing embryos. In general, blood acts as the universal transporting media that carries these resources throughout the body, given the optimal internal physiological state of the individual. This study aims to investigate the changes in blood profile through blood gases, biochemistries, and hematology parameters of green turtles over a series of nesting episodes. We hypothesize that parameters that are highly demanded during egg production and individual health maintenance will show variability as the nesting period progresses. A suite of 16 blood parameters, classified into three groups; (1) nutrients and metabolites (glucose Glu, blood urea nitrogen BUN, creatinine Crea, and lactate Lac), (2) elements and electrolytes (Sodium Na, potassium K, chloride Cl, Calcium ion Ca2+, bicarbonate ions HCO3-, anion gap AnGap), and (3) blood gases (partial pressure CO2, partial pressure O2, total carbon dioxide TCO2, oxygen saturation sO2, base excess BE, and pH), were analysed using a portable clinical i-Stat analyser, with CG4+ and Chem8+ cartridges. Hematology parameters include haemoglobin Hb, packed cell volume PCV, erythrocyte counts, and estimated and differential (%) leukocyte counts were analysed using standard hematologic techniques. The analyses were performed for all blood samples collected from individuals over consecutive nesting episodes. Analysis of variance (ANOVA) with repeated measures showed a significant difference ($p<0.05$) in blood parameters of individuals ($n = 5$) nested consecutively; pH, pCO2, pO2, sO2, TCO2, K, Cl, and Ca2+. Haemoglobin (Hb) and PCV are among hematology parameters that significantly differ ($p<0.05$) as the successful nesting episodes proceed. The reported findings of this study correspond with previously reported values, thus expanding the reference values for blood profiles for this particular nesting population. Being one of the important nesting grounds in the South China Sea rookeries, the health assessment of adult individuals is crucial for conservation. We suggest further study into finding the possible association between maternal blood profiles and reproductive output/success to elucidate maternal provisioning as a potential contributing factor to the hatchling success in the first few days, given that individual health would influence reproductive outcomes.

EPIBIONTS ASSOCIATED WITH NESTING FEMALES OF BLACK TURTLES (CHELONIA MYDAS AGASSIZII) FROM THE BREEDING POPULATION OF MICHOACAN, MEXICO

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In order to identify the presence of epibionts in nesting female black sea turtles (*Chelonia mydas agassizii*) at Colola beach, Mexico, 93 individuals were examined. The most frequent epibionts were balanos (*Chelonibia testudinaria*) with presence in 100% of the turtles, leeches (*Ozobranchus branchiatus*) were recorded in 48 individuals, six turtles presented barnacles (*Lepa anatiferas*) and in 26 turtles were recorded algae of the genus *Oedogonium* sp, *Enteromorpha flexuosa*, *Ectocarpus* sp. *Roicosphenia curvata*, *Navicula directa*, *Synedra ulna*, *Synedra dorsiventalis*, *Nitzschia* sp., *Gomphonema acuminatum*. On the other hand, the presence of polychaetes was observed in the balanus samples and nematodes, bryozoans and crustaceans in the algae samples present in the black turtle individuals. The present study found that the size of the turtles is a variable that does not affect the incidence of epibionts. However, their incidence varied in the different anatomical areas (carapace, plastron, head, flippers and base of the tail) of the turtles. Balans were more abundant in the carapace, leeches in the neck. In the case of barnacles, they were always found attached to the squid, mainly on the plastron. Algae were found only on the carapace.

THE ANTI-MÜLLERIAN HORMONE (AMH) AS A SEX IDENTIFICATION BIOMARKER: REVISITED*

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Imperiled sea turtle species with temperature-dependent sex determination (warm female-cool male) are especially vulnerable to climate change. A small increase in nest temperature can produce highly female-biased sex ratios, potentially threatening population stability due to a lack of males. Currently, there is no simple or non-invasive approach to identify sex of a sea turtle hatchling. A previous study used Western blots to identify a sex-specific protein, Anti-Müllerian Hormone (AMH), in male blood plasma of loggerhead (*Caretta caretta*) and red-ear slider (*Trachemys scripta*) hatchlings from controlled temperatures. This method relied on the use of a human AMH polyclonal antibody. However, when tested in loggerhead hatchlings from *in situ* nests, several inconsistencies emerged: (1) the "AMH" band in Western blots occurred in both sexes, and (2) the antibody interacted with other proteins resulting in multiple bands (non-specific binding). Consequently, we aimed to refine previous methods to identify hatchling sex from *in situ* nests. To increase specificity, a monoclonal antibody was produced based on a partial AMH sequence obtained using male green turtle (*Chelonia mydas*) gonad biopsies. Sequence comparison demonstrated that the nucleotide and the translated AMH amino acid sequence is highly conserved among sea turtle species and other freshwater turtles. Based on this information, an antigen was

designed and hybridoma technology was employed (ProMab Biotechnologies) to generate stable cell lines (clones) each producing a distinct monoclonal antibody. Testing of these different antibody clones in loggerhead hatchlings incubated under controlled temperatures showed two prominent protein bands, a ~60kDa band previously identified as AMH, and a lower band of around 30kD. We hypothesize that, as in humans, there is a cleavage site within the sea turtle AMH protein, resulting in two bands corresponding to the pro-peptide and the active form of AMH. Both appear to be detected in males and females.

REPORT OF A GREEN TURTLE (CHELONIA MYDAS) IMPACTION DUE TO MANGROVE PROPAGULES IN THE PHILIPPINES

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While foraging behaviour has been extensively studied in other countries, there is still a lack of understanding of their foraging habits in the Philippines although movement and genetic data highlight the country as an important foraging and development ground across the Indo-Pacific. The population of green turtles, particularly in Palawan island, is understudied, as is their foraging behaviour across the nearly 2000 km of coastline, ranging from small coastal seagrass beds to large foraging sites like Tubbataha Reefs Natural Park. Conflicts in the Western Philippine Sea, coastal development, and climate change potentially threaten these foraging sites. On February 23, 2023, the Port Barton Marine Park ranger found a stranded green turtle and necropsy was conducted on February 26, 2023. The carcass exhibited a distended distal colon, impacted with faecal matter, mainly composed of undigested propagules of *Rhizophora* sp. and several strands of synthetic string. The undigested propagule material was scattered throughout the small and large intestine. Collected samples (n=16) from the distal colon measured an average of 43.73 mm in length and 17.36 mm in width, with the largest fraction measuring 82 mm in length. The strings (n=31) ranged from 50 to 530 mm in length, and were identified to be polypropylene rope strands, flour sack strands, and nylon rope strands. The synthetic materials, while present across the intestine, did not seem to be the primary cause of impaction, nor did it cause other macroscopic pathologies like intussusception – a phenomenon often found in turtles with nylon fishing lines or ropes in their gastrointestinal tract. Intestinal impaction from the propagules was identified as the most probable cause of death. Previous necropsies of stranded green turtles in Palawan and the Philippines have reported seagrass, and algae as the main food sources, and this is the first report, to our knowledge, with large quantities of propagules ingested. While the reason for the ingestion of large quantities of propagule is unknown, days before the stranding, a mangrove planting initiative was coordinated by local groups and authorities a few kilometres from the stranding site. While no previous records occur in the Philippines to our knowledge, green turtles found in estuaries in the Galapagos Islands, Western Australia, and Shoalwater Bay, Australia have been reported to opportunistically ingest mangrove propagules, particularly the cotyledon and roots from Avicennia marina, as part of their diet, although these species are softer, less fibrous, with less probability to cause impactions. Since shifts in the green turtle diet often depend on the availability of food sources, caution and proper planning should be put in place to ensure proper habitat selection for mangrove greenings programs, avoiding existing seagrass beds and other important foraging habitats for local marine turtle populations.

COMPARING HEAVY METAL CONCENTRATIONS OF LOGGERHEAD TURTLES AND THEIR PREY ALONG THE US EAST COAST*

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The eastern coastline of the USA is highly urbanized, which has contributed to a significant anthropogenic output of pollutants (such as heavy metals) entering the environment and washing out to the ocean. This is of particular concern for long-lived marine species like sea turtles. Sea turtles, therefore, make useful indicator species because they incorporate environmental and dietary heavy metals as they migrate through marine habitats. Scute samples (from the carapace) can be collected in a relatively non-invasive manner and can reflect the environment and diet of sea turtles within 4-6 years of their life. To better understand trophic accumulation of heavy metals in loggerhead sea turtles (*Caretta caretta*), we collected scute samples during necropsies of cold-stunned loggerhead turtles from Cape Cod Bay, Massachusetts (CCB; n=17), as well as from live loggerhead turtles in the Mid-Atlantic Bight (MAB; n=37) and off the coast of North Carolina (NC; n=9). The three loggerhead turtle groups are of different life stages and exposure duration, with CCB having the smallest loggerhead turtles and MAB having the largest loggerhead turtles. Therefore, the heavy metal concentrations in their scutes act as indicators of what these sea turtles were exposed to in the environments they experienced and their diet at different stages of their lives. We also collected several commonly known prey items of loggerhead turtles including whelk (*Buccinum undatum;* n=12), Atlantic scallop (*Placopecten magellanicus;* n=10) and Jonah crab (*Cancer borealis;* n=5) from the Mid-Atlantic Bight region. The concentrations of silver (Ag), aluminum (Al), arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb), selenium (Se) and zinc (Zn) were analyzed using an Inductively Coupled Plasma Mass Spectrometry (ICP-MS). NC loggerhead turtles had higher heavy metal concentrations than other locations except for cadmium (mean ± SD $\mu g\ g^{-1}$ wet weight; CCB 0.256 ± 0.150; NC=0.103 ± 0.042; MAB=0.095 ± 0.040) and zinc (CCB=201.79 ± 0.50.97; NC=184.66 ± 70.85; MAB=172.92 ± 52.16), where CCB loggerhead turtles were higher. As NC and CCB loggerhead turtles' scute samples are probably still reflecting heavy metal concentrations from their juvenile omnivorous diets, the higher NC heavy metal concentrations are likely indicative of the heavy metals bioaccumulating in the larger NC turtles. On the other hand, NC turtles having higher heavy metal concentrations than MAB turtles indicates that MAB turtles' scute samples are probably reflecting heavy metal concentrations from their carnivorous adult loggerhead diet. We found that all heavy metals except silver, cadmium, and lead appear to be biomagnified (TTF>1) in loggerhead turtles. This study provided baseline information on heavy metal concentrations in loggerhead scute samples and their prey in east coast US.

INVESTIGATING THE DISTRIBUTION, BIOACCUMULATION AND SYSTEMIC TRANSLOCATION OF MICROPLASTICS IN TISSUES AND ORGANS OF THE MEDITERRANEAN LOGGERHEAD SEA TURTLE (CARETTA CARETTA)*

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Microplastics (MPs) are a pervasive marine environmental pollutant, posing serious threats to marine ecosystems and organisms at all trophic levels. Loggerhead sea turtles (*Caretta caretta*) have been identified as a promising plastic indicator species to monitor MP pollution globally; these long lived, highly mobile, wide-ranging species show high site fidelity and are particularly susceptible to marine MP pollution due to their visual feeding strategies and backward facing oesophageal papillae. The impacts of plastic pollution on marine turtles are well documented for ingestion, entanglement, and habitat degradation (e.g., coral reef and nesting beaches). Direct (i.e., mistaken for/ mixed with natural prey items) and indirect (i.e., trophic transfer) ingestion of plastics can have many possible lethal and sublethal impacts, with sublethal effects being far more difficult to detect and likely more frequent. In marine turtles, plastics can remain in the gut between 41 days and up to four months. During these long gut residency times it is possible that MPs and their associated toxicants can translocate past the gastrointestinal canal, contributing to a suite of sub-lethal effects. The ability of small MP particles (<10µm) to translocate across the gastro-intestinal membrane and accumulate in distal body tissues has been demonstrated in fish, mice, and humans. Microplastics contain additives and organic pollutants from production (e.g., PAHs, PCBs, PBDEs and BPAs) and readily associate with chemical contaminants from the environment (e.g., heavy metals and persistent organic pollutants). These can be released during digestion, transmitted in the circulatory system, gradually bioaccumulating in body tissues. Many of these contaminants possess endocrine disrupting activity and can lead to disruption of fundamental processes such as: growth and development, impacting fecundity, offspring viability and reproductive output, possibly leading to late sexual maturation and transmitting epigenetic transgenerational inheritance. All potential outcomes could have long-term demographic ramifications for the stability of marine turtle populations. A recent call for research highlighted that a better understanding of the translocation and bioaccumulation potential of MPs in marine turtles is required, to fully assess the impact that this anthropogenic pollutant poses to protected and vulnerable populations globally. Loggerhead turtles in the Mediterranean are an excellent candidate for this analysis, with record levels of MP concentrations reported in the Mediterranean Sea at 1.25 million fragments per km^2. Here we present the first comprehensive analysis of MP accumulation in several organs of 10 loggerhead turtles, examining the kidney, liver, spleen, heart, skeletal muscle, subcutaneous fat, oesophagus, stomach, small intestine, large intestine, and reproductive organs from deceased individuals received at the Oceanogràfic Foundation through the sea turtle stranding network in Valencia, Spain, between April 2022 – April 2023. Microplastic extraction was conducted using chemical tissue digestion (KOH 10%). Suspected MPs have, so far, been identified in the tissues of many individuals: intestine (n=2), kidney (n=5), lung (n=2), reproductive organs (n=6), spleen (n=8), faeces (n=2) and heart (n=2); MP types include fibres, fragments, and spheres, with polymer types to be confirmed using FTIR- ATR spectroscopy.

We will compare relative MP concentrations to identify which organs have higher levels of bioaccumulation.

CLINICAL AND PATHOLOGICAL FINDINGS OF A GERIATRIC GREEN TURTLE MAINTAINED IN CAPTIVITY WITH RESTRICTED WATER CIRCULATION: A CASE REPORT

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This case study investigates the clinical and histopathological aspects of a geriatric green turtle (*Chelonia mydas*) that was kept in captivity with restricted water circulation for over 10 years. The turtle displayed indications of loss of appetite and depression for a duration of 1 to 3 months. The radiograph was carried out during the second week, and blood was collected in the third week. Subsequently, after a month of sampling, the turtle exhibited the emission of mucous through its oral cavity during respiration. Following three days of displaying this symptom, the turtle perished, and samples were procured from its liver, kidney, colon, stomach, and lung for histopathological analysis. The water quality of the tank where the turtle was housed was monitored and found to possess elevated salinity and hardness. The findings of the comprehensive blood count, blood biochemical parameters, and thoracic radiography did not reveal any significant abnormalities. Nevertheless, the pathological examinations did identify the presence of some lesions. The liver exhibited a dark brown pigmentation as well as sinusoidal congestion, apoptotic bodies, and the accumulation of lipofuscin, suggesting the presence of foreign materials, while the kidneys displayed renal fibrosis, hemorrhage, and infiltration. The mucosa of the ileum, colon, and jejunum demonstrated signs of inflammation and abnormal coloring. Moreover, the stomach manifested an orange-reddish hue and contained green material, which is suggestive of moderately widespread colon melanosis. Additionally, the lung was diagnosed with gastro-enterocolitis and bacterial infection, whereby pathogens such as *Klebsiella oxytoca*, *Proteus vulgari*, and *Escherichia coli* were cultured from the lung. This specific case study highlights the importance of implementing comprehensive husbandry procedures when caring for marine turtles in captivity, especially for geriatric turtles, even when the clinical signs are not remarkable. The study suggests that the conditions of captivity may affect the levels of bacteria in the water or the susceptibility of turtles to bacteria, and this aspect should be considered when managing sea turtles and other aquatic animals in tanks with limited water circulation. Further investigation is needed to determine the factors contributing to this phenomenon and establish the best practices for captive environments.

BIOMARKERS OF REPRODUCTIVE OUTPUT IN FREE-RANGING HAWKSBILL SEA TURTLES (ERETMOCHELYS IMBRICATA) IN PANAMA*

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The Hawksbill (*Eretmochelys imbricata*) is a critically endangered sea turtle that is pan-tropically distributed. Of the seven sea turtle species, Hawksbills have one of the longest histories of exploitation by humans that have resulted in an estimated 80% decrease in their global populations in the last century. Understanding the intricate interplay between reproductive biomarkers such as testosterone, estradiol, and vitellogenin (VTG) and reproductive output is crucial for informing conservation strategies and management practices. This study investigates the temporal relationship between these reproductive biomarkers and reproductive output throughout the nesting season which will provide pertinent information about sea turtle reproductive physiology. VTG is a pivotal lipoprotein integral to oviparous vertebrate reproduction and plays a crucial role in the formation of egg yolk within ovarian follicles. The role of VTG in free-ranging sea turtles remains understudied, making this research particularly pertinent. Blood samples were collected from nesting Hawksbills between May and August 2023 along the Caribbean coast of Panama in Bocas del Drago. We utilized commercial steroid ELISAs (i.e., estradiol and testosterone) and an in-house VTG ELISA to quantify the concentrations of each biomarker. Our initial hypothesis was a gradual decrease in both sex steroid and VTG concentrations as the nesting season progressed. Preliminary findings indicate a consistent decline in testosterone concentrations, aligning with expectations. Given correlative observations in other organisms, including sea turtles, we anticipate that VTG concentrations will follow a similar trend. While further analysis is necessary, early data suggests a parallel trend in reproductive output. I expect that the reproductive biomarkers will provide an improved understanding of the physiological mechanisms governing the number of eggs per clutch laid by female Hawksbill turtles throughout the nesting season. The results of this study will enhance our fundamental understanding of sea turtle reproductive physiology and will also carry implications for conservation and management efforts in the future.

EVALUATING THE RELATIONSHIP BETWEEN IMMUNE FUNCTION AND REPRODUCTIVE SUCCESS IN NESTING TURTLES

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Energetic tradeoffs between immune function and reproductive output are common in sexually mature females and can be exacerbated by extended breeding periods and/or multiple reproductive events. For sea turtles, reproductive hormonal shifts months prior to nesting, long migrations from foraging grounds to nesting beaches, and multiple mating and reproductive events in a single nesting season require heavy energy expenditures. Immune suppression is a common tradeoff for producing high quality offspring but is not well documented in large marine reptiles. To evaluate immune function tradeoffs in nesting sea turtles, we examined proxies for immune function relative to reproductive output for loggerhead turtles (*Caretta caretta*) during the 2020-2021 nesting seasons in Florida, USA. We evaluated n=122 blood samples for packed cell volume, differential white blood counts, and plasma protein fractionation; associated female reproductive output was measured by hatching success and the number of reproductive events were categorized as early-, mid-, or late-season based on sampling day. Generalized linear models showed significant relationships between immune proxies, sampling date and female size, indicating physiological changes within the nesting season and size-based differences. Decreases in immune function in reproductive females leave them susceptible to diseases and parasites, and exposure increases with changing habitats during migrations. Understanding the relationships between immune parameters and reproductive output is vital to developing best management practices and gaining insight into energetic tradeoffs for reproductive females.

ASSESSING DIFFERENCES IN CHEMICAL RISK IN FORAGING GREEN SEA TURTLES (CHELONIA MYDAS) USING ANALYTICAL AND IN VITRO TECHNIQUES*

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Green turtles are exposed to, and accumulate, chemical contaminants such as trace elements and organic chemicals (*e.g.*, industrial chemicals, pesticides, pharmaceuticals) from the marine environment. Their high foraging site fidelity and long-lived nature make them excellent sentinel species for chemical pollution. Trace element exposure is best assessed using well-developed, sensitive, and inexpensive analytical techniques that are relatively comprehensive. Analytical techniques are less comprehensive for organic contaminants. There can be thousands of organic chemicals present in a sample and each group of chemicals (*e.g.*, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, organochlorine pesticides) requires a different analysis, which can quickly become expensive (>$2000/sample). These limitations can be overcome by testing the overall toxicity of complex chemical mixtures of organic contaminants using *in vitro* bioassays, which are relatively inexpensive. For sea turtles, this is accomplished by extracting organic chemical mixtures from turtle blood and testing the toxicity of this extract on sea turtle cell cultures. In this study, trace element chemical analysis and *in vitro* bioassays for organic chemicals were used to examine differences in chemical exposure and effect of green sea turtles foraging in three locations in Queensland, Australia: the Port of Gladstone, the northern Capricorn Bunker, and the southern Capricorn Bunker. The trace element analysis revealed that turtles foraging in Gladstone typically had significantly higher trace element concentrations, with concentrations indicating potential risk to this population. A small number of trace elements were significantly higher in turtle blood from the Capricorn Bunker locations (cadmium, arsenic, selenium) with no significant difference between north and south, potentially indicating inshore/offshore differences. Only vanadium was significantly higher in the southern Capricorn Bunker turtles, requiring further investigation. The *in vitro* bioassays indicated that organic contaminant concentrations in the turtles foraging in Gladstone and the northern Capricorn Bunker were similar and at levels high enough to cause risk to these turtles. The bioassay results for the southern Capricorn Bunker indicated low toxicity of blood extracts from these turtles. The low toxicity and low variation in results at this location indicate its potential as a reference location for organic contaminants in the southern Great Barrier Reef. Together, these results from the trace element analysis and bioassays indicate that offshore locations may experience different, but not necessarily lower, chemical risk and highlight the importance of characterising this risk to sea turtle populations.

IMPACT OF MULTIDRUG-RESISTANT BACTERIA ON SEA TURTLES AND THE MARINE ENVIRONMENT

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Sea turtles are not only charismatic and ecologically important species, but they also play a pivotal role in the health of marine ecosystems. Their unique life history traits, such as long lifespan, broad habitat range, and migratory behavior, make them valuable indicators of environmental quality and ecosystem health. As marine reptiles, sea turtles have the potential to accumulate and transport biotical or abiotic pollutants, including antibiotic-resistant bacteria, across different marine environments. This role as environmental sentinels positions sea turtles as important bioindicators of antibiotic resistance in the marine ecosystem. Among resistant pathogens, extended-spectrum beta-lactamase (ESBL) and carbapenemase-producing Enterobacterales are considered of critical priority according to the World Health Organization. The emergence of these resistant strains presents a significant challenge in clinical settings and public health, as infections caused by ESBL- and carbapenemase-producing Enterobacterales are often difficult to treat and can pose serious risks to human and animal health. Several studies have highlighted the prevalence of antibiotic-resistant bacteria, including ESBL and carbapenemase-producing Enterobacterales, in marine environments. A recent study in Brazil, evidenced CTX-M-15-producing *Enterobacter hormaechei* ST114 and *Citrobacter freundii* ST265 co-infecting a free-living *Chelonia mydas,* shedding light on the presence of CTX-M-15-producing extended-spectrum β-lactamase (ESBL) in marine animals. In another study, also conducted in Brazil, a novel sequence type (ST264) of *Citrobacter portucalensis*, a metallo-β-lactamase (NDM-1)-producing strain, was isolated from the blood sample of an infected migratory olive ridley, found stranded sick on the Southern part of the country. Both studies revealed the wide resistome of these pathogens, contributing to treatment failure and the death of the infected animals along the Brazilian coast. These investigations provide significant insights into the clinical and environmental implications of human-associated bacterial lineages for marine ecosystems, including the impact on endangered free-living sea turtles exposed to marine-polluted environments. The reports of multidrug-resistant Gram-negative bacteria in sea turtles are widely spread, reflecting the global nature of this issue. The risk posed by these antibiotic-resistant bacteria to sea turtles, already endangered due to numerous anthropogenic threats, is substantial. The potential impact on the health and survival of sea turtles, together with the implications for the overall marine ecosystem, underscores the urgent need for comprehensive monitoring, research, and conservation efforts to protect these emblematic marine species from these pathogens. The linkage between sea turtles and antibiotic-resistant bacteria is of particular concern due to the potential impact on both the health of sea turtles and the overall marine ecosystem. Sea turtles may serve as reservoirs and vectors of antibiotic-resistant bacteria, influencing the health of other marine organisms and contributing to the spread of antibiotic resistance in the marine environment. The monitoring and assessment of antibiotic-resistant bacteria in sea turtles provide valuable insights into the distribution, prevalence, and potential impacts of antibiotic resistance in the marine environment. By studying these interactions, researchers can better understand the evolution and dissemination dynamics of antibiotic resistance in marine ecosystems and develop effective strategies for the conservation of sea turtles and the maintenance of healthy marine ecosystems.

NOVEL BIOMARKERS OF ENVIRONMENTAL GENOTOXICITY IN GREEN TURTLE (CHELONIA MYDAS) ON THE COAST OF QUINTANA ROO, MEXICO

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Micronuclei and nuclear abnormalities are biomarkers of genotoxicity in wildlife caused by bioavailability and environmental exposure to chemical agents. The coast of Quintana Roo represents a critical foraging and nesting area of numerous species of sea turtles; however, it is a highly modified and disturbed habitat by the tourism industry. The goal of this study was to quantify nuclear abnormalities in erythrocytes of green turtles (*Chelonia mydas*) and to evaluate differences between age classes, sex, and size. Individuals were captured in 2019 in three feeding areas (Akumal, Xcalak, and Punta Herrero) of the Mexican Caribbean with distinct anthropogenic pressures; at each site, the capture method changed due to environmental conditions, the bay's characteristics, and the organisms' size. Once captured, blood samples were taken from the cervical venous sinus and the blood smears were prepared in duplicate and stained following a specific protocol for sea turtles using acridine orange staining. The cell count with nuclear abnormalities was performed on 20 digital photographs taken per animal with a fluorescence microscope, documenting the number of micronuclei and nuclear abnormalities in a total of 2000 erythrocytes per individual. To determine environmental quality, concentrations of organochlorine pesticides (OC's) and polychlorinated biphenyls (PCBs) were determined in samples of plasma of the same species, captured in the same areas during 2016 and 2017, which were processed using Gas-Mass Chromatography. Four nuclear abnormalities were identified for the first time in sea turtles: lobed nuclei, notched nuclei, nuclear buds, and figure-eight nuclei. Nuclear abnormalities were not correlated with the size of sea turtles. No significant differences were found in the frequency of micronuclei (KW-H=2.98, $p=0.22$), buds (KW-H=2.66, $p=0.26$), and nuclear abnormalities (KW-H=3.13, $p=0.20$) between study sites. Although, the 90% of sea turtles from the most touristic site (Akumal Bay) presented ≤140 nuclear abnormalities in 2000 erythrocytes, while the same proportion of individuals from Xcalak and Punta Herrero presented no more than 90 and 60 nuclear abnormalities in 2000 erythrocytes, respectively. Micronuclei were not found in green turtles from Punta Herrero; and buds were more common in individuals from Xcalak. The frequency of genotoxic damage matches the concentrations of OCs and PCBs, which were significantly higher in Akumal and Xcalak, respectively. These results suggest that Akumal continues to be the most affected area with intense genotoxic damage (highest proportion of individuals afflicted), probably associated with the increase in chemical contaminants derived from the various tourist activities at the site. The presence of contaminants, such as DDE in plasma, confirms the bioavailability and persistence of contaminants in the environment that have affected biodiversity for years. The green turtle can reside for up to 10 years in these feeding areas prior to sexual maturity; the effect that the genotoxic damage observed in the individuals from Akumal and Xcalak may have in the long term on the population of the Mexican Caribbean is unknown. The new abnormalities detected can be used as a biomarker to determine the anthropogenic damage generated in the bays.

EFFECTS OF INCUBATION FACTORS ON LOGGERHEAD HATCHLING CONDITION IN THE GULF OF MEXICO

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Over the course of the marine turtle nesting season on the Gulf of Mexico, female turtles will lay approximately 3 to 6 clutches of eggs every 10 to 14 days. Subsequent clutches of eggs decline in resource quantity over the course of the season as females fast during the nesting season and egg contents are leached from their bodies over the course of the summer. The effect of suboptimal nutrients on the developing hatchlings could influence developing hatchlings' size, body condition (BCI), and may cause anomalies of the carapacial scutes. Variations in the number of scutes of the carapace of hatchlings are becoming increasingly common but are understudied. The Sea Turtle Conservation and Research Program (STCRP) at Mote Marine Laboratory has monitored sea turtle nests on 56km of Sarasota County, Florida beaches since 1982. This nesting population is the largest loggerhead (*Caretta caretta*) rookery in the Gulf of Mexico. Annually, STCRP staff identify and tag nesting turtles in the region and have a database of over 5,500 unique nesters collected over 40+ years. For the project presented here, hatchlings were collected from known repeat loggerhead nesters on three beaches in Sarasota County from 2020-2023. The vertebral, costal, and marginal scutes were counted and anomalies were documented, along with hatchling length, body width, head width, body depth, and mass. Models were run to determine if the date the clutch was laid, incubation duration, or nest order had a significant effect on the presence of carapacial scute anomalies. Over the course of the study, a subset of nests were outfitted with temperature data loggers that logged every 15 minutes throughout development. Linear models were run to identify whether temperature fluctuations had a significant influence on the presence of scute anomalies. We will discuss how factors during clutch incubation can impact hatchling conditions. The hatchling body condition index (BCI) was calculated using the method described by Lamont and Johnson. The date the nest was laid significantly affected the average hatchling BCI ($p<0.001$). This finding suggests that nests laid later in the nesting season have a higher chance of carapacial scute anomalies. The duration/length of clutch incubation also had a significant impact on the number of extra scutes per hatchling ($p=0.034$). Shorter incubation durations were directly tied to an increase in the presence of extra scutes. Interestingly, nest order also had an impact on the average number of extra scutes per hatchling. The third or fourth known nest laid by individual females had a significantly higher likelihood of hatchlings developing extra scutes compared to hatchlings from her first or second nest. Average ambient temperatures increase throughout the nesting season, causing incubation duration to shorten, due to quicker development. Hatchlings' carapace patterns are thought to be developed in the middle third of incubation, making it a crucial period of incubation to study. Increasing temperatures eventually have a negative impact on hatch success, and average to high temperatures may also increase the chances of hatchlings developing carapacial anomalies, yet their effect is unknown.

ASSESSING GENOTOXICITY IN GREEN TURTLE CELLS USING FLUORESCENT MICROSCOPY AND AUTOMATED IMAGE ANALYSIS*

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Anthropogenic contaminants can have a variety of adverse effects on exposed organisms, including genotoxicity in the form of DNA damage. One of the most commonly used methods to evaluate genotoxicity in exposed organisms is the micronucleus (MN) assay. It provides an efficient assessment of chromosomal impairment due to either chromosomal rupture or mis-segregation during mitosis. However, evaluating chromosomal damage in the MN assay through manual microscopy is a highly time-consuming and somewhat subjective process. High-throughput evaluation with automated image analysis could reduce subjectivity and increase accuracy and throughput. In this study, we optimised and streamlined the HiTMiN assay, adapting the MN assay to a miniaturised, 96-well plate format with reduced steps, and applied it to primary cells from green turtle fibroblasts (GT12s-p). Image analysis using both commercial (Columbus) and freely available (CellProfiler) software automated the scoring of MN, with improved precision and drastically reduced time compared to manual scoring and other available protocols. The assay was validated through exposure to two inorganic (chromium and cobalt) and one organic (the herbicide metolachlor) compounds, which are genotoxicants of concern in the marine environment. All test compounds induced MN formation below cytotoxic concentrations. Once validated, genotoxicity of turtle blood extracts were then assessed from captured turtles of three major foraging grounds within Port Curtis, Gladstone, Queensland. All sampling sites induced MN formation above the detection limit and below cytotoxic concentrations with spatial variability observed. The HiTMiN assay presented here greatly increases the suitability of the MN assay as a quick, affordable, sensitive and accurate assay to measure genotoxicity of environmental samples in cultured cell lines.

ENDOSCOPY AND RECTAL ENEMA FOR FECAL COLLECTION IN WILD SEA TURTLES (CHELONIA MYDAS, ERETMOCHELYS IMBRICATA) IN A FIELD SETTING

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Forty-seven free-ranging sea turtles (46- *Chelonia mydas*,1- *Eretmochelys imbricata*) were examined via novel use of an endoscopy combined with a rectal enema to obtain large fecal sample volumes. The cloaca was insufflated using an endoscope, after which the bladder and rectum separated, allowing access to the colon. Environmental conditions and location influenced the performance of the procedure initially, but after several attempts the procedure was successfully initiated. In all cases, fecal samples were obtained, and the animals were released to their respective locations. Fecal sample collection using this approach enhances the ability to obtain diagnostic information and perform other scientific analyses of sea turtles.

BIOMARKERS OF FORAGING AND REPRODUCTION IN NESTING FEMALE HAWKSBILL SEA TURTLES (ERETMOCHELYS IMBRICATA) IN BOCAS DEL TORO, PANAMA*

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Breeding strategies are important to understand when utilizing conservation approaches to protect endangered species, such as the Hawksbill sea turtle (*Eretmochelys imbricata*). Two opposing strategies often compared include capital and income breeding. Income breeders continuously forage during their reproductive season, whereas capital breeders fuel reproduction from energy stored prior to reproductive events. The goal of this research is to explore which strategy best fits the habits of the Hawksbill sea turtle. To determine how foraging is linked to reproduction, we are analyzing the concentration of β-hydroxybutyrate (BHB), triglycerides (TRG), total protein (TP), and testosterone (T) in nesting Hawksbill sea turtles. Blood samples from nesting adult female Hawksbill sea turtles were collected May-August 2023 in Boca del Drago, Panama. Blood was drawn from the dorsal cervical sinus with 21-gauge 1.5-inch needles and heparinized syringes. Using Inconel and PIT tags, the flippers were tagged for identification. After the blood samples were collected, the blood was centrifuged at 10,000 RPM for 10 minutes. The

plasma was then stored frozen until assaying. In total, 49 samples were collected from 26 different turtles over 75 days. There were 12 'returning' Hawksbill turtles that were sampled at least two times. To analyze trends in the metabolites, the season was arbitrarily parsed into three 25-day periods: early season, mid-season, and late season. Averages from the samples were calculated from each of the relative times. The average T concentration (pg/mL) for early, mid, and late season were 2,329.4, 1,920.9, and 1,525.4, respectively. The average TRG concentration (mg/dl) for early, mid, and late season were 875.9, 606.6, and 533.8, respectively. The average BHB concentration (uM) for early, mid, and late season are 484.8, 737.4, and 683.8, respectively. The average TP concentration (mg/mL) for early, mid, and late season are 25.4, 22.1, and 22.8, respectively. Results suggest Hawksbill turtles are capital breeders, which is consistent with decreasing TRG concentration and increasing BHB concentration. Decreasing T concentration across the nesting season are consistent with literature. The results of this study serve to narrow the location of the most important foraging grounds for this population of Hawksbill turtles. The capital breeding strategy suggests these turtles are foraging prior to their reproductive migration. Due to their conservation status, protecting their feeding grounds is critical. Learning when they are acquiring most of their energy fuelling reproduction will help to locate the most important feeding grounds for these animals.

CHARACTERISATION OF GASTROINTESTINAL TRACT DISORDERS IN RELATION TO MARINE DEBRIS IN SEA TURTLES USING POSTMORTEM COMPUTED TOMOGRAPHY

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Sea turtles are often used as indicator species to evaluate the extent of marine debris as well as umbrella species to promote public awareness on conservation issues because of their propensity to ingest debris. Standardizing methods to facilitate spatial, temporal, and species comparisons are critical. Assessing the entire gastrointestinal tract during necropsy is considered the most effective sampling strategy compared to lavage or fecal assessments. Method choices for identifying debris items likely affect debris detection among gut contents and bias the size range of items discovered. Few studies provide clear descriptions and counts of lethal cases of debris ingestion, but all should. Virtopsy has the advantages of being observer-independent, non-subjective, non-invasive, digitally storable and transferable in facilitating a second-opinion by expert or institute located anywhere in the world. In human medicine, post-mortem computed tomography is used for the detection of bowel obstruction in natural cause of death. The yielded computed tomography dataset can be presented as virtual endoscopy that allows the evaluation of hollow gastrointestinal tract, offering fly-through and fly-around function based on 3D data subjected to surface or volume rendering. Debris ingestion in sea turtles can have a range of effects from a benign response, where items simply pass through the gastrointestinal tract, to lethal effects caused by gut impaction or perforation. Our study aimed to characterize gastrointestinal tract disorders in relation to marine debris in sea turtles, and assess the impacts of marine debris on the body condition, diseases, and mortality in sea turtles stranded in Hong Kong waters. Various post-mortem computed tomography signs of gastrointestinal tract disorders in relation to marine debris were characterized in 94 individuals, including whirl sign, coffee bean sign, bird beak sign, and u-shape sign. Contrast computed tomography was used to evaluate motility on live-stranded cases and to detect and characterize obstructions and other abnormalities such as radiolucent foreign bodies, obstructions, and plications. Virtual gastroscopy resulted by computed tomography volume rendering technique allowed detection of intestinal impaction, perforation, intussusception, parasitic gastritis, ulcerative gastritis and other gastric lesions, as well as subtle mucosal changes. Ingested foreign items including fishing gears were also identified using computed tomography in live-stranded cases and removed under imaging guidance. In summary, marine debris such as different plastic items, fishing lines, and fishhooks were found in the gastrointestinal tract of 72% of deceased sea turtles, while the ingestion of marine debris was identified as the cause of death for one stranded green sea turtle where a latex glove was found obstructing the oesophagus with intestinal congestion associated with other ingested debris. Fifty-two live stranded sea turtles were found with evidence of ingested or entangled marine debris, which potentially threatened their lives. This study demonstrated virtopsy is a potentially powerful tool, providing non-invasive and objective measurements to supplement the necroscopic findings for detection of marine debris in the gastrointestinal tract of sea turtles. The calibrated 3D documentation and analysis of virtopsy findings would lead to qualitative improvements in conventional necropsy for the impact assessment of marine debris in sea turtles.

IMPACTS OF RISING INCUBATION TEMPERATURES ON LEATHERBACK NEONATES AS MEASURED BY KEY BLOOD VALUES AND SKIN MICROBIOTA DATA*

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There are seven extant species of sea turtles, all of which are imperilled. As such, large efforts are aimed at understanding the effects of climate change on these animals to aid conservation efforts. Currently, a large knowledge gap exists across hatchling and post hatchling baseline health values and the potential impact of elevated incubation temperatures. Filling these knowledge gaps is critical for these imperilled species, especially leatherbacks. All leatherback populations are considered endangered, but isolated populations of leatherbacks are at higher risk of extinction. The Eastern Pacific population is anticipated to become extinct within the next 100 years. As such, maintaining this population of leatherbacks in temporary human care may be necessary to rescue the population. But to do this successfully, we need to have baseline information, including baseline blood and microbiota parameters. Here we present baseline blood data, preliminary skin microbiota data, and their relation to incubation temperatures in leatherback neonates. We analyzed the effects of incubation temperature on key blood values and found that hatchlings emerging from warmer nests had higher A/G ratios, higher alpha-1 globulin values and lower beta globulin values. All values were assessed again in 3-4 weeks and these alterations persisted. We also assessed skin microbiota at both time points and found significant differences in microbial diversity on turtles emerging from hotter nests. These alterations suggest that increasing nest temperatures are physiologically straining hatchlings at emergence and continue to cause physiologic differences up to a month of age. Suboptimal physiologic states, such as dehydration, inflammation, or skin dysbiosis negatively impact overall fitness and survival of a hatchling. These data provide initial information to begin assessing hatchling health and possibly elucidate a cause for decreased survival in hatchlings incubated at higher temperatures. Ultimately, these findings can be useful for developing management strategies to mitigate the effects of elevated incubation temperatures in nature.

GREEN TURTLES (CHELONIA MYDAS) FROM MEXICAN CARIBBEAN PRESENT OXIDATIVE STRESS RESPONSES TO ENVIRONMENTAL VARIABILITY*

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The Mexican Caribbean region located at the Mesoamerican Reef System is home to some of the most important foraging and nesting habitats for green sea turtles (*Chelonia mydas*) and is characterized for vast expanses of seagrass beds. During the last 25 years, urban development and tourism have increased in the Quintana Roo state. Additionally, this region has been ecologically affected in the last decade by pelagic *Sargassum* blooms. Information about the biochemical responses of green turtles from the Caribbean is limited, impeding the use of the oxidative stress biomarkers for the evaluation of the health status of this population. The goal of this study was to quantify the biochemical oxidative stress indicators in intracellular material of red blood cells of green turtles inhabiting the coast of Mexican Caribbean and characterize the variations in relation to biotic (sex, size, age class, fibropapilloma) and abiotic (years, areas and sampling duration) factors. Free-living green turtles (n=195) were captured in four foraging bays during 2015-2018. Activities of glutathione peroxidase (GPx r=-0.61, p=0.03) and superoxide dismutase (SOD r=0.54, p=0.04) were correlated with handling time prior to venipuncture in Akumal and Xcalak, respectively. Activity of SOD was correlated with body size of the individuals (r=0.21, p=0.04), with green turtle adults captured in the northern region (Punta Arenas) presenting with the highest activity of this enzyme (p=0.02). Levels of carbonyl proteins presented a decreasing pattern from north (Punta Arenas) to south (Xcalak). Annual variability in oxidative stress responses of green turtles from Akumal and Punta Herrero was found; in the former sites, individuals captured during 2015 were characterized for presenting highest activities of glutathione-S-transferase (GST), GPx, and highest levels of thiobarbituric acid reactive substances (TBARS). A multivariate analysis discriminated the annual biochemical responses of green turtles captured in Akumal bay (Wilks' Lambda=0.06, p<0.001), where their production rate of superoxide radical ($O2^{\bullet-}$), activities of SOD, GPx, GST, and the levels of TBARS were highest in 2015 than the following years. Biochemical responses of green turtles captured during 2015 in Akumal and Punta Herrero Bays coincided with one of the first peaks reported of massive atypical influx of pelagic Sargassum, which in turn decreased in 2016 and 2017. Results of this study corroborates the utility of the oxidative stress indicators as biomarkers of environmental conditions in this sentinel's species.

PREVALENCE, DISTRIBUTION AND ETIOLOGY OF FIBROPAPILLOMATOSIS IN IMMATURE GREEN TURTLES (CHELONIA MYDAS) OF THE WEST INDIES*

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The fibropapillomatosis (FP) is a deadly neoplastic disease recorded in all of the seven sea turtle species but it is more frequently observed in green turtles. At the first stages, this disease is characterized by external tumors on soft tissues but could evolve in internal tumors, blood parameter and behavior disorder which could potentially lead to the death of the animal. The Chelonid Herpesvirus 5 (ChHV5) has been associated to FP tumors and could be the main aetiologic agent of the disease. FP could spread through mechanical vectors such as marine leeches or cleaner fishes for instance. Transmission of the disease could also occur during physical interactions between turtles. The recent increasing in FP prevalence despite a million years coexistence between turtles and ChHV5 suggests a significant role played by environmental cofactors. Sea surface temperature and salinity seems to affect FP prevalence. Moreover, FP is frequently associated with pollution of coastal waters close to human activity. Metallic contaminants, persistent organic pollutants and eutrophication associated with a high rate of arginine in sea turtle foraging resources are suspected to facilitate the turtle sensibility to FP. In Martinique, FP has been observed since 2011 in immature green turtles. These turtles recruit in Martinique at around 25cm carapace length and find here ideal condition to perform their development to adult stage. These juveniles contribute widely to Atlantic population and their conservation is therefore crucial. Thus, occurrence of FP in Martinique green turtles highlights the need to understand the characteristic of the disease in these foraging grounds. A preliminary study demonstrated that prevalence vary between sites and could reach 50% of the population. It is therefore critical to provide knowledges on 1) the dynamics of FP in Martinique juvenile green turtle population and on the triggering factors of the disease, on 2) the genetic variations of ChHV5 between geographic locality and their implications on the etiology and symptomatology of the disease, and on 3) the demographic, physiological and behavioral consequences of the disease on green turtles. In order to meet these objectives, the study rely mostly on a long-term capture-mark-recapture protocol started in 2013, during which individual measurements, health status and biopsies are collected, and on environmental quality assessment (benthic biocenosis cartography, coastal environment contamination by pollutants). First results and attached conservation implications will be detailed in this presentation.

ACOUSTIC MONITORING OF NEST ESCAPING ACTIVITY IN SEA TURTLE HATCHLINGS

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The incubation period and subsequent emergence from the nest is a critical phase in the life cycle of sea turtle hatchlings, fraught with challenges that can significantly impact their survival. Understanding the behaviors and physiological responses of hatchlings during this stage is crucial for improving conservation strategies. However, insights into the effects of clutch size on hatchling emergence and energy expenditure remain limited. The objectives of this study were to investigate the impact of clutch size on the nest escaping duration, digging duration, morphological attributes, and fitness of sea turtle hatchlings, and to develop minimally disruptive methods for monitoring these factors in situ. This study was conducted at Chagar Hutang Turtle Sanctuary, Malaysia, employing a controlled experimental setup. Eggs from 45-day-old nests were transported to the laboratory, preserving their natural orientation. They were divided based on clutch size into 'large' and 'small' categories, with a ratio of 3:1. Artificial nest chambers equipped with lavalier microphones were positioned at three depths within the nest: bottom (just above the eggs, 60 cm from the sand surface), middle (25 cm above the bottom), and top (10 cm below the sand surface), facilitating the recording of digging activity. After emerging from the nest, hatchlings were measured for morphological attributes, and a randomly selected group underwent fitness testing. The nest escaping duration was not significantly different between large and small clutches but large clutches tended to emerge faster, with a moderate negative effect size of -0.49 (95% CI [-1.625, 0.677]). Straight carapace length and width were significantly larger in small clutches than large clutches, while no significant differences were found in the measurements of frontal flipper length, body depth, external yolk sac, mass, blood glucose concentrations, and self-righting capability. Both nest depth and clutch size, as well as their interaction, had significant effects on the digging duration. The digging duration for large clutches decreased across nest depths, with estimates of 25.6 (± 2.23), 21.8 (± 2.23), and 17.4 (± 2.51) seconds for nest depths at bottom, middle, and top, respectively. Deeper nest depths might have more compacted sand, requiring more effort and time to excavate compared to shallower depths. Significant differences in digging duration were observed between large and small clutches at the bottom and top nest depths ($p < 0.05$), with larger clutches exhibiting longer digging durations. Higher number of hatchlings from large clutches involved in digging may accelerate the excavation process, but this faster emergence could potentially lead to smaller body sizes. At the middle nest depth, no significant difference was found between large and small clutches ($p > 0.05$), indicating unique challenges for small clutches during the digging process at this depth. The study offers valuable insights into hatchling behavior and physiology, highlighting a clear influence of clutch size on their development path and survival strategies. The minimally disruptive monitoring technique developed here provides a new avenue for observing hatchling behavior without disturbing the natural process.

VARIATIONS IN MEAN BREVETOXIN CONCENTRATIONS BY TISSUE TYPE IN THREE FLORIDA SEA TURTLE SPECIES

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Nutrient inputs from terrestrial sources and increasing global temperatures have raised concerns about the frequency and intensity of harmful algal blooms (HABs), as they can lead to population declines of keystone and endangered species as well as major economic losses. *Karenia brevis* is one of the main microalgae implicated in the HABs that occur in Florida coastal waters. *K. brevis* produces polyether neurotoxins called brevetoxins (PbTx), which are known to cause immunomodulation, oxidative stress, increased stranding incidence and mortality, in sea turtles that have been exposed via inhalation or ingestion. To better understand how different species are impacted by this biotoxin, it is important to characterize its distribution, storage, and removal from the body. This meta-analysis aggregated available data regarding PbTx concentrations in a variety of tissues and biological products across three species of turtles that utilize Florida waters and nesting beaches, including green (*Chelonia mydas*), loggerhead (*Caretta caretta*), and Kemp's ridley (*Lepidochelys kempii*) sea turtles. Reported mean PbTx-3 concentrations from studies that measured concentration using enzyme-linked immunosorbent assays were systematically collected from the literature and grouped by species and sample type. Two-way ANOVA with interaction and Tukey multiple comparisons test were used to determine significant differences in PbTx concentrations between sample types and species. Mean PbTx concentrations were determined to differ significantly between sample types, with digestive tissues (stomach contents, and faeces) containing significantly higher concentrations than other samples (bile, kidney, liver, lung, plasma, urine, whole blood), supporting conclusions that ingestion is the primary route of exposure and that these species can remove significant quantities of PbTx via excretion. Interestingly, there were no significant differences in PbTx concentrations between the three species, potentially indicating that exposure risk is similar across species despite differences in diet and spatial distribution in coastal waters.

CHARACTERIZING HARMFUL ALGAL BLOOM-ASSOCIATED BIOTOXIN CONCENTRATIONS AND CHELONID ALPHAHERPESVIRUS 5 PRESENCE IN THE BLOOD OF NESTING LEATHERBACKS IN PALM BEACH COUNTY, FLORIDA, USA

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Leatherback sea turtles (Dermochelys coriacea) have long been considered to be primarily pelagic. However, recent research indicates that they also heavily utilize coastal foraging areas, where they may be exposed to coastal stressors such as harmful algal blooms (HABs). Many species implicated in HABs produce biotoxins, which have toxic effects on multiple sea turtle species and can possibly serve as cofactors in the development of diseases, such as chelonid alphaherpesvirus 5 (ChHV5), the virus associated with fibropapillomatosis (FP) in Cheloniid species. Limited reports of FP, ChHV5, and some HAB-associated biotoxins exist in leatherback turtles. This study aims to characterize the concentrations of HAB-associated biotoxins and presence of ChHV5 in Northwest Atlantic leatherbacks nesting in Palm Beach County, Florida, USA, to provide a better understanding of how leatherbacks are affected by these stressors. Blood samples were collected from leatherbacks nesting on Juno and Jupiter Beaches, Florida, during the 2023 nesting season. Plasma fractions will be screened for a suite of HAB-associated biotoxins (e.g. domoic acid, lyngbyatoxin-A, microcystin-LA, microcystin-LR, microcystin-RR, microcystin-YR, nodularin, okadaic acid, anatoxin-A, brevetoxin-B, brevetoxin-3, cylindrospermopsin, neosaxitoxin, and saxitoxin). Whole blood will be analyzed using quantitative polymerase chain reaction to detect the presence of circulating ChHV5. These data will allow us to establish a baseline relating health parameters and HAB stressors in coastal leatherback turtle populations.

HISTOLOGICAL RECONSTRUCTION OF THE OLIVE RIDLEY SEA TURTLE HATCHLING HEAD

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There are seven species of sea turtles in the world, of which six belong to the *Cheloniidae* family and one to the *Dermochelyidae* family. Studies of the head anatomy have been carried out for species of both families; however, these primarily exist for adult sea turtles. Interestingly, the craniofacial region is the most affected by congenital malformations in sea turtles, and histological analysis of the cranial structures only exists for freshwater turtle hatchlings. In this study, in order to have a reference for the head histology of normal hatchlings and to be able to compare them with abnormal specimens in future studies, we performed the first histological analysis of the olive ridley sea turtle (*Lepidochelys olivacea*) hatchling head. Our results concur with the anatomical descriptions previously reported for adult and juvenile turtles of the *Cheloniidae* family, although small variations exist. For example, the brain in the olive ridley sea turtle is proportionally larger in hatchlings and juveniles in comparison to subadults and adults of the same family. The division of the nasal cavities for hatchlings was also very similar to juvenile and adult sea turtles in the *Cheloniidae* family. Finally, in general terms, the histology of the olive ridley hatchling head was also very similar to that reported for freshwater red-bellied shortneck turtle (*Emydura subglobosa)*. These findings are important because will serve as a basis for histological comparisons with hatchlings presenting congenital craniofacial malformations in future studies.

IMPACTS OF INCUBATION TEMPERATURE ON LOGGERHEAD (CARETTA CARETTA) SEA TURTLE HATCHLING MORPHOLOGY AND HYDRODYNAMICS

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Nest incubation temperatures affect many physiological and behavioral aspects of sea turtle hatchlings, including body characteristics that may impact swimming efficiency. Hotter nest temperatures result in smaller hatchlings with larger yolk stores, which could affect buoyancy, thrust, and stroke rates, though how these factors are interrelated is not yet known in hatchling sea turtles. This project examined the effects of incubation temperature on body morphology, buoyancy, swimming kinematics, and blood chemistry to better understand variations in locomotor performance in loggerhead (*Caretta caretta*) sea turtle hatchlings of South Florida. Nest temperature, body measurements, and blood samples were collected in conjunction with swim trial force measurements and video recordings. Hatchlings from nests with higher incubation temperatures (mean > 33°C) were significantly smaller in size, less buoyant, and displayed lower power stroke frequencies. In addition to lower hatch and emergence success, the relationships between morphology and performance suggest hatchlings of high temperature nests may exhibit weaker swimming abilities. Combined with their smaller body size, poorer swimming efficiency would make them more vulnerable to predation than hatchlings from cooler nests. The results of this study provide a further understanding of the effect of increasing incubation temperatures, as with climate change, on hatchling physiology and survival during the frenzy period.

NON-INVASIVE HEART RATE MEASUREMENT OF GREEN TURTLE EMBRYOS

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Measuring embryonic heart rate provides important information about development and activity rhythm of embryos. Non-invasive heart rate measurement of embryos using infrared light has been a useful technique in birds and reptiles including snakes and freshwater turtles. In this study, we evaluated how green turtle embryo activity rhythms responded to different incubation temperatures using non-invasive heart rate measurements. We collected green turtle eggs from 12 clutches after they incubated in situ for approximately 40 d from egg deposition at Omura Beach, Chichijima Island, Ogasawara, Japan. After eggs were transferred to the Ogasawara Marine Center, 15 eggs from each clutch were separated into three incubators (5 eggs each; i-CUBE Hot & Cool incubators, AS ONE Corporation) where the temperature was constantly set to 26℃, 29℃, and 32℃. Eggs were separately placed on water-dampened sphagnum moss on a plastic dish. After an acclimatization period of at least 12 hours, the heart rate of each embryo was measured with a digital egg monitor Buddy Mk II (Avitronics). We measured the heart rate every 6 hours (00:00, 06:00, 12:00, and 18:00) for 3 consecutive days. The results clearly showed that heart rates of embryos increased as temperature increased. In addition, heart rates varied across clutches. We investigated the relationship between heart rate and incubation temperature in the field for 5 of the clutches before the collection of eggs. We also discuss whether green turtle embryos have a circadian rhythm that has been previously reported from freshwater turtles.

METABOLIC HEATING IN GREEN TURTLE HATCHLINGS DURING NEST ESCAPING ACTIVITY*

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Temperature insulation in sea turtle nests plays a crucial role in monitoring the survival of embryonic development inside the eggs. The climate change phenomenon has been shown to influence the morphological and physiological traits of reptiles, including the sea turtle population, where it has significantly contributed to the increasing turtle nest temperature affecting the incubated eggs and hatchlings. In addition to the external temperatures, metabolic heat generated by the incubated hatchlings within the nest could potentially alter their phenotype and morphological traits, resulting in the production of abnormalities. The impact of this metabolic heat is substantial and is influencing the decline of their habitat range worldwide. Hence, this study aims to investigate the effect of incubation temperature and the presence of metabolic heat produced by the hatchlings on their digging performance and general fitness. Temperature data loggers were deployed in three different clutch sizes of green turtle nests, varying from 50, 30, and 15 sizes. The time taken for the hatchlings to emerge from their nest was recorded to observe

their digging duration. The findings revealed that larger clutch sizes were associated with slightly shorter digging duration, and hatchlings with smaller body size, lower body weight, larger umbilical scar size, lower glucose level, and quicker self-righting time compared to hatchlings with smaller clutch sizes emerged. This study provides evidence that the presence of metabolic heat within sea turtle nests could potentially alter the temperature along the nest column, adversely affecting emergence hatchlings. Warmer nests are highly exposed to risks such as increased predation due to smaller body sizes, decreased physical responses, and reduced overall fitness. This condition may introduce the hatchlings to dehydration and possible inflammation or stress, increasing the risks to their survival. As temperatures continue to rise, sea turtle hatchlings are at increasing risk of developing suboptimal physiological features that would negatively impact their overall fitness and survival. This study was crucially important to understand the circumstances of rising environmental temperatures, coupled with metabolic heat in incubated sea turtle nests on the hatchlings. Such insights are crucial for the development of effective sea turtle management plans in the face of changing environmental conditions.

MAXIMISING CAPTIVE RELEASES OF LEATHERBACK TURTLES USING INSIGHTS FROM SIMULATED GROWTH AND REPRODUCTION MODELS

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The longevity of a population hinges on the ability of its individuals to reproduce, which is dependent upon energy acquisition, constrained by access to suitable temperature and sufficient food resources. Leatherback turtles are highly migratory and globally vulnerable to numerous widely dispersed anthropogenic threats, though little is known about their energy acquisition. What is known is based on a few studies of leatherbacks in captivity. Relevant physiological data (length, weight, oxygen consumption, metabolic rate) can be extrapolated to the pelagic life phase using Dynamic Energy Budget (DEB) theory. DEB theory provides the basis of mechanistic modelling presented here to demonstrate that varying temperature and food availability has impacts on the ability of leatherback turtles to grow and reproduce. Our model will identify the range of food and temperature thresholds which maximise early life leatherback growth. As a leatherback hatchling migrates from its nesting beach through the pelagic ocean, there may be certain migratory paths that fall within these maximum growth thresholds. Identifying these paths could inform conservation actions and allow release of leatherback hatchlings into the most favourable conditions, maximising early life growth and enhancing conservation efforts.

LOGGERHEAD SEA TURTLE DETECTION OF AMMONIA ODORS: SENSITIVITY TO TERRESTRIAL STIMULI

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Loggerhead sea turtles *(Caretta caretta)* exhibit natal homing and feeding site fidelity following large-range migrations, a navigational phenomenon that is not yet fully understood. Previous studies suggest that turtles use Earth's magnetic field to relocate their natal regions, but it is likely sea turtles use additional cues, such as olfactory stimuli, in combination with other navigation methods to localize specific beaches and islands. Migratory sea birds can detect and follow odour plumes of airborne ammonia, which is a volatile organic compound produced from seabird fecal matter and bacteria in marsh habitats, to relocate nesting islands. Given that sea turtles detect air and water-based odours, they may also rely on ammonia as an additional cue for local navigation. Previous unpublished data demonstrate that turtles can detect and respond to ammonium hydroxide (10µM & 100nM). In these experiments, turtles spent significantly more time with their nares out of water and took more breaths when doors of ammonia were present compared to odours of seawater; both of which are behaviors performed by turtles when they detect an odour of interest. Sensitivity to concentrations of any olfactory stimuli has yet to be investigated in loggerhead sea turtles and this study aims to determine their detection threshold of airborne ammonia. Turtles placed in an experimental arena were exposed to three additional concentrations of airborne ammonia (1mM, 1nM, and 10pM) spanning the previously studied concentrations, along with food (positive control) and seawater (negative control) odours. Preliminary analysis suggest that turtles take a higher number of breaths in response airborne ammonia, similarly as they do to food odours. Thus, it appears that sea turtles may be able to detect and respond to airborne ammonia at biologically relevant concentrations. Further work is needed to compare turtle responses to concentrations of ammonia in natural environments. While this response may be an innate cue, juvenile turtles likely learn or reinforce this terrestrial odour while spending time in nearshore feeding grounds. This may reinforce airborne ammonia as a navigation cue used later in life to locate nesting or foraging grounds.

HEAVY METAL ACCUMULATION IN CAPTIVE-REARED SEA TURTLES AT A SANCTUARY OFF THE COAST OF RAYONG PROVINCE, THAILAND*

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Heavy metals bioaccumulate and biomagnify in sea turtles and their food webs. High concentrations of these contaminants in turtle tissues may pose risks to the health of these protected animals. We studied the rate of increase for six heavy metals in captive-reared marine turtles at a head-starting facility off the coast of Rayong province in eastern Thailand. We collected blood samples from 193 hawksbill turtles and four green turtles fed frozen fish and commercial pellet food. Blood samples were pooled for individuals under the age of 12 months, as the required amount of blood for analysis was greater than 1% total blood volume. We recorded body size (minimum curved carapace length and curved carapace width), mass, and approximate age for each animal. We measured cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), and zinc (Zn) concentrations in whole blood *via* microwave plasma atomic emission spectrometry (MP-AES). A multiple analysis of covariance (MANCOVA) model treating log-transformed body size (geometric mean of carapace length and width) as a covariate showed that heavy metals increased more with body size than age. We therefore removed age from the final model. Overall, heavy metal concentrations differed significantly between the species ($P = 0.032$), and increased with body size ($P < 0.001$). Post-hoc univariate ANCOVAs indicated that only one metal differed between the species, with cadmium concentrations lower in green turtles than hawksbills ($P = 0.034$). Three of the six metals (Cu, Fe, Zn) increased significantly with body size while one (Pb) increased slightly with body size (all $P < 0.001$). Curve-fitting regression specified a linear relationship with body size for Zn ($r^2 = 0.49$) and a quadratic relationship for Cu, Fe, and Pb (power equations: $r^2 = 0.63$, 0.81, and 0.17, respectively). For animals ≥ 12 months old (non-pooled samples), a multiple regression model revealed that no relationship existed between body size and heavy metal concentrations ($P = 0.89$, adjusted $R^2 = 0.00$). Heavy metal concentrations were substantially higher in the food sources than the water (N = 4 for each) for all metals (Mann-Whitney tests: $P = 0.029$) except for Pb ($P = 1.00$). While we know that metals increased with body size, we do not yet understand how metals may impact growth rates and general health. The identical foods fed to all turtles at the facility may also have implications for metal accumulation in green turtles that naturally intake a largely plant-based diet. Further study is needed to assess whether heavy metal accumulation has implications for turtle health and growth both within the facility and after release.
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HUMAN-WILDLIFE INTERACTIONS AND THEIR CONSEQUENCES FOR SEA TURTLE HEALTH IN MALAYSIA

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Human-wildlife interactions, including wildlife provisioning and ecotourism, are increasingly prevalent, raising concerns about their effects on wildlife welfare and coexistence. This study investigates the impacts of these interactions on the health of sea turtles in Terengganu and Sabah, Malaysia, and their implications for the conservation of these iconic marine species. Drawing upon a body of research in terrestrial and marine ecosystems that has examined interactions involving various species, including tigers, macaques, dolphins, and tiger sharks, our study focuses on understanding the dynamics of these interactions. We also assess the potential co-benefits of combining conservation and economic valuation. Our hypothesis centres on the effects of provisioning activities, such as swimming and feeding with sea turtles, on sea turtle health and the balance between tourism-related interactions and conservation. We conducted this investigation in two prominent locations: Teluk Dalam in Terengganu, known for swimming and feeding activities, and Semporna in Sabah, where tourists engage in swimming and diving with sea turtles. To comprehensively assess sea turtle health, we conducted detailed examinations that included measurements of weight, morphometric data, physical evaluations, and clinical pathology analyses. We examined ten green turtles in Teluk Dalam and 36 turtles (32 green and four hawksbill) in Semporna. Our results revealed that the turtles exhibited blood values within expected ranges compared to previous studies, and they displayed no clinical signs of ill health based on body condition scores and index. A significant finding emerged when comparing provisioned (Teluk Dalam) and non-provisioned (Semporna) turtles. Provisioned green turtles exhibited significantly higher levels of Blood Urea Nitrogen (BUN) and Creatinine (Crea), with a mean of 88.71 (±44.58) mg/dL and 10.14 (±10.59) mg/dL, respectively, while non-provisioned green turtles had a mean of BUN 8.94 (±6.68) mg/dL and Crea of 0.29 (±0.09) mg/dL, suggesting an early diagnosis of kidney diseases. This highlights the potential detrimental effects of provisioning activities on sea turtle health. This study highlights the importance of achieving a balanced approach to human-wildlife interactions where meaningful encounters are maintained while safeguarding the vital ecological roles that sea turtles play in marine ecosystems. By shedding light on the potential impacts of provisioning activities, we emphasise the need for responsible management of these interactions to protect the well-being of sea turtles and preserve their essential ecological functions in the marine ecosystem.

PROVISIONING OF VITELLOGENIC FOLLICLES CONTINUES AFTER GREEN TURTLES ARRIVE AT THE NESTING BEACH IN TORTUGUERO, COSTA RICA*

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Yolk to nurture growing embryos starts being deposited into vitellogenic ovarian follicles 8 to 12 months prior to sea turtle reproduction. Yolk deposition is believed to be completed prior to reproductive migration in leatherback (*Dermochelys coriacea*) and Kemp's ridley turtles (*Lepidochelys kempii*). However, follicle size and circulating concentrations of yolk precursor indicate that yolk deposition is completed during the nesting season of green turtles (*Chelonia mydas*) in the Indian and northwest Atlantic oceans, respectively. From 2021 to 2023, I collected the ovaries of 69 green turtles depredated by jaguars (*Panthera onca*) while nesting at Tortuguero National Park, Costa Rica, and I counted and measured the diameter of all vitellogenic follicles present in each ovary. When I compared the number of vitellogenic follicles in both ovaries with the average clutch size and frequency for green turtles nesting at Tortuguero, it was clear that a vitellogenic follicle size hierarchy existed. The diameter of small follicles increases up to 13 mm prior to ovulation due to yolk deposition during the nesting season at Tortuguero. Is the increase in size due only to water deposition or were lipids and/or protein being deposited as well? To answer this question, I dehydrated small (~ 23mm) and large (~29mm) vitellogenic follicles at 70º C and weighed sequentially until stable mass was achieved. Prior to dehydration, small follicles (n = 376) weighed an average of 8.8 g (± 3.5) and large follicles (n = 397) weighed an average of 14.4 g (± 3.5). After dehydration, large follicles lost an average of 47.1% (± 4.1) of the initial weight, whereas small follicles lost an average of 49.6% (± 4.1) of the initial weight. The yolk of small follicles had significantly higher proportion of water than the yolk of large follicles (Kruskal-Wallis test, $H_1 = 172.8$, $p < 0.001$). Because the yolk in small follicles was more diluted than the yolk in large follicles, the increase in diameter of green turtle vitellogenic follicles during the nesting season at Tortuguero is due to the deposition of not only water, but mainly lipids and/or protein. I am currently quantifying lipid and protein content in the samples, which we expect will not differ between small and large follicles. These results will be ready to present at the ISTS42. Though there is evidence that females will eat opportunistically during the nesting season, sea turtles are considered capital breeders that amass all the energy required for reproduction at foraging grounds. Here, we show that provisioning of vitellogenic follicles, a major energy expenditure associated with reproduction, was still underway when female green turtles arrived at the nesting beach in Tortuguero. It remains to be seen whether food intake at the nesting beach provides energy for Tortuguero green turtles to produce the egg yolk that complements small vitellogenic follicles. This would enhance our understanding about the energetic requirements for reproduction of this important population of endangered green turtles, which is even more crucial in light of the rapid worldwide decline of seagrass meadows, its main food source.

EVALUATING THE SUB-LETHAL EFFECTS OF RED TIDE BLOOMS AND BREVETOXIN EXPOSURE ON NESTING LOGGERHEAD SEA TURTLES

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Blooms of the harmful algae *Karenia brevis* are a significant and persistent threat to sea turtles that inhabit the Gulf of Mexico. A bloom off the coast of southwest Florida, USA from October 2017 through February 2019 was the longest continuous bloom since 2006 and resulted in the largest number of sea turtle deaths ever attributed to a single red tide event. In 2019, we launched a study on Sanibel Island, Florida to investigate the long-term effects of this unprecedented bloom on health and reproductive success of nesting loggerhead sea turtles (*Caretta caretta*). Our objectives were to (1) quantify brevetoxin concentrations in plasma for loggerheads nesting on Sanibel Island, Florida, USA, following an intense and prolonged red tide bloom, (2) establish correlations with brevetoxin exposure and blood analytes, (3) determine brevetoxin concentrations in unhatched egg contents and dead-in-nest hatchling livers, and (4) identify impacts of brevetoxin exposure on hatching success. Between 2019 and 2022, we collected 428 blood samples from 305 nesting loggerheads without clinical evidence of brevetoxicosis. We also collected 276 dead-in-nest hatchlings and 1,593 eggs from nests laid by these females. Plasma, hatchling livers, and egg contents were analyzed for total brevetoxins. Hatching success was used as an index for reproductive output. Maternal plasma brevetoxin concentrations were low in comparison to animals that strand during red tide blooms, ranging from 0.1 to 24.6 ng/mL Stable isotope analysis indicated that loggerheads foraging in the Gulf of Mexico had significantly higher plasma brevetoxin concentrations than those using Caribbean foraging grounds. Several correlations of brevetoxins with blood analytes provided evidence of subclinical effects on immune functions and overall health. Mean hatchling liver brevetoxin concentrations ranged from 12.0 to 534.0 ng/g and were significantly higher in 2020 and 2021 compared to 2019. Brevetoxin concentrations in hatchling livers and eggs from the same nest were significantly correlated, but no correlations were observed between these values and maternal brevetoxin concentrations. Hatching success did not significantly correlate with plasma, egg, or liver brevetoxin concentrations. Histopathologic evaluation of hatchling tissues was performed, but indicated no relationship with brevetoxin concentrations in hatchling livers. Our results provide evidence that even when harmful algal blooms do not cause direct mortality of exposed wildlife, they can potentially act as a physiological stressor with long-term impacts on the health of sea turtles. Additionally, our data confirm that toxin transfer occurs from nesting female to egg/offspring, with high values reported in many hatchling liver tissues, but brevetoxins do not appear to impact reproductive success. The combination of global climate change, potential tropical cyclone intensification, and eutrophication will likely increase the incidence and intensity of harmful algal blooms. It is important to consider the impacts of these blooms on sea turtle health and reproduction when evaluating stressors on the population and developing management strategies.

DISENTANGLING THE IMPACTS OF CONTAMINANTS ON GREEN SEA TURTLE PHYSIOLOGY*

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The escalating threat of pollution has breached critical ecological thresholds, heralding severe consequences for marine ecosystems and essential processes. While our understanding of contaminants' impacts remains an ongoing challenge, the effect of pollutants on the health of marine organisms, particularly sea turtles, is gaining more attention. This study aimed to assess the health implications due to contaminant uptake in three foraging populations of green turtles (*Chelonia mydas*) in the southern Great Barrier Reef of Australia. A comprehensive field study conducted health assessments, including visual, biochemical, and haematological evaluations, on 45 juvenile and sub-adult green sea turtles across offshore and inshore foraging sites. An *in vitro* cytotoxicity assay using green turtle fibroblasts was used to test the toxicity of blood extracts. Additionally, trace element analysis via ICP-MS identified concentrations of 14 essential and non-essential elements in whole blood. These analyses revealed associations between increased cobalt, molybdenum and manganese concentrations and diminished kidney function and overall body condition. Surprisingly, our findings indicated higher cytotoxicity in the two offshore foraging sites. While these sites were anticipated to have low contaminant exposure, individuals displayed an increased level of overall toxicity despite showing no visible signs of decreased health and no significant changes in health parameters. This discrepancy underscores the intricate and complex nature of ecotoxicology and health assessments in marine turtles and highlights the need to learn from inevitable research oversights. Moving forward, this study emphasises the need for future investigations delving deeper into immune responses and endocrine disruption, essential for a more wholistic comprehension on the impact of contaminants on sea turtle health. This research illustrates the intricate relationship between contaminants, health, and the environment, signifying both the challenges and the crucial importance of further exploration for the sustainability of marine ecosystems.

PLASTIC INGESTED BY GREEN SEA TURTLES (CHELONIA MYDAS) WITH FIBROPAPILLOMATOSIS (FP)

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Marine ecosystems face an escalating threat from plastic pollution, and among the most vulnerable inhabitants are sea turtles. Listed as either vulnerable or endangered on the IUCN Red List, sea turtles ingest plastics that can result in severe physiological consequences, including gut compaction, gut perforation, and leaching of toxic chemicals from plastics into their tissues. This study delves into the relatively unexplored domain of plastic-induced physiological impacts on sea turtles while extending its focus to elucidate potential disparities in these impacts between turtles afflicted with Fibropapillomatosis

(FP) and those without this debilitating disease. Our study investigates the variability of plastic ingestion among green sea turtles and between ontogenetic stages and FP. During necropsies the gastrointestinal tracts from 46 green sea turtles were collected and placed in aluminum pans. The gastrointestinal contents were removed and digested by 10% KOH for up to ten days. After digestion of non-debris material, the contents were filtered to obtain marine debris greater than 2mm. The debris was then counted and categorized using ImageJ software. There were twenty-one FP turtles sampled and seventeen of them had plastic (81%), most were juveniles. There were twenty-four non-FP turtles sampled and fifteen of them had plastic (63%). A total of 742 pieces of marine debris (2mm or larger) were found in the turtles and 40% of this total was found in FP turtles. The highest number of plastic pieces found in one individual was 160 and it was a turtle without FP. Black and white pieces were the most common in FP (23% and 26%, respectively) and non-FP turtles (29% and 25%, respectively). Filament was the most common type of marine debris found in FP (69%) and non-FP turtles (72%). These preliminary results suggest that there are no significant differences in plastic marine debris consumption between FP and non-FP green sea turtles; this study builds upon our current knowledge of marine debris and FP in sea turtles.

MATERNAL TRANSFER OF MICROPLASTICS IN LOGGERHEAD SEA TURTLE (CARETTA CARETTA): EFFECTS ON THE EMBRYO HEALTH CONDITIONS*

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The Loggerhead Sea turtle, *Caretta caretta*, is exposed to numerous natural and anthropogenic threats during its long and complex life cycle. The potential toxicity of contaminants, in particular marine litter, has received the interest of the scientific community due to their possible impacts on the survival of this sea turtle species worldwide. Therefore, *C. caretta* has been identified as the official bioindicator for the Descriptor 10 "Marine Litter" in the European Union’s Marine Strategy Framework Directive and UNEP/MAP Barcelona Convention. The presence of microplastics (MPs) could act in synergy with other contaminants and biotic factors impairing the health condition of sea turtles starting from the embryonic phase, one of the most sensitive phases of its entire life cycle. Consequently, this study aimed to investigate the presence of MPs in unhatched embryos. From 180 unhatched eggs collected from nests laid along the Northwestern Mediterranean coast, only 17 unhatched embryos at stage 30 of development were considered suitable for MPs extraction and following analysis. Alkaline digestion and Raman microspectroscopy were performed on yolk and liver samples to investigate the maternal transfer and the absorption of MPs. All microplastics were categorized in terms of abundance, size, shape, color and polymer. All microplastics identified were smaller than 5µm, the more abundant shapes were spheres and fragments and the main polymers were Acrylonitrile butadiene styrene, polyvinyl chloride and polyethylene. Furthermore, to determine the effects of MPs on the embryo's health status, selected biomarkers, defined as any measurable parameter indicating stress status (such as melanomacrophages and cortisol levels in the liver), inflammatory processes (such as IL-1β levels in the liver) and exposure to contaminants (such as CYP4501A1 levels in the liver), were evaluated. These biomarkers were assessed through histology, immunohistochemistry and western blotting performed on liver samples. The effects of

MPs on the embryo's health status was confirmed by the statistical correlation analysis between the expression of these biomarkers and the number of microplastics. In particular, the abundance of melanomacrophages could represent an optimal biomarker for MPs presence due to the very strong correlation. Further studies should be performed to increase the knowledge about the possible effects of MPs and associated pollutants on embryonic development and provide standardized protocols for future assessments.

HORMONE LEVELS ASSESSMENT FOR SEX CLASSIFICATION AND SEXUAL MATURITY IN GREEN TURTLE (CHELONIA MYDAS) FROM THE COAST OF QUINTANA ROO, MÉXICO*

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In sea turtles, the hormonal profile is an effective and minimally invasive method that provides basic information about reproductive state and sex identification in some species; however, hormone concentrations and their utility as demographic predictors are unknown for the green turtle (*Chelonia mydas*) population of the Mexican Caribbean coast. The objectives of this study were to determine hormonal concentrations of estradiol (E_2), testosterone (T), and thyroxine (T_4) and to evaluate their usefulness for sex and maturity stage classification. Length (standard curve carapace length CCL) was measured and a blood sample was collected from 150 free-ranging green turtles. Individuals were classified by stage of maturity (immature and adults) and by sex, according to their size, morphological characters (adults) and inguinal ultrasounds (immature). The hormone concentrations matched the expected steroid levels for the species and proposed age/size classes for other foraging populations. E_2 and T levels discriminated reproductive stages, with 100% correct classification of immatures, when using the minimum nesting size (86 cm CCL) (Wilk´s λ= 0.37, p= 0.01). CCL and E_2 discriminated adult green turtles of known sex from immatures with suggested sex (ultrasound) (Wilk´s λ= 0.43, p= 0.0001). However, sex identified morphologically was not discriminated by hormones or size in adult turtles. Hormones and size of adults correctly predicted 83% of females and 78% of males by a logistic regression analysis, meanwhile, only the 69% females and 56% males were accurate predicted by the variables when immatures of suggested sex (ultrasound) was analyzed in tandem. Results indicate that the hormonal profile and size are useful to discriminate the reproductive stage of green turtles when used simultaneously during modelling. More evaluations are required to understand the relationship between hormone profiles and sex of the green turtle population inhabiting in the coast of Quintana Roo, Mexico.

WHY THE LONG FACE? HAWKSBILL FORAGING STRATEGIES WHEN SYMPATRIC WITH GREEN TURTLES

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Sea turtle head shape varies with phylogeny, ontogeny, and ecology. Among the extant sea turtle species, the hawksbill (*Eretmochelys imbricata*) stands out from other cheloniid species as having a head that is twice as long as it is wide. The jaws form a narrow "v" in dorsoventral view. In comparison, the green turtle (*Chelonia mydas*) differs in the other extreme; its head is rounded in profile with a blunt snout and the jaws are "u-shaped" in dorsoventral view. We hypothesize these two very distinct head shapes reflect foraging differences. We tested this hypothesis with morphological comparisons as well as field observations. Head shape was quantified by measuring heads of live turtles, dead strandings, and skulls. The head is structurally and functionally formed by two parts: the facial component and the neurocranial component. The neurocranial part of the skull houses jaw muscles and the attachments of neck muscles. We focused on comparisons of facial proportions and neurocranial proportions at several life stages. Facial elongation was most pronounced in juvenile hawksbills. Interestingly, adult hawksbill facial proportions became proportionately shorter while the neurocranial component became more robust. In green turtles, facial versus neurocranial elongation differed less in juveniles to adults. The two species occur sympatrically on shallow reefs in the waters of Hawaii (U.S.A). Both forage on algae. The hawksbills feed on algal colonies in crevices, often removing obstructions with their jaws. We hypothesize that the elongation of the hawksbill neurocranium supports the muscular and biomechanical requirements for this behavior. In contrast, green turtles scrape algae from larger colonies growing on open flat hard surfaces. This foraging mechanism requires broad flat scraping or nipping jaws and likely less mechanical advantage to depress or elevate the head. The head proportions and shapes align with the differing foraging techniques of each species.

CONSERVATION, MANAGEMENT, AND POLICY

RAS BARIDI TURTLE CONSERVATION INITIATIVE (RBTCI): A COMPREHENSIVE SAUDI ARABIAN APPROACH FOR LONG-TERM CONSERVATION

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Ras Baridi beach holds the distinction of being the most crucial nesting site for green turtles in the Saudi Arabian Red Sea. However, this vital area faces numerous threats that jeopardize the survival of nesting turtles, their nests, and hatchlings. In response to these multifaceted threats, the Baa Foundation entrusted KAUST-Beacon Development with the task of developing and implementing a Saudi-led initiative to safeguard this essential turtle nesting beach along the Red Sea coast. The Ras Baridi Turtle Conservation Initiative (RBTCI) harbors the overarching goal of ensuring the long-term survival of marine turtle populations in the Red Sea and preserving this critical marine turtle rookery for future generations, guaranteeing its sustainability for years to come. To achieve these objectives, RBTCI's efforts are primarily directed towards mitigating direct human impacts and climate change effects, while simultaneously fostering an educational and awareness campaign that promotes engagement with the project among national and international stakeholders. Our conservation efforts can be categorized into two main phases: short-term (immediate) and long-term actions. Conservation issues that have been promptly addressed and managed include beach driving, human beach activities, and plastic pollution. Also, we promote the study of those ones that require further investigation before effective mitigation strategies can be implemented, such as loss of nesting habitat, beach erosion, artificial light, cement crusts, natural obstructions, and wind-blown cement dust. RBTCI also lends support to research endeavours aimed at enhancing our understanding of various aspects of nesting ecology at Ras Baridi beaches. To date, we have achieved the following: (a) removal of 581.8 kilograms of plastic from the turtle nesting habitat, (b) conduct of nine oral sessions to educate 106 participants, (c) rescue of 1,366 light-disoriented hatchlings, (d) assessment and tagging of 384 green turtles, and (e) georeferencing of 332 nesting events along Ras Baridi beaches. Moreover, Saudi Local Environmental Wardens have carried out the vast majority of activities in-situ, ensuring that talented locals take the helm in the country to foster continuity and local ownership of conservation efforts in the Kingdom of Saudi Arabia. RBTCI is an expanding initiative that advocates for the conservation of marine turtles as umbrella species, striving towards the long-term protection of the entire ecosystems utilized by these threatened species.

INGENI-CARETTA PROJECT: MANAGEMENT OF EMERGING NESTING SITES OF LOGGERHEAD SEA TURTLES, BASED ON SCIENTIFIC KNOWLEDGE AND COORDINATION BETWEEN MEDITERRANEAN SPANISH REGIONS

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The western Mediterranean is experiencing an increase in nesting events of the loggerhead sea turtle (*Caretta caretta*), which corresponds to a colonisation process of the species as an adaptive response to the increase in global temperature, due to climate change. This phenomenon is considered of significant importance for the species because of predictions of future feminization of populations and reduction of incubation viability on the original nesting beaches, while the new nesting beaches have more favourable conditions in the current global warming scenario. To date, an alteration of such magnitude in the distribution range of nesting sea turtles has not been detected for any species of sea turtles in response to global warming. Furthermore, this colonisation occurs in areas with high human occupation and frequent use. For this reason, a coordinated and well-organised management plan needs to be established to promote hatching success, in coexistence with human presence. In this context, we present the ***InGeNi-Caretta project***, started in 2023, with the aim of understanding this colonisation process, and providing a solid base of scientific knowledge for its management and conservation along the Spanish Mediterranean coast. It is a multidisciplinary project, which brings together, for the first time under all the researchers who have worked in recent decades on loggerhead turtle nesting in Spain. The main objectives of this 2-year project are:

1) to evaluate and analyse the sand beaches along the Mediterranean Spanish coast for nesting activity of sea turtles;
2) to do research on the environmental and reproductive parameters of *in situ* nesting events;
3) to infer the number, origin and behaviour of reproductive individuals through genomic studies;
4) to study of dispersion and habitat use of both reproductive adults and offspring;
5) to evaluate *ex situ* conservation techniques applied in nesting management; and
6) to disseminate and transfer of results. During the first year, after a record season in numbers of nesting, research for this project has been started.

First preliminary analysis, include: a characterization of Spanish beaches, based on their environmental characteristics and anthropic impacts, such as light pollution; the study of the nesting process *in situ,* as the main source of information and samples of the project; a genetic census of the reproductive individuals participating in the observed nesting, including an estimate of the sex ratio of the adult population; data analysis on turtle movement and habitat use via electronic satellite tracking tags; determination of parameters for both incubation and nest success (hatching rate and emergence of nests, embryonic development rate, incubation temperature, humidity, presence of microorganisms, etc.); and, finally, the dissemination and transfer of results, being a fundamental part of the project to promote management and conservation of the loggerhead turtle, and particularly its nesting, based on solid scientific knowledge. Thus, InGeNi-Caretta aims to transfer the knowledge generated by the project to managers and decision makers in all regions of Spain, to facilitate the planning and management of this threatened species in the immediate future, as it is increasingly affected by climate change.

IMPLICATIONS OF LOW HATCHLING PRODUCTION FROM HATCHERIES FOR SEA TURTLE POPULATIONS IN INDIA

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Sea turtle conservation in India often involves incubating threatened eggs in protected spaces called hatcheries to improve hatchling production. However, not all hatcheries use best practices, so hatchling numbers may be low. Our research examines the implications of low hatchling numbers for local populations and, subsequently, recommends improvements for hatcheries. Stage-based Leslie matrix population modelling is being used to obtain intrinsic growth rates of study sea turtle populations in India, with fecundity, survivorship, and stage durations sourced from published literature. Elasticity analysis against survivorship and stage duration will determine the contribution of each life stage (hatchlings, juveniles, sub-adults, adults) to population growth. The study is in progress and is scheduled to be completed in January 2024. We anticipate that findings will demonstrate a threshold below which low hatchling production from hatcheries may result in the loss of local populations. Results will be used to recommend hatchling production targets over time for hatcheries. Establishing a target hatchling production and success rate to ensure population longevity will motivate hatcheries to use evidence-based best practices for collecting, moving, and incubating eggs. Meeting targets over time will also be proposed to relevant government authorities as a requirement for permit issuance and renewal for hatcheries.

A NEW OLIVE RIDLEY HOPE SPOT: A PRELIMINARY ASSESSMENT OF MARINE TURTLES NESTING IN PALAWAN, PHILIPPINES*

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The coast of the province of Palawan, Philippines hosts important foraging and nesting grounds for at least three species of marine turtles: olive ridley turtles (*Lepidochelys olivacea*), green turtles (*Chelonia mydas*), and hawksbill turtles (*Eretmochelys imbricata*) currently listed as vulnerable, endangered, and critically endangered respectively. Many anthropogenic activities still threaten these populations, and most of the nearly 2000 km of coastline across 1700+ islands, remain unmanaged. In the last ten years, several conservation initiatives have been initiated and implemented by local communities, people organisations, government agencies, NGOs and private groups, across many of the 23 municipalities and the one city, with a wide range of successes, failures and impacts. Here, we present preliminary nesting data and threats information collected by the different stakeholders during the last 10 years from 10 municipalities and the capital city. Between 2014-2022, a total of 1,030 marine turtle nests were reported, consisting of 614 (59.6%) olive ridley nests, 254 (24.7%) green turtle nests, 40 (3.9%) hawksbill turtle nests and 122 (11.8%) unidentified nests (species was not reported/identified). Additional data from other Municipalities are available but not yet included yet in this preliminary study. Olive ridley nesting season occurs from November to February, occasionally extending into October and March, with temporal and geographical variation. A significant increase in olive ridley nest reporting in the last 5 seasons has been observed, thanks to the increased effort and participation in beach patrolling along the West Philippines Sea coast. This, paired with the geographical distribution of the reporting and extent of unsurveyed beaches, further highlight the need to expand this work and stakeholders involvement. Threats distribution and frequency vary across the province, with nest depredation from stray dogs and wildlife (i.e. monitor lizards), eggs poaching for local consumption and trade, habitat modification, and poor hatchery management being the most significant. Currently regulated but unmanaged, the population of stray dogs has been reported by many stakeholders as one of the main threats to wildlife in the province, often at a scale similar to illegal wildlife trade. Based on three months of dedicated survey effort in (January-March) 2023, over 150 nests were depredated by dogs and an additional 100 incidents were reported by local partners in one single municipality. In conclusion, despite the lack yet, of a comprehensive assessment, these preliminary data highlight Palawan as one of the most important nesting and migratory habitats for olive ridley turtles in the region and the critical role of community-based conservation initiatives for their survival. Furthermore, when augmented with nesting data from the islands of Luzon and Mindanao, the Philippines as a whole, plays a vital role for the conservation of this species across Southeast Asia and West Pacific. Addressing the stray dog situation, training more local stakeholders in accurate data collection, centralising and

digitising data collection and reporting, and designing a roadmap for the sustainable management of hatchery programs in the province should be the highest priorities within the next five years.

MARINE TURTLES AT THE SAUDI ARABIAN VISION 2030 PROGRAMME: CONSERVATION HOTSPOTS, DISTRIBUTION, MIGRATORY PATHWAYS IN THE RED SEA*

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Marine turtles are highly mobile species, and they are exposed to multiple threats through their habitats. In the Red Sea, previous authors have identified nesting beaches for green and hawksbill turtles; however, there is still little information regarding their re-nesting success, intervals, and post-breeding displacements. As part of the Vision2030 Programme, ruled Saudi Arabia and implemented at Red Sea Global, we assessed for green and hawksbill turtles': (a) nesting behavior; (b) distance between nesting beaches and feeding grounds (migratory pathways); and (c) location of feeding habitats. To achieve this, between 2019 and 2022, we satellite-tracked 64 female turtles (54 greens, and 10 hawksbills) from Breem, Al-Waqqadi, An'Numann Islands, and Ras Baridi beach. Nesting Success Rate (NSR-%) and the Inter-Nesting Intervals (INI-days) were calculated; and we assessed the movement of equipped turtles. In average, we tracked hawksbill turtles during 269.2 days (range= 58-416), and green turtles during 229.94 days (range= 11-437). NSR was estimated for hawksbill turtles in 85.7%, and 70.42% for green turtles; while the INI average periods had a mean of 13.72 days (range= 11-18) and 11 days (range= 9-20) respectively. Migration periods averaged 5.25 days (±5.844; range= 1.1 to 16; n=10) for hawksbills, and 19.06 days (±16.701; range= <1 to 51 days; n=52) for greens. Average distances between the nesting and feeding grounds were 121.46 km (range= 12.9-535.82; n=10), and 473.95 km (range=3.8-1,367; n=52) for hawksbill and green turtles correspondingly. Some feeding grounds overlapped between and within species, and we identified some areas that have potential to be considered as foraging hotspots as southern Jeddah bays, Ras Baridi and NEOM seagrass beds, Wadi El Gemal Hamata National Park (in Egypt), and the Dahlak Marine National Park (in Eritrea). Our results are particularly important for conservation planners, as they will inform management and conservation actions at national and international level.

ACCURACY OF LOCAL COMMUNITIES IN IDENTIFYING LEATHERBACK TURTLE NEST LOCATIONS AT JEEN YESSA BEACH IN THE BIRD'S HEAD REGION OF PAPUA, INDONESIA

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Jeen Yessa Beach (formerly Jamursba Medi) is one of the largest nesting beaches for leatherback turtles (*Dermochelys coriacea*) in the Pacific. It is part of the Jeen Womom Coastal Park Marine Protected Area. Despite having relatively high leatherback turtle nesting activity, low hatchling production is thought to be one of the factors that impeded population recovery. To increase hatchling production, the nesting beach team of the Science for Conservation Program at the State University of Papua (UNIPA) protects nests *in situ* by shading nests threatened by high sand temperatures with palm leaves and fencing nests threatened by predation. For these nest protection methods to work effectively *in situ*, nest protection must be erected just above the nest. However, with an 18-km long beach and insufficient personnel, most nesting activities are missed during night patrols, and the exact nest locations are unknown. Therefore, we recruit people from the communities living in villages around Jeen Yessa beach as local patrollers to record turtle nesting activity and identify nest locations in the morning. The number of local patrollers recruited increased from 5 in 2018 to 6 in 2019 and 7 in 2021 and 2022. To measure these local patrollers' accuracy of nest location identification, we analyzed April to September nesting data from the 2018, 2019, 2021, and 2022 nesting seasons. Local patrollers at Jeen Yessa Beach correctly located 355 out of 375 (94.7%) leatherback turtle nests. With such accuracy, we can confidently erect *in situ* leatherback nest protection at nest locations identified by the local patrollers.

ADDRESSING BYCATCH THROUGH FISHERMEN’S WIVES AND CHILDREN IN THE KINGDOM OF MOROCCO

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The Kingdom of Morocco extends from the Mediterranean into the Atlantic Ocean with a coastline of 3,446 km. Little nesting takes place in the country, but juvenile and sub-adults loggerheads are the most commonly encountered species in these waters. Evaluating and mitigating mortality of sea turtles in Moroccan fisheries and creating a greater awareness for their protection are crucial to the survival and recovery of several nesting populations in the Atlantic and the Mediterranean. Efforts have been underway since 1999 to organize sea turtle workshops at major ports, and recruit and train fishermen to collect data

on turtles caught in their fishing gear. More recently, women's groups were created in northwestern Morocco to promote the involvement of local women (fishermen's wives, and women who go fishing and diving) in addressing fisheries issues and marine conservation. The women's groups are engaged in beach clean-ups, ocean surface garbage clean-ups, and in education and awareness activities about plastics and the proper disposal of discarded fishing gear and garbage by the fishermen. A marine education program has also been started for their children by high school students and includes quizzes, drawing competitions, etc. Theatrical plays and short films by fishermen children were produced and published on social networks. Activities of the women and children have been filmed and will be played back to them and other communities to generate further discussion about marine issues. The goal is to gradually make this a national women's and children's network. By making marine conservation a family activity, where fishermen's wives /children can begin to influence their husbands/fathers, the project hopes to have an even bigger impact on sea turtle conservation in Morocco.

TOWARDS EFFECTIVE RESTORATION OF MARINE TURTLES IN JORDAN'S AQABA COAST LINE*

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Five species of marine turtles can be found in the Red Sea, the green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*) are the most common, with the leatherback turtle (*Dermochelys coriacea*) and olive ridley turtle (*Lepidochelys olivacea*) being infrequently seen with no recorded nesting. CITES lists all marine turtles in its Appendix I (prohibited from international trade), IUCN red lists include the species as Vulnerable through to Critically Endangered. Jordan's territorial water in the Gulf of Aqaba is famous for its rich coral reefs, and it contains seagrass beds and these provide extensive feeding habitats for populations of two species of marine turtles: the green turtle and the hawksbill turtle. Turtles are not recorded as nesting on Jordan's coastline and very little information is available in Jordan's Gulf of Aqaba, regarding their abundance and distribution and their foraging sites. The scant published information indicates that the hawksbill turtle is the dominant species with majority in sub-adult stage within the Jordanian waters. In Jordan's Gulf of Aqaba, turtles face significant threats and challenges. These include fisheries-related mortality (by-catch), habitat destruction (habitat loss), plastic pollution, and a lack of government commitment to biodiversity protection. Additionally, the absence of understanding about the ecological value of turtles and their habitats has led to inappropriate coastal ecosystem management and development practices. The Jordan Society for the Conservation of Turtles and Tortoises (JSCT) has developed a comprehensive plan encompassing a range of proposed actions. The primary objectives of this plan are to mitigate both direct and indirect threats to turtles and safeguard their foraging habitats. The aim is to achieve these goals through initiatives such as promoting turtle rescue and rehabilitation, conducting extensive research and monitoring efforts, to gather crucial information about turtles along the Jordanian coast. As well as organizing public awareness campaigns and capacity-building programs for diverse local community groups. Among its activities, the JSCT implemented a follow-up program for two marine turtles existing in the lagoons at Ayla project - Aqaba, which were previously in the Marine Biology Museum of the Marine Science Station (MSS) and were suffering from some health problems and injuries. This program began on year 2022 and include visual inspection, measurements of growth rates, medical check and laboratory examinations. The results suggest that the two sub-adult female turtles are in good health and exhibiting normal growth progress, this reflects the favorable condition of the lagoon environment, making it a suitable place for rehabilitating injured turtles before their release into the wild. Before the end of 2024, the association will implement a capacity-building program for a group of fishermen and a team of naval forces, this program aims to educate them on the steps for rescuing and rehabilitating marine turtles accidentally caught, with the goal of minimizing turtle mortality during fishing activities. The JSCT seeks to perform effectively through an integrated national network including community participation, government and related stakeholders.

MARINE TURTLE MANAGEMENT AREAS: A FINE-RESOLUTION SPATIAL SOLUTION BENEATH SOUTHEAST ASIAN REGIONAL MANAGEMENT UNITS*

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Marine turtle Regional Management Units (RMUs) are region-wide discrete marine turtle population boundaries beneath the species level and above the genetic stock. However, the RMUs have a coarse resolution, which make it difficult for conservation professionals within an RMU to precisely identify and prioritize areas that require immediate attention or if threats within an RMU could even be managed within their regional, national, or local jurisdiction. We developed finer resolution boundaries in the green and hawksbill turtle Southeast Asian RMUs, called Marine Turtle Management Areas (MarTuMAs), with the objective of developing boundaries that "break up" regional RMUs into boundaries that would be meaningful for marine turtle conservationists. These are discrete boundaries which encompass a single or overlapping nesting-foraging networks (nesting groups), and hence lie beneath RMUs but above the genetic stock. We collated published and unpublished data from collaborators throughout Southeast Asia, including Indonesia, Malaysia, Vietnam, and Thailand. Satellite tracks were first grouped by their nesting group, followed by bootstrapping satellite returns to develop multiple minimum convex polygons that were then averaged and merged (if overlapping was substantial) to create MarTuMAs. Six green turtle MarTuMAs and two hawksbill turtle MarTuMAs were identified from data contributed by regional collaborators. Green turtle MarTuMAs were identified for the Andaman Sea, Java Sea, Raja Ampat, South China Sea, northern Borneo, and the Sulu and Celebes Sea, while hawksbill turtle MarTuMAs were only identified for the Melaka Straits and the Sulu Sea. A future step is to develop conservation priorities for each identified MarTuMAs using a quantitative criterion that is scored by marine turtle conservationists for their respective MarTuMA. This will allow conservation professional to identify whether MarTuMAs that are relevant to them require immediate conservation action or not. The process of identifying sub-RMU boundaries was conducted within a biologically important region of the world, but this framework can be adapted and applied to other RMUs for other marine turtle species across the globe.

FROM POACHERS TO PROTECTORS: A COMMUNITY BASED APPROACH ON SEA TURTLE CONSERVATION IN THE LAMU ARCHIPELAGO, KENYA

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The Lamu archipelago on the northern coast of Kenya is home to 68% of Kenya's mangrove forests, coral reefs, and seagrass habitats that provide habitat for numerous marine mammal and fish species, as well as 4 species of sea turtle. Established in 1992, the Lamu Marine Conservation Trust (LaMCoT) is a registered Community Based Organisation (CBO) based in the Lamu Archipelago and was set up as a response to the unsustainable harvesting of turtles and their eggs. LaMCoT has maintained a focus protecting turtles whilst expanding its links with the local community to work for both conservation and local development. Through the bycatch program local fishermen turn in turtles accidentally caught in their nets. Turtles are then measured, treated for any health problems, before being tagged and released. Ex-poachers have been trained to patrol local beaches to prevent the illegal poaching of eggs, mark out new nest sites and monitor them until hatching. Guests and community members are invited to watch these hatchings, helping to protect hatchlings from predators encountered on their way to the ocean. Nest sponsorship also sustains turtle protection efforts. Through education programmes LaMCoT increases the awareness of why turtles should be protected, and this also encourages community members to inform us of any turtle exploitation or poaching activity. Between 2001 – 2023 LaMCoT tagged 1,224 turtles, and helped 102,251 hatchlings to the ocean from 892 nests. Here we present the size frequency trends, health and recapture data from green and hawksbills collected from the bycatch program, as well as nesting trends and success rates for 1997 – 2023.

COMMUNITY-LED CONSERVATION: A DECADE OF SUCCESS IN MARINE TURTLE VOLUNTEER PROGRAMS IN VIETNAM

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Marine and Coastal Program, IUCN Vietnam

Since 2014, IUCN Vietnam has engaged volunteers in conservation efforts across various sites, including Con Dao National Park (NP), Hon Cau Marine Protected Area (MPA), Bai Tu Long NP, Nui Chua NP, and Ly Son MPA. The primary objectives are to enhance public awareness of the crucial role in marine turtle conservation, assist rangers in relocating turtle eggs to designated incubator areas during the nesting season (June-August), and subsequently release hatchlings into the sea. Additionally, the volunteers aim to advocate for biodiversity protection and marine conservation at the national level. The program has garnered significant interest, with over 12,000 applicants expressing their willingness to participate. More than 600 individuals were carefully selected from this list, with women comprising more than 60% of the participants. The IUCN marine turtle volunteer Facebook fan page has achieved substantial reach, boasting 176,000 post impressions (inclusive of repeat views), 165,000 post reach (reflecting individual views), and 34,700 interactions (including likes, comments, and shares). Furthermore, the initiative has generated extensive media coverage, thousands of stories, and photos featured on social networks, over 40 articles

and 15 events featured in well-known national outlets, and 12 out of 60 videos and films have been aired on national channels. When asked about the reason for participating in the program, the top motivation for participating in a marine turtle conservation volunteer program is to join hands in marine environment protection and marine turtle conservation work, accounting for 98.2%. While the communication aspects of the marine turtle volunteer program have been commendable, certain challenges persist. Firstly, releasing hatchlings, common in many marine turtle nesting sites, is viewed as a potential revenue stream for NPs/MPAs and an opportunity for awareness-raising. However, adhering strictly to scientific guidelines and employing correct methods is imperative. Secondly, the influx of visitors eager to witness marine turtle hatchlings poses a risk to their well-being. Addressing this issue requires careful management to prevent any negative impact on their health, and the Volunteer could play a crucial role as a guide. Lastly, ensuring sustained funding for the volunteer program remains challenging as almost all funding currently comes via IUCN from the U.S. Fish and Wildlife Services (FWS). Given its proven low costs and high benefits, NPs and MPAs should take ownership of the program, proactively engaging in marine turtle conservation efforts more comprehensively over the long term.

THE MTSG BURNING ISSUES INITIATIVE: THE LONG AND WINDING ROAD TO A SHARED UNDERSTANDING OF GLOBAL SEA TURTLE CONSERVATION PRIORITIES BY AND FOR THE PEOPLE WHO CARE ABOUT THEM*

Marine Turtle Specialist Group Burning Issues Working Group

IUCN Marine Turtle Specialist Group

Because sea turtles range across vast geographic ranges throughout the global tropics and subtropics where they are exposed to variations in threats and environmental conditions, it is challenging to establish consistent, globally applicable priorities for their conservation. The IUCN Marine Turtle Specialist Group (MTSG) launched the Burning Issues (BI) workshop series in 2003 with the aim to better direct on-the-ground conservation actions toward the highest priorities for preventing extinctions. The first six Burning Issues (BI) workshops culminated in two seminal publications: 1) describing regional management units (RMUs) for all sea turtle species (2010), and 2) a conservation priorities portfolio (CPP) evaluating the risk and threat to each RMU (2011). More than 10 years later, the MTSG's seventh Burning Issues workshop (BI-7) was undertaken to not only improve and update past outputs, but also to move beyond them to recommend even finer-scale priority setting for sea turtle habitats. BI-7 is a collaborative, inclusive, and science-based initiative intended to draw the most accurate and comprehensive picture possible of global sea turtle conservation status to guide policymakers, managers, funders, and others to take effective conservation actions. Since early 2020, BI-7 has cultivated a collaborative space for MTSG experts and others to contribute their expertise and unique perspectives to generate a suite of freely available products that partners worldwide can use to inform and advance conservation strategies. BI-7 products include:

1. Guidelines and criteria for delineating Important Marine Turtle Areas, which consider not only areas of biological significance to sea turtles, but also culturally significant areas;
2. An update of RMUs and genetic stocks that incorporated information from >1,000 sources published since 2009;
3. An update of the CPP, including the original risk and threats criteria (2010), as well as new criteria such as conservation dependency and conservation capacity.

The BI-7 co-creation process has included several webinars; a powerful, shared ArcGIS platform to enable updates to RMU boundaries; multiple surveys and shared working documents; subject-matter expert reviews of inputs to ensure consistency; and flexible deadlines to maximize opportunities for participation by the largest possible number of experts globally. We will describe the iterative, collaborative processes that made these products possible, and the lessons learned from the nearly 20 years of work leading up to their completion. At least 150 different individuals from dozens of countries were able to participate in BI-7, and will ultimately appear as co-authors on the resulting products. We are proud and excited to share the results of the MTSG's BI-7 Workshop with the ISTS community, and hope that our results will serve to focus, coordinate, strengthen and speed sea turtle conservation globally.

HATCHERIES, HATCHLING RETENTION, AND HEADSTARTING - DISCUSSING THEIR CONSERVATION VALUE*

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On sea turtle nesting beaches, nesting females, eggs, and hatchlings are exposed to a variety of natural and anthropogenic threats. Even if the hatchlings manage to emerge from the nest, natural circumstances, mainly predation, results in only about one of 1,000 hatchlings reaching maturity. Sea turtle conservation projects around the world use a variety of methods to increase the survival probability of sea turtles and their offspring on their nesting beaches in order to contribute to the survival of the species. The approach to focus on nesting beaches to protect sea turtles is close at hand, and one of the most favoured and effective methods is direct protection by patrolling. Other common activities are egg incubation in hatcheries, and sometimes also hatchling retention and headstarting. Egg incubation in protected hatcheries is generally used to protect nests from flooding, predation, light pollution, and human egg collection. If nest relocation and hatchery management are following best practice procedures, they can be successful in terms of increasing hatching success. However, careful consideration is required because hatcheries are altering the natural behaviour of nesting sea turtles and may introduce risks, such as altered sex ratios, we don't fully comprehend yet. Sometimes hatchlings are not released immediately but are retained for several hours or even days for various reasons, including waiting for visitors to release them. The last step in this series of methods is headstarting, where hatchlings are kept in tanks for a longer period of time. We distinguish headstarting from hatchling retention once people start to feed the hatchlings. Headstarting is often based on the hypothetical assumption that a natural "1 in 1,000" chance of survival for sea turtle hatchlings can be increased by raising them in a protected environment and "making them stronger". In our presentation, we discuss the potential benefits and risks of these methods, based on lessons learned by various sea turtle conservation programs, relevant literature and our own observations, to help conservation groups make informed decisions about protecting sea turtles on their nesting beaches.

TWO DECADES OF DEDICATED CONSERVATION: AN OVERVIEW OF TREE FOUNDATION'S IMPACT ON SEA TURTLE CONSERVATION ALONG THE EAST COAST OF INDIA*

Supraja Dharini

TREE Foundation, India

In the area of marine conservation, TREE Foundation stands as an example of dedicated long term efforts, focusing primarily on the conservation of olive ridley turtles along the east coast of India. Established in 2002 by Dr. Supraja Dharini, inspired by the legacy of Dr. Jane Goodall DBE, the Foundation addresses the critical decline in nesting numbers of olive ridley turtles – a decline attributed to the destruction of ecosystems by impoverished coastal communities. TREE Foundations primary initiative involves community-based sea turtle conservation programs, engaging 222 fishing villages across Tamil Nadu, Andhra Pradesh, and Odisha. Through education and outreach, the Foundation has transformed 363 local young fishermen, once turtle and egg poachers, into the Sea Turtle Protection Force (STPF) members. Their efforts have not only protected tens of thousands of olive ridley nests but have also led to the protection of over 33,60,000 hatchlings through dedicated hatcheries. This article also explores the extensive training programs conducted by TREE Foundation, engaging 4,565 artisanal fishermen and over 3,750 government officers. The impact reverberates through coastal communities, with more than 3,75,000 individuals enlightened on the ecological significance of sea turtles. TREE Foundations strategic involvement with trawl boat owners has led to the voluntary trials of Turtle Excluder Devices, which significantly reduce accidental turtle by-catch. TREE Foundations satellite tagging of 2 olive ridleys and one green turtle, was a milestone as the first NGO in India to undertake this initiative. Acknowledging the vulnerability of olive ridley turtles during breeding and nesting seasons, TREE Foundation collaborates with governmental agencies, including the Wildlife Wing of the Forest Department, the Department of Fisheries, the Indian Coast Guard, and the Marine Police. Through education and awareness programs, the foundation seeks to influence policies, engage communities in sustainable practices, and protect all endangered marine species. Mission Sea Turtle workshops and Endangered Marine Species workshops for the enforcement departments strengthen the network with officials. Education remains a cornerstone of the Foundations strategy. Over 300,000 students have been reached through biodiversity awareness activities in 348 schools and colleges along the coasts of Tamil Nadu and Andhra Pradesh. Programs such as the Ocean Guardian School Program and Mission Sea Turtle Float have further extended the Foundations impact, covering students, teachers, and fishing communities. Among its initiatives, TREE Foundation actively works to minimize accidental by-catch and entanglement. Through community motivation, over 110 tons of ghost nets have been retrieved since June 2021. The Foundations commitment extends further to include a stranding network, and a Rescue Rehabilitation Centre. As TREE Foundation completes over two decades of tireless work the presentation captures the comprehensive nature of its initiatives, ranging from educational programs and guided turtle walks to the retrieval of ghost nets. The Foundations journey underscores the vital role of community engagement in the sustained conservation of sea turtles, serving as a beacon of hope for global marine conservation endeavours.

OVERCOMING BARRIERS TO KNOWLEDGE: A MULTI-LINGUAL SYSTEMATIC REVIEW OF MOVEMENT AND MIGRATORY CONNECTIVITY OF GREEN SEA TURTLES AROUND SOUTHEAST ASIA*

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Understanding where and how species' critical habitats are connected is crucial for adequate biological protection and habitat conservation of marine ecosystems. Sea turtles, being among the most widely monitored and protected organisms, are particularly vulnerable due to their migratory nature and susceptibility to various threats throughout different life stages. In Southeast Asia, where six of the seven sea turtle species are found, there are increasing spatial conflicts between animals and human activities including habitat degradation caused by coastal development, direct and indirect fishing capture, and disturbance from marine traffic and recreational activities. As sea turtles require a wide range of habitats and movement corridors through the waters of several countries and the open sea to complete their reproductive migrations and ontogenetic shifts in habitat use, it is imperative to identify the connections between habitats at scales and extents that are appropriate for the species' persistence. However, as the common practice of searching and compiling literature and datasets on habitat use is mainly through English peer-reviewed journal articles, important work and information in non-English languages and grey literature are systematically neglected, rendering the conclusions of evidence syntheses at regional or global levels biased towards certain information resources. To overcome this barrier, we conducted a systematic literature search in seven regional languages to present a comprehensive review on the movement and migratory connectivity of green sea turtles (*Chelonia mydas*) around Southeast Asia. Using regional and global literature databases as well as unpublished data, we identified 104 sources, spanning peer-reviewed journal articles (24.0%), reports (26.9%), conference proceedings (20.2%), online websites and databases (18.3%), theses and dissertations (8.7%), and unpublished data (1.9%). The empirical evidence for the movement and migration of green sea turtles is limited geographically, mainly to particular nesting and foraging sites. Interestingly, usage of information derived from low-cost technology such as flipper tag and photo ID in informing movement patterns and habitat use at the global/regional level is less

apparent than satellite telemetry. This study also reveals that, while evidence of animal movement is consistently collected to various degrees across countries, substantial information fails to be made accessible in a manner that allows for regional synthesis. To bridge these knowledge gaps effectively, collaborative efforts at a regional level are essential. This involves standardising and contributing data to online repositories, reducing barriers to accessing governmental information, and enhancing organisational capacity for the online indexing of documents containing data and knowledge. These actions will enable us to synthesise a more comprehensive body of evidence, guiding the effective implementation of sea turtle conservation and management strategies.

A COMPREHENSIVE REVIEW OF SEA TURTLE NESTING ROOKERIES ALONG BANGLADESH COAST

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The Bangladesh coast spans from St. Martin Island in the southeast to the Sundarbans mangrove coast in the southwest, covering a coastline of 710 kilometers. Our study focuses on the sandy beaches, approximately 400 kilometers in length, for sea turtle conservation efforts. The sea turtle program targets three main regions: A) Southeast coast (including St. Martin Island, Teknaf Peninsula, Sonadia Island, Kaladia-Laldia-Dhalghata-Matarbari beach, Kutubdia, and Bashkhali-Gohira-Parki), B) Southcentral coast (encompassing Kuakata, Char Kukri Mukri, Sonar Char, Tuphania, and Shib Char), and C) Sundarbans mangrove coast (comprising Dublar char, Katka, Mandarbaria, Egg Island, and Hiron Point). These areas fall under nine districts and nine Forest Divisions. The southeast coast faces threats from indiscriminate development and alteration of sand dunes and beach habitats. Additionally, the government's establishment of Coal-Based Power Plants at Matarbari, several LNG (Liquified Natural Gas) offshore terminal west of Haserchar and Sonadia island immensely impacted the nesting habitat at Haserchar (Gholghata), Kaladia, Laldia and Sonadia during the recent years (2018-2023). The Rampal coal based powerplant in the Sundarbans area further jeopardizes the coastal environment with more marine traffic and pollution. The Bangladesh coast serves as a critical nesting ground for various sea turtle species, including the Olive Ridley, Green, and Hawksbill turtles. Despite their ecological significance, sea turtles encounter numerous threats, including coastal development, habitat degradation, light pollution, incidental capture in fishing gear, egg poaching, and climate change impacts. Efforts to conserve sea turtles include the establishment of protected areas, community-based restoration programs, habitat restoration projects, and research initiatives. Collaborative programs, such as the Community-Based Sea Turtle Restoration Program led by the Marinelife Alliance, engage local communities in conservation efforts through awareness campaigns, nest monitoring, and sustainable fishing practices. Research projects utilizing satellite tracking devices have provided insights into sea turtle migration patterns and nesting behaviors. However, challenges persist, necessitating continued collaboration among government agencies, NGOs, and local communities. Addressing climate change impacts and developing adaptive conservation strategies are essential for the long-term survival of sea turtle nesting rookeries. Despite challenges, there is hope for the preservation of

sea turtle habitats through collaborative conservation efforts and community engagement. The review underscores the ecological importance of sea turtle nesting sites along the Bangladesh coast and the need for sustained conservation efforts to ensure their survival and contribute to global marine biodiversity conservation. Nesting occurrences vary across the coast, with green turtle nesting predominantly observed on St. Martin Island, while olive ridley nesting extends from St. Martin Island to the Sundarbans coast. The Sundarbans and some coastal islands along the south-central coast experience changes due to mainland siltation and climate change, impacting nesting occurrences. Approximately 800-900 nests are recorded annually in the current sea turtle program, with the possibility of nesting occurring on new sand bars formed seasonally along the south-central coast during winter months.

CARBON FINANCING CONTRIBUTING TO SEA TURTLE CONSERVATION IN SRI LANKA*

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Sri Lanka provides nesting beaches for five species of sea turtles including green turtles, olive ridley, hawksbill, loggerhead, and leatherback turtles. In Sri Lanka, hatchery owners buy eggs from egg collectors and rebury them in a protected area. There, the eggs are incubated until turtle hatchlings emerge. These hatcheries have become a popular tourist attraction for many local and international visitors. While this ex-situ conservation method has gained popularity along the southwestern coastline of Sri Lanka, there is also a community based in-situ turtle nest protection programme that is underway in the Rekawa beach in the Southern province. Despite the ecological benefits from this initiative, funding for these community-based turtle conservation projects remains a challenge. Recruiting local community members as turtle nest protectors, maintaining research centers, equipment, vehicles, and other administration costs require consistent funding. This situation has been further exacerbated by the drop in tourism following the COVID-19 pandemic and the resultant financial crisis, harming the sustainability of many sea turtle projects in the country and around the world. Carbon financing is an innovative funding tool that places a financial value on carbon emissions and allows companies wishing to offset their own emissions to buy carbon credits earned from sustainable projects. Potential projects that can lead to emission trading can be projects that involve CO2 emission avoidance and those with emission sinks. As far as GHG emissions are concerned, the carbon sequestration potential in the forestry sector can be enhanced by encouraging plantations such as Mangroves in the coastal landscape. Considering these factors, the Sri Lanka Turtle Conservation Project (TCP) initiated a new Climate Resilient and Community-Driven Mangrove Afforestation Project in Sri Lanka in collaboration with the Ministry of Coast Conservation in 2021. This project aims to establish 3000 hectares of Mangroves around Sri Lanka with an initial budget of US $ 4.3 million. The project, expected to last 20 years, will receive more funding after the selling of carbon credits to a suitable buyer in the future. The TCP was able to allocate part of the funding it received through mangrove afforestation for sea turtle conservation activities in Sri Lanka. It has identified crucial nesting beaches for sea turtles and is currently sponsoring conservation activities at these locations. The TCP is responsible for paying the salaries of the community turtle nest protectors working at Rekawa Turtle Sanctuary while also maintaining its educational information centers at Rekawa and Panadura beaches. Furthermore, TCP conducts many educational programmes and exhibitions at schools and coastal locations. Educational materials such as posters, leaflets, brochures, and magazines have been designed and printed for distribution among locals. All these conservation activities are being carried out through the funding received via carbon financing. Considering the limitations and challenges faced due to the lack of adequate funding, the TCP has identified how carbon financing projects can be used to implement turtle conservation activities. This paper discusses the potential for utilizing carbon financing as a partnership opportunity for turtle conservation projects in Sri Lanka and other developing countries.

A ROAD MAP FOR THE MARINE TURTLE CONSERVATION ACT*

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The Marine Turtle Conservation Act (MTCA) has been contributing to the protection and recovery of sea turtle populations and conservation of nesting habitat for two decades. This is based directly on the 2004 authorizing legislation and includes financial and technical support for projects throughout the world to conserve marine turtle populations and nesting beaches, as well as address key threats to their survival. Marine turtle biology and threat complexity require a long-term endeavour for the protection and recovery of these species. As we evaluate our strategy to carry out the purpose of the MTCA and our requirement for “each program be designed with clear goals, objectives, and measures” (2 CFR 200.301), we set up a roadmap to depict the relationship between the MTCA and its intended impacts. The roadmap connects the resources provided and the activities conducted to the desired outcomes, aligning with the MTCA. The activities of the MTCA can achieve important outcomes by reducing critical anthropogenic threats such as bycatch, coastal development, poaching, and trafficking, and measure our success in the short-term. Transdisciplinary teams who work together to problem solve on threats can support techniques that will address marine turtle threats using a “whole-system thinking” approach to better understand the drivers of exploitation, alternate livelihoods, and community engagement. Setting up measurable indicators of progress in the short term will allow us to adapt our approach over time and incorporate effective methods to progress a sustainable conservation approach. Growing conservation efforts of enduring value around the world requires more than addressing threats in the short-term, but rather engaging individuals from a range of backgrounds, experience, and expertise to be resilient, conservation leaders within their community. Over the last ten-years, an increasing number of community-led conservation efforts have proven successful in protecting and managing biodiversity throughout the world. Community-led conservation incorporates community socioeconomic knowledge and conservation to promote stewardship. The goal of the community-led approach is to increase conservation efforts while providing for the well-being of those communities. Drawing on cultural knowledge and expertise to address the anthropogenic threats faced by those species has also been found to promote sustained conservation efforts and foster conservation stewardship. As we work toward a framework to guide our MTCA program implementation into the future, we seek to incorporate these effective methods toward a sustainable conservation approach. Promoting engagement with local communities and other relevant stakeholders and measuring our progress along the way will further long-term success and durability of conservation investments.

COCOMESH AS A NEST SHADING MATERIAL TO LOWER SAND SURFACE TEMPERATURES AT JEEN YESSA BEACH AT THE BIRD'S HEAD REGION OF PAPUA, INDONESIA*

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Jeen Yessa and Jeen Syuab beaches in Papua, Indonesia, have the highest leatherback nesting activity in the Pacific and form the Jeen Womom Coastal Park Marine Protected Area, designated in 2017. Previous research has identified that marine turtle nests at Wembrak Beach (6.4 km), one of three Jeen Yessa's beaches, are threatened by high sand temperatures. Shading nests *in situ* using palm leaves (*Cycas sp.*) successfully reduces sand temperatures at nest depth and increases hatching success, but the availability of palm leaves is limited. We investigated the potential of cocomesh, woven coconut rope, as an alternative shading material that is also abundant locally, sustainable, and biodegradable at Wembrak Beach during the April-September 2023 nesting season. We compared two different cocomesh heights (60 and 120 cm) and two mesh size weaves (1 and 1.5 cm) with a control (no cocomesh) and placed the five treatments (120x1 cm, 120x1.5 cm, 60x1 cm, 60x1.5 cm, and control) at 5 locations 1 km apart within the westernmost 5 km of Wembrak Beach. We measured sand surface temperature within the different treatments at 06:00, 14:00, and 20:00 between mid-July and mid-September. Average sand temperatures without shading at 06:00 is 25.90 °C (range = 23.6 - 35.7°C), at 14:00 is 35.18°C (range = 25.2 - 42.50°C), and at 20:00 is 26.92°C (range = 22.9 - 29.20°C). At 06:00 and 20:00, sand surface temperatures under all cocomesh treatments do not differ from the control. At 14:00, a cocomesh with 120 cm in height and 1 cm in mesh size lowers the sand surface temperatures significantly more than other treatments, by 0.81°C on average. In conclusion, cocomesh, which is 120 cm in height and 1 cm in mesh size, is best at lowering sand surface temperatures. We will examine the effect of this size of cocomesh on the hatching success of leatherback nests in the April and September 2024 nesting season and compare the hatching success to other shading treatments and control (no shading).

PEOPLE'S PERCEPTIONS ON THE CONSERVATION OF SEA TURTLES AND THEIR ASSOCIATED HABITATS ALONG THE PONTA DO OURO-KOSI BAY TRANSFRONTIER CONSERVATION AREA, MOZAMBIQUE AND SOUTH AFRICA, SOUTH-EASTERN AFRICA

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The Ponta do Ouro – Kosi Bay Transfrontier Conservation Area (TFCA) encompasses the Maputo National Park (MNAP) in Mozambique and the iSimangaliso Wetland Park World Heritage Site in South Africa. This area serves as an important courtship and nesting ground for loggerhead and leatherback sea turtle populations in the South Western Indian Ocean. Despite its biodiversity richness, local communities face persistent social and economic challenges. Thus, this study aims to document the value of sea turtles, their conservation impacts on people, and their wider influence on the surrounding social and economic system. Filmed interviews and participatory mapping were utilized to gather and interpret knowledge. Using the 'snowball' sampling method, interviews were conducted in English (n=35), Portuguese (n=35), Rhonga (n=23), and Zulu (n=16). These interviews were transcribed and analyzed using Nvivo software, employing the reflective thematic analysis and grounded theory approaches. Mapping interviews on occurrence areas (n=86), value (n=52), and threats (n=69) were assessed using QGIS 3.12.0 Bucaresti software. The findings revealed concerns about declining agricultural and fisheries yields, unemployment, and limited access to healthcare, education, and transportation. However, the people recognize the value of sea turtles, particularly their economic significance (55%). Individuals residing near nesting and courtship sites benefit the most, either through employment (as monitors, tourism guides, etc.) or by enhancing their businesses (ocean safaris, hospitality, and informal markets). In iSimangaliso, employment opportunities linked to sea turtles serve as the primary income source due to restricted access to natural resources and limited business prospects. Despite evolving values over time, sea turtles in iSimangaliso and the MNAP continue to be valued for their meat (approximately 49%) and eggs (about 19%). Notably, in iSimangaliso, sea turtle eggs are also prized for medicinal purposes (22.2%). Concerning threats, there is a shared understanding of reduced risks to sea turtles (52.3%), predominantly focused on onshore threats. In iSimangaliso, threats primarily involve poaching of nesting females and nest raiding (51.1%), alongside fishing and pollution (22.2%). In the MNAP, threats revolve around fishing (25%), natural predators (23.4%), and coastal development (21.8%). Notably, potential coastal developments like housing and access roads, and the deep-water 'ghost' port, were not extensively addressed, possibly due to a lack of awareness regarding their impact on sea turtles and their habitats. The study participants emphasized ongoing efforts to generate knowledge (33.3%) and improve enforcement (44.0%) by enhancing communication between authorities and communities. The main occurrence areas highlighted by respondents include the nesting beaches of Bhanga Nek and Ponta Malongane and the potential feeding grounds in Mangal, a seagrass bed within the MNAP. Identified threat areas encompass Maputo Bay, Ponta do Ouro, and the Kosi Mouth area, attributed to artisanal fishing, coastal development, and poaching, respectively. In conclusion, while facing numerous social and economic challenges, people value sea turtles and their habitats due to the diverse direct and indirect benefits derived from their presence. This comprehensive understanding is essential for implementing sustainable conservation strategies that prioritize both the needs of the people and the conservation of these migratory species, the sea turtles.

CLEANING UP BEACHES, PROTECTING NESTING GROUNDS, BUILDING ARTIFICIAL REEFS, PROMOTING LOCAL ECONOMIES: RE-THINKING OUR STRATEGIES TO REDUCE BYCATCH OF CRITICALLY ENDANGERED SPECIES*

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Bycatch is considered the most important threat to the survival of marine turtles. Most solutions to reducing bycatch focus on the effects of modified fishing gears on target species catch and marine turtle bycatch. However, for a population like the critically endangered East Pacific leatherback turtle, finding statistically significant solutions is practically impossible due to their low abundance and resulting low bycatch rate. One way to obtain data on modified fishing gears is to run trials where populations are abundant and then export the modifications that prove to be working to other areas with lower abundance levels but highly threatened species. However, fishing gears and techniques are so unique in each community that those solutions might not work. For the past two years, we have been working with fishing communities to identify strategies that could work at individual community levels. Our methodology was based on 5 steps: 1) identify bycatch hotspots through surveys, 2) get an in-depth understanding of the bycatch in these areas, 3) work with members of fishing communities to design a strategy to reduce bycatch, 4) test the strategy in the field, and 5) assess if it was successful and eventually modify certain steps. This approach has led us to design a variety of strategies, some of which we are testing in the field and are providing positive results. As an example, in Barra de Tecoanapa, Guerrero, residents came up with the idea of creating a group of volunteers to protect an important sea turtle nesting ground. Through this initiative, not only have they protected nesting female leatherbacks from being killed for their eggs and meat, they are also contributing to increasing awareness to the point that now some of the fishermen are reporting incidental catches of marine turtles and filming their release from nets. In a nearby community, Punta Maldonado, removing abandoned nets from the beach has increased awareness such that volunteers are now willing to monitor endangered hawksbill turtles in their bay and find other solutions to reduce bycatch. In San Ignacio, Baja California Sur, projects aimed at diversifying the sources of income of local families have allowed to release some pressure from the fishery and have effectively reduced the fishing effort in that area. In Southern Sinaloa, monitoring understudied beaches has provided important info on mortality events and raised a lot of interest in fishery learning exchanges to discuss solutions among peers (fisherman to fisherman). Other strategies include setting up artificial reefs to create productive grounds where people are willing to fish with hook and line only, and restoring mangroves, to protect the land from extreme weather events and to protect important nursery grounds for commercially important species. Bycatch in artisanal fisheries is difficult to address, a one-size-fits-all solution is not realistic due to the incredibly high degree of diversity in fisheries and communities. Creating opportunities for fishing communities to work out their own, custom-made solutions is a just, equitable approach that shows promise in reducing marine turtle bycatch.

UNDER THREAT: PREVIOUSLY UNDOCUMENTED HAWKSBILL (ERETMOCHELYS IMBRICATA) NESTING ON THE WEST END OF ST. CROIX, U.S.V.I.*

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Although hawksbill sea turtles (*Eretmochelys imbricata*) nest in almost every country in the Caribbean, nesting density remains low. Areas with high hawksbill nesting densities have been designated as index beaches, but many nesting beaches have yet to be evaluated adequately. It is essential to identify additional hawksbill index nesting beaches to recommend protective measures across the species' entire range. In the U.S. Virgin Islands, the majority of sea turtle nesting occurs on St. Croix, where hawksbill nesting has been reported on most beaches. The purpose of this study was to evaluate the west end beaches of St. Croix to quantify previously undocumented hawksbill nesting and evaluate artificial light levels detectable from the beach. We recorded sea turtle activity during morning beach patrols from 2021 - 2023. In 2023, drone photography was used to create a comprehensive image of the coastline and vegetation, and lighting surveys measured skyglow and lux to identify the brightest sections of the beach. Since 2021, volunteers have located and documented 620 hawksbill nests along 5 km of beach that is not designated as critical habitat. This nest density is comparable to known high-density, federally protected nesting beaches on St. Croix such as Sandy Point National Wildlife Refuge and Buck Island Reef National Monument. We found the highest hawksbill nest density was on west end beaches with low artificial light levels and an adjacent thick coastal forest. We used drone images to map the vegetation and identified openings in vegetation cover. Artificial light hotspots match these gaps in vegetation and are areas that have the most hatchling disorientation events. Specific management strategies such as planting additional native vegetation and minimizing beachfront lighting is needed to protect nests in this area. Our goal was to identify anthropogenic threats for nesting hawksbills and to provide this information to stakeholders and territorial management agencies. The results of our study support actions to mitigate the impacts of artificial lighting on nesting beaches on St. Croix and to establish all of St. Croix's west end beaches as critical nesting habitat to protect and restore hawksbill populations in the U.S. Virgin Islands.

MINIMUM COST ESTIMATE TO PROTECT 80% — 100% OF WESTERN PACIFIC LEATHERBACK NESTS AT THE JEEN WOMOM COASTAL PARK IN THE BIRD'S HEAD REGION OF PAPUA, INDONESIA*

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One of the strategies to help the recovery of marine turtle population is to maximize hatchling production. At the Jeen Womom Coastal Park in the Bird's Head region of Indonesia, this is achieved by protecting as many nests as possible against various threats. The Jeen Womom Coastal Park annually hosts the greatest leatherback nesting activity in the Pacific, at Jeen Yessa (18 km) and Jeen Syuab (6 km) beaches, that has declined significantly since the 1980s. Threats to marine turtle nests at these beaches include predation by pigs, dogs, and monitor lizards, high sand temperatures, tidal inundation, erosion, and invasion of *Ipomoea sp.* roots. The Abun Leatherback Project (ALP) has identified effective methods to increase the hatching success of leatherback nests and applies them to as many nests as possible. With 41-55 team members on the ground, the ALP protected 40-65% of leatherback nests in 2021, 2022, and 2023. With an overall hatching success of less than 50%, it is crucial to protect a greater proportion of leatherback nests, and this can be achieved by adding more resources at the nesting beaches. This paper provides a cost estimate for annually protecting 80% — 100% of the leatherback nests laid. We used nest count data between 2018 and 2023 to calculate the number of nests that need to be protected to reach 80% and 100%. Using a linear equation resulting from the relationship between the number of people working at the beach and the number of nests protected between 2021 and 2023, we calculated the additional number of people required to protect 80% and 100% of nests. Then we calculated the cost of protecting a single leatherback nest using expenses recorded in 2023, such as wages of field technicians and local patrollers, food, transportation of food and logistics, fuel for post generators and field boats, communications, and salaries of supporting staff at the project home base. To reach 80%, the ALP team has to protect 1894 leatherback nests on average per year (range = 1202 — 2232 nests/year). To reach 100%, the ALP team has to protect on average 2367 leatherback nests per year (range = 1503 — 2793). The cost of protecting one leatherback nest is 1,558,404 IDR or 100.54 USD. Therefore, the cost of protecting 80% and 100% of the nests at the Jeen Womom Coastal Park is approximately 190,387 USD/year and 237,983 USD/year, respectively. To increase the percentage of protected nests from 50% to 80% or 100% in an average year, the ALP needs an additional 37 to 62 people working at the beach and 71,383 USD to 118,939 USD, respectively, in funding annually. This is the minimum required without including the cost of community empowerment, outreach, and partnership programs in the project. Given that Jeen Womom hosts the last, largest remaining leatherback nesting population in the entire Pacific, protection at the nesting beaches is a global priority.

PROTECTING INDONESIA'S LARGEST GREEN SEA TURTLE NESTING ROOKERY: A TWO-DECADE RETROSPECTIVE AND KEY INSIGHTS

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The Berau or Derawan archipelago off the east coast of Borneo (East Kalimantan, Indonesia) is considered the largest nesting site for green turtles (*Chelonia mydas*) in Indonesia and the eighth largest globally. It is part of the Coral Triangle and encompasses 31 mangrove and coral islands, with about 90% of nesting concentrated on the five uninhabited coral islands Sangalaki, Bilang-Bilangan, Mataha, Belambangan, and Sambit. However, decades of unbridled commercial egg harvesting, combined with demand from the Balinese turtle meat market and the spread of destructive fishing practices, is thought to have caused the green turtle population in Berau to decline by more than 90% since the 1950s. In 2000, Turtle Foundation (TF) and local partners launched conservation efforts on Sangalaki Island. Despite national protection of sea turtles since 1999, licensed egg harvesting persisted until late 2001. It wasn't until January 2002 that egg harvesting was prohibited on Sangalaki, allowing TF to secure the nesting beach year-round with dedicated rangers stationed in a newly erected facility. In 2008, TF was allowed to replicate the successful Sangalaki protection model on Bilang-Bilangan and Mataha, ensuring the protection of approximately 75% of the green turtle nests in Berau. Since then, the remaining two important nesting islands Belambangan and Sambit were focused as the next targets for protection. In the meantime, however, different perspectives between local stakeholders have resulted in transferring responsibilities for Sangalaki to the nature conservation authority BKSDA (since 2012), and for Bilang-Bilangan and Mataha to a local NGO (since 2017). With three nesting islands now protected from what used to be almost 100% egg exploitation, we were particularly pleased for the opportunity to establish a protection programme for Belambangan and Sambit in 2019. However, the situation changed again when we had to transfer this programme to another local NGO by end of 2021 but returned to Bilang-Bilangan and Mataha in the beginning of 2023. Since its inception, TF has benefited the local community by providing income to local people through turtle conservation work. Activities were later expanded to include environmental education, most notably extended school visits throughout the Berau district. Currently, the centre of our community activities is on the inhabited island of Maratua, where a dedicated community coordinator leads various alternative income, outreach, and education activities. While accurate calculations remain difficult due to data fragmentation across organisations, the current average number of nests laid by green turtles in Berau is estimated to be around 15,000 per year. Collective conservation initiatives have likely saved over 15 million green sea turtle eggs over the past two decades, almost completely protecting a once severely threatened turtle nesting population. Throughout this long and challenging journey, one of the most important lessons learned is recognising the significance of working with local communities to achieve sustainable nature conservation. During this process, the Indonesian TF "Yayasan Penyu Indonesia" has emerged as a national charitable organisation that now stands as a renowned entity in the field of sea turtle conservation in Indonesia.

A FIRST GLOBAL NETWORK MODEL TO DESCRIBE KNOWN GREEN SEA TURTLE MIGRATORY CONNECTIVITY*

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The conservation and protection of marine megafauna requires robust knowledge of the location and movement of animals throughout different life stages. Migratory species depend upon critical habitats for breeding and foraging, as well as pathways connecting these habitats. The technological advances in remote monitoring devices have greatly improved our capabilities to assess animal movement and study the migratory connectivity of marine mega-vertebrates. Satellite telemetry in particular, has contribute to monitoring migratory animals remotely, allowing us to collect information on habitat use, movement, and connectivity. The green turtle (*Chelonia mydas*) is one of the most studied species in terms of movement ecology. Nonetheless, an understanding of connectivity between breeding and non-breeding areas for most populations still eludes researchers. Despite numerous studies assessing movement behaviour of green turtles, we have not yet found an adequate way to aggregate this information into functional networks that contribute regionally or globally to the species' conservation. Here, we present a global migratory connectivity network for green turtles; based on available tracking literature, we identify important habitats for this species, and the linkages among them. We examined peer reviewed articles, book chapters, scientific reports, and conference procedures, published between 1990 and 2022. We compiled eligible references and extracted information on 1) ocean basin for each study, 2) sampling techniques used, 3) sex class and life stage of turtles monitored, and 4) geographic coordinates for deployment and destination sites for each turtle. To define a connectivity network, we identified sites used by green turtles as well as movement among different sites. Sites were defined as 1° georeferenced areas and routes were defined as connections among sites. Where sites overlapped and described a common area, they were aggregated into "meta-sites". We compiled information from 113 studies, conducted across different regions: 42.5% in the Atlantic, 17.7% in the Indian, and 39.8% in the Pacific basin. We found four tracking techniques reported (Mark-Recapture, Satellite Telemetry, Acoustic Telemetry, and diving loggers), all addressing different questions: 37.2% investigated post-nesting migrations, 27.4% swimming behaviour, 17.6% habitat use, 12.4% foraging range, 3.6% were technical trials, and 1.8% assessed interaction with fisheries. Breeding females were the most studied animals, present in 68.6% of sources, followed by indetermined juvenile (24.2%), and males (7.7%). We based the global connectivity network on 525 sites where green turtles were studied in different stages during their life cycle. Those sites were determined to be nodes of connectivity for different populations. From these, we aggregated 195 "meta-sites" encompassing the occurrence of green turtles tracked from two or more sites. Finally, we discuss the implications of the immense regional and global connectivity described by this novel network model for conservation across scales.

RE-MIGRATING TO LOCAL SHORES: REINTEGRATING COMMUNITY PARTICIPATION IN PROTECTING THE MOST SIGNIFICANT NESTING SITE IN MALDIVES, L. GAADHOO*

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Sea turtle conservation in the Maldives archipelago is largely overseen by the central government, with national level legal protections implemented since the late 90s. Due to the geographically dispersed nature of ~1200 islands, of which only 188 are residential, community-based enforcement and the implementation of legislation remains difficult at island level, especially with a top-down approach where the central government develops conservation guidelines for the whole country. This disconnect between the local and central government often makes changing of behaviors and mindsets to support conservation a challenge. This was exacerbated when the central government imposed a ban on harvesting sea turtles and eggs, which had been a traditional source of food. The active participation of the community in conservation is recognized as pivotal for effective change at island-level to protect sea turtles in the country. In this regard the Environmental Protection Agency of Maldives (EPA) together with conservation charity Olive Ridley Project (ORP) piloted a project that re-integrates traditional conservation practices in managing the most significant green turtle nesting site in the country, Gaadhoo island located in Laamu Atoll. The island's 500m strip of southwestern beach, known locally as 'velaa heylhi', is estimated to have recorded as much as 1,400 nests annually in the 1900s according to residents, who are known to be the only community to have monitored and managed a nesting beach prior to national level protections, implementing selective egg harvesting practices. Gaadhoo community relied on indigenous knowledge of sea turtle reproduction and nesting beach maintenance, and had actively defended the nesting beach against hunters. However, they were disempowered from continuing the practice in 2006, with the sudden ban on sea turtle egg harvesting enforced by the central government, which restricted access to the beach altogether. Without a tangible system in place for the government to enforce the ban, the island became a hotspot for illegal sea turtle hunting and egg take, which was further escalated when the residents were relocated in 2016. Anecdotal data suggests nesting had declined significantly after 2016, and ad hoc data collected between 2018-2022 indicated a high amount of illegal egg take. To address this issue, a ranger was hired to monitor Gaadhoo's nesting beach in January 2023, with preliminary findings indicating a steep decrease in illegal egg take after the monitoring efforts began. The historical methods for sea turtle conservation and beach maintenance by Gaadhoo community were also documented, identifying gaps in the existing management framework that can be improved with feedback from the community. The project also identified stakeholders such as the police, local NGOs- some led by former Gaadhoo residents - that have shown willingness to take ownership of the program. Efforts are underway to build capacity through shared learning in nesting beach management and move towards community-based monitoring. In the meantime, 161 nesting activity (91 true nests) have been recorded in 10 months of data collection, with only 2 poaching incidents recorded - suggesting hopeful signs for the protection and management of Gaadhoo's sea turtle nesting beach.

EVALUATING THE SUSTAINABILITY OF COMMON APPROACHES TO SEA TURTLE CONSERVATION

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In 2020, the global Society for Conservation Biology recognized the need for more community centered conservation wherein the economic and sociocultural aspects of conservation are equally evaluated and considered as the ecological (Armitage et al., 2020). In doing so they've developed a sustainability framework with a goal of converting current conservation practices to more sustainable ones by 2030 (Armitage et al., 2020). This poster will summarize the scope of a PhD project that aims to evaluate the ecological, economic, and sociocultural aspects of four common sea turtle conservation approaches: aquaria, marine protected areas, and nesting shores in South Africa; and hatcheries in India. Sea turtles have been selected as a representative taxa for examining this sustainability framework as the species 1) occur globally; 2) have life history stages occurring across three habitat types (terrestrial, neritic, and oceanic); and 3) are conservation dependent, with six of seven species listed as vulnerable to critically endangered on the IUCN Red List of Endangered Species, with the seventh species, flatback sea turtles, categorized as 'Data Deficient'. Sea turtle conservation practices in South Africa and India have been chosen as both countries exhibit globally recognized practices. In South Africa, sea turtles have been protected since 1963 and the Ezemvelo Wildlife turtle monitoring program is further celebrated as being amongst the oldest and longest running turtle monitoring programs in the world. Furthermore, most of the South African coastline participates in a national turtle stranding network which includes four sea turtle rehabilitation centers (South African Association of Marine Biological Research; Two Oceans Aquarium Foundation). In India, sea turtle hatcheries are prevalent with the relocation of sea turtle nests to hatcheries being a common practice. There are guided sea turtle walks and sea turtle festivals associated with hatcheries in different parts of the country. To evaluate the ecological and economic aspects of these four common sea turtle conservation efforts, relative reproductive values will be used to quantify the number of sea turtles each conservation approach is protecting, while a cost-effectiveness analysis will be used to determine the cost, benefits, and feasibility of each conservation approach. These two data sets will be complimented by sociocultural surveys to understand how various demographics directly and indirectly benefitting from the four sea turtle conservation approaches value sea turtles and their conservation approaches. Surveys will be conducted as i) semi-structured interviewers with direct benefiters (e.g., local community members and personnel) and ii) questionnaires with indirect benefiters (e.g., visitors). The responses from both survey methods will undergo content analysis using a phenomenological research paradigm. The results of these three analyses will be compared to best understand the ecological, economic, and sociocultural benefits and challenges of each conservation approach. Understanding the trade-offs of these four conservation approaches will allow sea turtle conservationists to better curate and implement conservation approaches depending on an area's biodiversity and human needs.

GLOBAL TRENDS IN SEA TURTLE RESEARCH AND CONSERVATION: USING SYMPOSIUM ABSTRACTS TO ASSESS PAST BIASES AND FUTURE OPPORTUNITIES*

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We quantified research trends in the field of sea turtle science by collating data from 30 years of abstracts presented annually at the International Sea Turtle Symposium – the largest scientific symposia focusing exclusively on sea turtles. From the analysis of 7370 abstracts, we revealed five key findings: (1) loggerhead and green turtles were studied more than any other species; (2) the most studied Regional Management Units (RMUs) were typically those in the North Atlantic Ocean while the least studies were in the Indian Ocean; (3) almost half of all sea turtle studies were conducted on nesting beaches, leaving juveniles and adult males extensively understudied; (4) the most studied threat to sea turtles was fisheries bycatch although the proportion of studies on climate change increased rapidly after 2006; and (5) mark-recapture was the most utilized method for studying sea turtles but its use has dropped proportionately alongside an increased use of more modern tools such as satellite telemetry, stable isotope analysis, and genetics. We conclude that long-standing biases exist in sea turtle science and this has led to many regions, habitats, and life-stages being chronically understudied. While trends suggest that these biases are slowly being addressed, efforts are still required to ensure that future studies effectively address the greatest conservation needs or fill the largest knowledge gaps on a truly global-scale.

PROTECTING SEA TURTLES THROUGH THE BERN CONVENTION

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Policymakers at local, national, and international levels are of vital importance. Biodiversity policies promote the protection, conservation, and sustainability of biologically diverse ecosystems and habitats and decide the implementation of protection measures. Established in 1979, the Bern Convention was the first international treaty dedicated to the conservation of European wildlife and habitats. The Convention's goal is to unite European countries towards the protection of endangered and vulnerable species of flora and fauna. Through the implementation of monitoring and reporting actions by its partners, the Bern Convention promotes conservation policies, pollution, legislative, and educational measures, and

coordinates international efforts. The Convention organizes annual meetings (Standing Committee) where experts present reports and recommendations, and submit complaints regarding unlawful practices in hotspot areas (case files). Since 1984, MEDASSET has been pushing/lobbying/advocating for the creation and implementation of legislation at national, EU, and regional levels. MEDASSET, in collaboration with other NGOs, monitors the implementation of the Convention's recommendations in two major sea turtle nesting areas in Greece (Zakynthos and Kyparissia) and three in Turkey (Anamur, Kazanli, and Fethiye-Patara). Laganas Bay (Zakynthos island) is one of the most important nesting sites in the Mediterranean region, reporting more than 1,800 nests in 2023. However, the island experiences uncontrolled anthropogenic pressure (touristic activities, coastal development, etc.). Kyparissia Bay constitutes the most important nesting location for *Caretta caretta* in the Mediterranean Sea, with more than 6,000 nests recorded in 2023. However, Kyparissia is subjected to many violations of the Convention's recommendations and the Greek legislation (uncontrolled tourism, construction, and agricultural activities). Fethiye and Patara Bays in Turkey have been monitored as they form important nesting habitats for *Caretta caretta* and *Chelonia mydas*. The region is affected by the lack of management and protection, and the rapid construction and touristic development of the area. Anamur Bay is the 4th most important nesting site in the Mediterranean Sea, reporting more than 1,000 nests of *Caretta caretta* annually, and an important habitat for *Chelonia mydas* and *Trionyx triunguis*. Anamur is negatively impacted by the lack of law enforcement, illegal sand extraction, and coastal development. The aforementioned sites are currently open case files at the Standing Committee of the Bern Convention due to continuous monitoring by MEDASSET officers. Moreover, Kazanli Bay, a significant nesting site for *Chelonia mydas*, has been subjected to the release of toxic waste from a Soda Chrome Factory since 2000. In 2023, the situation remains unchanged with widespread chemical pollution and lack of monitoring and conservation actions. For more than 40 years, MEDASSET has been advocating for the protection of sea turtles and their habitats across the Mediterranean. In the future, MEDASSET is dedicated to continuing its efforts to monitor the Government’s actions and follow up with the Convention’s Recommendations to ensure adequate protection for the species.

EDUCATION, OUTREACH AND ADVOCACY

CITIZEN SCIENTIST COME OUT OF THEIR SHELLS*

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The US SAS Data for Good program and the USFQ-UNC Galapagos Science Center (GSC) have partnered to bring the power of data science and analytics to several research programs in the Galapagos. One of them is the sea turtle research program carried out by the GSC since 2011 (Programa Tortuga Negra). This pilot photo-ID initiative is based on each sea turtle being “naturally identified” with a unique scale pattern on its face. The project asks online volunteers to experience a "matching game" with images of Galapagos sea turtles. The goal is to use these thousands of images to mass train a SAS® computer vision model to accurately recognize individual turtles on its own. That artificial intelligence (AI) model can then be used on more turtle photographs from any location and source (e.g. social media), to get even more useful information into the hands of researchers. The current phase of this app is for people to get involve, participate in citizen scientist initiatives, learn and identify and match individual turtles. This creates a dataset of matching images and trains the model how to identify an unknown turtle. If we can successfully train the model to identify individual turtles (based on the unique patterns on their head), the next phase is to feed additional images of unknown turtles into the model and identify the turtles “automatically.” Sea turtles are migratory species, positive identification of an individual turtle would allow researchers to collect information, population, migratory movements, and health in a non-invasive and rapid manner, causing less stress to the turtles and providing essential management data almost in any way. real time.

BENEFITS OF HOUSE OF LEARNING, AN AFTER-SCHOOL PROGRAM AS PART OF A MARINE TURTLE CONSERVATION EFFORT, TO LOCAL STUDENTS

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Providing incentives to the local community is a tool to promote actions compatible with conserving natural resources. In addition to economic incentives, the Abun Leatherback Project of the Research and Community Service Institute of the State University of Papua (LPPM UNIPA) provides educational benefits to local communities living near important leatherback nesting beaches at the Bird's Head region of West Papua, Indonesia that support marine turtle conservation. Jeen Yessa (formerly Jamursba Medi) and Jeen Syuab (formerly Wermon) beaches, located in the Bird's Head region of Papua, Indonesia, have the largest leatherback turtle (*Dermochelys coriacea*) nesting activity in the western Pacific. Local communities legally owned Jeen Yessa and Jeen Syuab. Low Human Development Index (54,63 in 2022) characterized these communities. To improve local students' abilities and increase environmental awareness, the Abun Leatherback Project created the House of Learning. It is an after-school program where local students can improve their abilities and is a part of the project's Community Empowerment program. Four Houses of Learning are currently spread over five villages (Resye, Womom, Syukwo, Wau, and Weyaf) near Jeen Yessa and Jeen Syuab. In UNIPA's House of Learning, local students improve their reading, writing, basic arithmetic, basic English, basic computer skills and learn about marine turtles and their environment in environmental education. In addition, the students also learn to love reading through the mobile library and, medicinal plants around them, and habits for healthy living. Community workers placed in the villages for ten months out of a year facilitate the learning and conduct different activities. They also track each student's progress through the various learning indicators by conducting monthly assessments. We examined the educational benefits of the Houses of Learning using 2022 assessment data. The pretest was completed in April, and the last posttest in December. After eight months of learning, reading skills improved in 58 of 121 students (48% of total number of students assessed), writing in 49 of 119 students (41%), basic arithmetic in 64 of 113 students (57%), basic English in 29 of 108 students (27%), and basic computer in 54 of 105 students (51%). For environmental education, 71 of 123 students showed improvement. We also found that 50 students (44%) participated actively in the mobile library, learning about medicinal plants and habits for healthy living activities. In the end-of-year program evaluation, 100% of local community members (n=76 households) felt that the House of Learning benefitted the community, and the community workers implemented the activities satisfactorily. The House of Learning has benefitted many families in the villages because most households have elementary-school-aged children, and this, in turn, helped secure leatherback conservation at the Jeen Womom Coastal Park.

THE FIRST WORKSHOP ON VETERINARY MEDICINE FOR SEA TURTLES IN COLOMBIA

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During November 3 and 4, 2023, the "First Workshop on Veterinary Medicine for Sea Turtles in Colombia" took place at the Marine Museum - Aquarium of the University of Bogotá, Jorge Tadeo Lozano, Núcleo Rodadero, Santa Marta, Colombia. This event was organized by veterinarians Gilberto Borges Guzmán from Venezuela and Albert Bassols García from Spain, along with members of the Programa de Conservación de Tortugas y Mamíferos Marinos (PROCTMM), and in collaboration with the University of Bogotá through Jorge Tadeo Lozano, from Colombia. The workshop, featuring the participation of The Turtleman Foundation and Artesanias Tortugas Sin Fronteras, consisted of 12 theoretical hours and a 3-hour practical session. A total of 55 participants from 12 locations in Colombia participated (Barranquilla, Bogotá, Cali, Cartagena, Chía, Medellín, Palomino, Rionegro, Santa Marta, Soacha, Tayrona and Turbo) and one participant from Costa Rica (Ojochal), including biology and veterinary students, as well as professionals from both fields, engaged in the workshop. The topics covered during this inaugural workshop on sea turtle veterinary medicine included anatomy, biology, major diseases, sample collection, diagnoses, stranding responses, headstarting, facility management, necropsies, surgeries, practical sessions with necropsies, facility visits, and drills for stranding response. Such activities play a crucial role in the conservation endeavours for sea turtles in Colombia, as there is currently a limited number of veterinary professionals in the country dedicated to the preservation of these threatened species. It is hoped that these workshops will contribute to the training of more veterinarians and professionals in Colombia, ultimately aiding in the recovery of sea turtles facing health challenges, and in the future, we hope to improve and continue giving these workshops annually to continue training future professionals in Colombia and Latin America.

DIGITAL MARINE GUARDIANS: BRIDGING RESEARCH AND OUTREACH THROUGH 3D SURFACE SCANNING AND MOBILE COMMUNICATION TOOLS*

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Sea turtle conservation is a complex matter that requires transdisciplinary scientific research, regional management, as well as ocean literacy among the public. Despite the impressively rich marine biodiversity of South China Sea, limited exposure of sea turtle exists among citizens of Hong Kong. Physical contact with the protected species in the wild is prohibited by law, and only a handful of rescued individuals deemed unfit for release are kept in aquarium for rehabilitation and exhibition. Unlike in some other countries, there is no field trips or hatchling release activities in Hong Kong that can engage the community in sea turtle awareness and conservation. Since August 2019, virtopsy (virtual necropsy) has been implemented into the sea turtle stranding and salvage programme in Hong Kong. Live stranded or deceased sea turtles routinely underwent diagnostic imaging examinations, including computed tomography and 3D surface scanning. Handheld 3D scanners were used to capture the external features (i.e., shape, size, color) of every sea turtle retrieved. The data acquisition using professional scanners generates calibrated 3D models which are true-to-scale, allowing forensic investigation like matching analysis with suspected injury-inflicting tools. The authentic color information facilitated veterinary assessment on their biological health condition and cause of death. The digital nature of virtopsy data permitted knowledge transfer and retrospective studies after the animals were released or dissected. These digital archives not only served as scientific evidence for the scientific community, but also provided excellent opportunities for public outreach. 3D models can be easily assessed using online viewers, or incorporated into virtual reality medical training system for anatomy education and in the metaverse for public engagement. These digital tools eliminated the need for physical encounter with the animal, which is usually impractical and potentially hazardous considering the risk of zoonotic infection. Sea turtle replicas could be 3D printed using safe and durable materials, allowing people to "get in touch" with the protected species. By bringing real sea turtle cases to the public eye, we aimed to advocate better ocean literacy towards marine conservation. Sea turtle salvage is often hindered by the lack of proactive input from the public. Instead of reporting to relevant agencies, most opportunistic encounters involved photo taking and posting on social media. The late notice to response personnel resulted in delayed recovery, overdue rescue of stranded animals or advanced decomposition of carcasses, which hindered post-mortem investigation. In certain occasions, deceased sea turtles were photo-identified by scute patterns with underwater footages of live animals taken by recreational divers, implying the potential of utilizing these communal records for life history monitoring. To encourage reporting of sea turtle sightings and strandings by the public, a mobile application has been developed to leverage citizen science effort into research and conservation. This not only improved the workflow of stranding response and post-mortem investigation, but also provided valuable baseline population data. With the synergy of enhanced community education and streamlined reporting system via these immersive technologies and digital tools, we hope for better utilization of sea turtle data for their urged conservation.

BUILDING LOCAL CAPACITY FOR NATURAL HERITAGE CONSERVATION. CHELONIA MYDAS IN SINALOA, MEXICO

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The northern zone of the state of Sinaloa is an essential area for the feeding of five species of sea turtles, among them the leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), loggerhead turtles (*Caretta caretta*), and at a more considerable extent the eastern Pacific green turtle (*Chelonia mydas*) and the olive ridley (*Lepidochelys olivacea*). This area is significant for its high biodiversity and very particular characteristics for which the lagoon systems of northern Sinaloa are listed as priority wetlands by the RAMSAR convention. Sea turtle populations face serious threats that put at risk their conservation, incidental and directed capture, contamination, and diseases, among others. We implemented three approaches as follows: 1) Workshop for fishers from two communities (Topolobampo and Lazaro Cardenas) for in-water monitoring of sea turtles (*Chelonia mydas* and *Eretmochelys imbricata*) in the Sinaloa region. 2) Initiate a community-based sea turtle monitoring program in the Topolobampo-Ohuira-Santa María Lagoon system, integrating new members from two communities (Topolobampo and Lazaro Cardenas). 3. Science camp for young leaders in the community. This is why this study will provide a platform to initiate a monitoring and conservation program carried out by community members from two fishing communities: Topolobampo and Lazaro Cardenas. Therefore, this work aimed to generate meaningful information about sea turtle habitat use of the Topolobampo-Ohuira-Santa Maria lagoon system, as well as for the population characterization, the temporality of migration and residence, and other ecological data.

UPDATE ON COMMUNITY OUTREACH TOWARDS SEA TURTLE CONSERVATION AT KALPITIYA PENINSULA OF SRI LANKA FROM 2020 TO 2023

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Five species of sea turtles come ashore to nest in Sri Lanka, while their feeding habitats and migration routes are located around the island (green sea turtle, leatherback turtle, olive ridley, loggerhead turtle and hawksbill turtle). The Kalpitiya peninsula is located in the Gulf of Mannar on the northwest coast of Sri Lanka. The fishing communities on the Kalpitiya peninsula depend on seasonal artisanal gillnet fishing for pelagic schooling fish. Sea turtles often get entangled in the sea and lagoon causing damage for fishing nets. In response, fishers either beat the turtles' heads until they rendered unconscious, or hack off the turtles' body parts to make disentanglement easier. The turtles are then either discarded at sea, or brought back to shore for illegal processing of their meat for local consumption. Fauna and Flora Protection Ordinance (FFPO, 1972; amendment 1993 and 2009) prohibit harming and killing the turtles, or possessing their body parts. Coastal communities need to be educated about the importance of protecting sea turtles and coastal ecosystems including various habitats such as coral reefs, mangroves, seagrass beds, etc. The objective of this programme was to educate and raise awareness of coastal communities such as fishermen, school children and other users of coastal resources about sea turtle biology and conservation, legislation and enforcement. Educational programmes for students and community members were conducted in schools, children's clubs and fishing community associations. Workshops were held for fishermen to train and sensitize them on how to safely release bycatch turtles in their fishing gear. The programmes continued from 2020 to 2023 with some restrictions during the Covid 19 pandemic. In addition, various field activities such as beach clean-ups and tree planting in home gardens were carried out. The community members (both adults and school children) actively participated in the above field activities and were very enthusiastic about the field activities. Many newspaper articles were published in two local newspapers, and about 200,000 copies of the newspaper were distributed with the news throughout the island. Therefore, a larger group read the conservation message. Most of the community members were very interested in the education programmes and received information about coastal biodiversity conservation. They understood how they can benefit from coastal biodiversity conservation, including sea turtles. The active participation of coastal populations (both adults and children) in coastal biodiversity conservation such as beach cleaning, mangrove replanting has increased, and fishermen attitudinal surveys confirmed that fishers are releasing more bycatch sea turtles in the fishing gears without harming them. This has been the most important result and more field work needs to be done to gain community attention for conservation.

SEA TURTLE AMBASSADORS FOR THE GULF: PLACE-BASED LEARNING THROUGH FIELD EXPERIENCES FOR TEACHERS AND STUDENTS*

Yasmeen Fadlallah

Inwater Research Group, USA

Inwater Research Group IRG has been conducting sea turtle research in the Big Bend region of Florida since 2012. The habitat surrounding Citrus, Pasco, and Hernando Counties has been identified as critical foraging habitat for endangered sea turtle species. Recognizing the need for marine conservation in this region, IRG partnered with the three underserved school districts located adjacent to the Nature Coast Aquatic Preserve to create the Sea Turtle Ambassadors for the Gulf (STAG) program. Our goal was to create local conservation ambassadorships with students and teachers by harnessing the power of place-based learning and sharing our research in real-time. Select K-12 students and teachers from three school districts joined us in nearshore waters where they experienced sea turtle research first-hand from the biologists in their own "backyard." This type of experience increases knowledge retention, tethers emotions to anthropogenic impacts, changes behaviors, and creates a sense of local environmental stewardship. After the field experience students and teachers joined IRG educators in the classroom for both a brainstorming student workshop and a teacher professional development. The student workshop served to expand on what the students learned in the field, discussing ways they could become sea turtle ambassadors and share conservation messages with their peers. The teacher professional development walked teachers through IRG's hands-on, real-world applicable traveling trunk programs, which were donated to the districts that participated in the field experience. Afterwards student ambassadors began working on campus projects that would amplify what they learned in the field and workshop to bring those lessons to other students. Teacher ambassadors began utilizing our trunk programs in their classrooms, sharing their experiences through realistic simulations based on the research they witnessed. Student projects were shared with IRG as well as other participating groups from across the Big Bend region. Projects include conservation clubs, composting efforts, poster campaigns, reusable water bottle programs, and more. Teachers continue to utilize our trunk program with new students in perpetuity, and reach thousands of additional students. Approximately 60 educators and 65 students were directly reached by this program, with its influence extending to thousands more through ambassadorship efforts. Program efficacy was measured using feedback from participants and focus groups. Place-based learning bridges the gap that frequently separates scientists from the public, playing a vital role in our efforts to mitigate behaviors and activities that contribute to sea turtle mortality. The STAG program not only shares with students the incredible wildlife that lives in their communities but it helps students grasp challenging scientific concepts they struggle with. In the state of Florida, only 44% of K-12 students test "proficient" in science. This program, including student projects and the trunk lessons, allows students to learn about the scientific world not through a textbook, but through hands-on instruction, increasing their understanding.

COMMUNITY-BASED SEA TURTLE MONITORING IN PANTAI SAUSAPOR NATURE RESERVE AND ITS SURROUNDING: AN APPROACH TO STREAMLINE SEA TURTLE CONSERVATION MANAGEMENT*

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The Pantai Sausapor Nature Reserve and the surrounding coastline in northwest Papua, Indonesia is home to critical turtle nesting beaches. Unfortunately, these beaches are under significant threat due to habitat degradation, abrasion, extant poaching, and low effectiveness of MPA management, as evidenced by the METT (Management Effectiveness Tracking Tool) score, which has remained at 56% since 2021. To address these challenges, plans to prioritize protection, research, and natural resource management practices are necessary. These plans should also focus on increasing the capacity of community resources and engagement in habitat conservation and developing a sea turtle monitoring system. This approach will foster a mutualistic relationship as well as provide environmental service benefits for the surrounding communities. Flora & Fauna, in collaboration with the Regional Natural Resources Conservation Agency of West Papua, has designed a three-step development strategy to streamline area management. The first step is to strengthen the community's capacity and conservation knowledge in and around the area. The second step is assisting KTH (Forest Farmer Group) Klafli in establishing Megame Village as a pilot site for sea turtle monitoring. The final step is to initiate a sustainable financing mechanism through a small grant to support sea turtle monitoring. Results from written pre- and post-tests have shown that training activities have increased the knowledge of 22 locals (18 men and 4 women) from seven villages in the area, including two men from KTH Klafli, from 44.74% to 57.92%. This improvement in capacity has become a valuable asset in conducting patrols and monitoring. KTH Klafli routinely monitored sea turtles for 105 days in 2023 (February 28 – June 12) at Megame Beach, which is 2.2km long. This period has been identified as the primary nesting season in the Pantai Sausapor Nature Reserve and its surroundings for olive ridley, leatherback, green, and hawksbill sea turtles. During this period, the greatest number of turtle activities and encounters were recorded in May. Olive ridley turtles had the greatest number of tracks and nests recorded (17), and hawksbill turtles had the greatest number of individuals encountered (5). Regarding sustainable financing, 11 priorities were identified in Megame's Village Strategic Plan of which three are related to sea turtle conservation actions. These include training on sea turtle and nest protection, shelter construction, and SMART patrol implementation for monitoring. These activities have been scheduled and group members have been trained to measure activity achievements in written reports. In addition, strategic planning activities have resulted in the development of research sites, ensuring the sustainability of monitoring efforts. Implementing these three strategies is expected to significantly enhance the efficacy of protection measures in Pantai Sausapor Nature Reserve and its surrounding areas while fostering self-reliance among community groups engaged in the region's sea turtle conservation activities. These collaborative monitoring efforts are also expected to provide essential data to strengthen conservation area management efforts and formulate relevant recommendations for future action.

COMMUNITY MONITORING, CONSERVATION AND SECURING THE FUTURE OF FLATBACK TURTLES (NATATOR DEPRESSUS) IN PORT HEDLAND, WESTERN AUSTRALIA*

Kelly Ann Howlett

Care For Hedland Environmental Association Inc, Australia

Port Hedland is 1,800km north of Perth, in the resource rich Pilbara region of Western Australia. Local Aboriginal rock carvings depicting sea turtles have been dated to approximately 12,000 years of age. Today with a population of 15,000 people, Port Hedland beaches are a far cry from what they once were. The lifting of the iron ore export embargo in the late 1960s, the subsequent dredging and transformation, sees Port Hedland harbour now being the largest bulk tonnage export port in Australia. Prior to 2003, little was known or documented of flatback turtle (*Natator depressus*) activities from October to March, on local town beaches. In 2004, our community volunteer organisation, the Care For Hedland Environmental Association, commenced its' monitoring and conservation program specifically for our flatback turtles. Today, three town beach areas are monitored. Each are predisposed to a number of threatening factors, that could detrimentally impact turtle nesting: high level of disturbance by people (direct contact, off road vehicles, tourism, disturbance of nests, harbour dredging and landside developments including marina and rock sea wall), commercial and residential lighting and feral animal predation. The monitoring methods used are track identification, mark/recapture and nest excavation/success. These methods have enabled the documentation of seasonality, numbers, inter-nesting rates, recruitment rates, spatial distribution, familial relations, successful hatch rates, hatchling emergence, hatchling orientation and any disturbance. From the data collected, Cemetery Beach for an 800m section of beach, is unparalleled to any other turtle nesting residential town beach in Australia. Population modelling indicates a relatively stable medium sized female population (200-450 per season). Analysis of our data shows that the Port Hedland rookery is regionally important within the WA North West Shelf Flatback population, DNA analysis has genetically linked our turtles with the Barrow Island and Mundabullangana populations. Consistent small percentage of tagged individuals are nesting on other regional beaches and nesting in Port Hedland. Annually new recruits are 14% and 25% of our tagged females return to nest the following year, providing evidence for an annual nesting migration in our population. Concerningly, nest excavation data shows Port Hedland beaches are some of the warmest, with nest success varying widely from 64%-20%, often correlating with extreme weather events. Consequently, Cemetery Beach records some of the lowest hatch success rates when compared to other regional habitats. Over the past two decades, the data collected has been able to guide local management decisions, particularly regarding the impacts of negative human-turtle interactions, lighting of surrounding infrastructure, impacts of fox predation, timing of dredging campaigns, managing recreational activities and proposed new developments. It is commonly thought in our local community, that there would be no turtles still nesting today, if it were not for our Association's efforts, intervention, continued ongoing monitoring, data collection and communication of findings. While still more to do, importantly on the cusp of our 21st season, much has been done to ensure that the turtles of Port Hedland continue to have a long association with local people for the next 12,000 years and beyond.

COMMUNITY-BASED SEA TURTLE BYCATCH MITIGATION IN SOUTHWEST CAMBODIA

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Along Cambodia's southwest coast, green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) sea turtles forage and rest in regionally important coral reefs and the largest seagrass meadows in mainland southeast Asia. These populations are highly diminished relative to historic levels and face continued pressures from habitat degradation and fisheries, particularly illegal bottom trawling. Urgent protection of sea turtles and their foraging habitats is needed to ensure they remain in Cambodia's seas. Since 2017, Wild Earth Allies has documented and responded to sea turtle bycatch in collaboration with coastal communities in Kampot province. This project is part of our overall program to strengthen co-management of Marine Protected Areas (MPAs) and fisheries. Our collaboration with coastal communities' centers on strengthening the capacity of Community Fisheries (CFis) to manage marine resources and protect at-risk biodiversity, including sea turtles. CFis are recognized under Cambodian Fisheries Law and comprise communities or groups of small-scale fishers who are granted management and use rights of resources within a marine area, including setting boundaries and permissible fishing gear and practices. There are now 45 CFis across 4 coastal provinces playing a central role in managing Cambodia's coastal and marine areas. This community-based approach improves equity in access to marine resource management and protection. The CFi model has also provided an opportunity for developing collaborative, community-based sea turtle conservation efforts. Together with 10 CFis, we have launched community-led patrols to mitigate threats to sea turtles, namely trawling and other forms of IUU fishing. We have also developed a community-based response system in Kampot province for sea turtle bycatch incidents. Our team trained response teams in safe handling of sea turtles and individual tracking methods using external flippers tags. Response teams are composed of CFi committee members and Fisheries Administration officers at the provincial level. Our team and CFi committees use signage, in-person meetings, and digital communications (e.g., Telegram groups) to raise awareness about the program and how to contact the response team if a sea turtle is accidentally captured. Non-monetary incentives are used to encourage fishers to report bycatch incidents, such as t-shirts and certificates honoring their service. This has resulted in increased reporting of sea turtle bycatch in Kampot province, with a 200% increase in reported incidents in 2022 versus 2017. In total, the team successfully released 15 green turtles and 4 hawksbills between 2017 and 2022. The team also documented one dead green turtle, bringing the total bycatch record to 20 incidents over the 5-year period in Kampot province, Cambodia. Results are input into the national sea turtle database, which is managed by the Fisheries Administration. While these bycatch rates are low at a global scale, sea turtle bycatch and sightings are higher in Kampot relative to other provinces in Cambodia. Our results demonstrate the importance of engaging coastal communities in the protection of sea turtles and vital foraging habitats in southwest Cambodia. As a next step, we are improving community patrol effectiveness and data collection with SMART technology (Spatial Monitoring and Reporting Tool).

A STUDY ON THE EFFECTIVENESS OF SCHOOL AWARENESS PROGRAMMES TO INCREASE KNOWLEDGE ABOUT SEA TURTLES BY CONSIDERING SELECTED SCHOOLS IN TWO PROVINCES IN SRI LANKA*

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Programmes such as school lectures on a particular subject or area to increase students' knowledge, so that they know what are sea turtles and how to identify them. These programmes provide structured lessons, identifying and refreshing the knowledge and can greatly improve student knowledge on sea turtles. Schools are the ideal places to initiate significant change in the society. This study aims to show the effectiveness of school awareness programmes among students. The main objective of the school lectures is to inspire the younger generation to protect sea turtles from extinction in the future by creating a passion for sea turtles on them. The lecture of the sea turtles includes Introducing species, their behavior and habitats, their ecological importance, threats and their conservation and management. Ten selected schools were evaluated from both provinces and the series of awareness programmes started in March 2023. The evaluated schools are from North Western Province and Western Province in Sri Lanka. Five schools were evaluated from each province. The evaluation process was done by administering pre and post-questionnaires. The questionnaire includes ten questions of basic knowledge of sea turtles and both have same questions. Both male and female students from the age of 9 to 12 participated in this. Here, ten students who participated in the lecture were selected and before the lecture, they were given a pre-questionnaire to be completed in ten minutes and the post-questionnaire also to be completed by the same students in ten minutes after the lecture. Accordingly, the effectiveness of the programme was evaluated before and after the lecture. The effectiveness was estimated by the difference between post and pre questionnaires. The mean values of estimated effectiveness data were calculated for each province. The mean value of the North Western Province is 40.8% while it was 51.6% for the Western Province. The null hypothesis is there is no significance difference between in programmes of two provinces. The P value is 0.002 (Two sample T test: $p < 0.05$). According to the results, the effectiveness values between North Western Province and the Western Province are significantly different. This could be due to facts that variations of the distance of the capital city which belongs to the Western province, proximity to the beach, the age difference among students, the lack of interest in the topic and the method of delivering the lecture. To get the optimal knowledge gain, the delivering method can be changed provincially. Hence, the proximity to the beach could be taken as a factor to the tailor the content of the future programme. In addition, the assessment tests can be done after 6 months to check long-term knowledge retention. However, it is concluded that school awareness campaigns are an appropriate way to develop awareness about sea turtles among school students and inspire them to protect them.

REDUCING POACHING IN SAL ISLAND: A WIDE APPROACH BEYOND TRADITIONAL BEACH PATROLS

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In Sal Island, Cabo Verde, traditional foot patrols have been the primary method of preventing poaching of Loggerhead turtles since 2008, further supported by sensitisation through an educational program introduced in 2015. In more recent years, alternative approaches have been initiated to enhance the anti-poaching campaign, from expanding the sensitisation program to reach other communities, to use of new technologies to monitor nesting beaches. Currently, the anti-poaching campaign involves the use of drones to cover more isolated beaches, to carry out targeted missions on beaches with higher levels of poaching and to support foot patrols on the principal nesting beaches. Outreach within the community, aside from the traditional school and youth group activities, involves working in partnership with local fishermen's associations and other communitarian groups, which conduct voluntary foot patrols on their local beaches during the nesting season. A partnership with the military is well established, with soldiers supporting traditional patrols on beaches with higher mortality, as well as conducting patrols on their local beaches, both by foot and by quad bike. As a touristic island, sensitisation of the year-round tourists is conducted through the use of the conservation hatchery during nesting season, as well as year-round hotel visits. This several-tiered approach will be presented to share the lessons learned that helped reduce the mortality of an increasing nesting population.

ENHANCING SEA TURTLE STRANDING MONITORING ON THE TUNISIAN COAST: LEVERAGING CITIZEN SCIENCE WITH TWO DISTINCT TOOLS – SOCIAL NETWORKS AND A MOBILE APPLICATION*

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One of the most pressing environmental concerns of our era is the decline in biodiversity, and the preservation of biodiversity has emerged as a major global issue. New methods are now accessible to complement, or even substitute, conventional monitoring techniques. Citizen science approaches are poised to bolster biodiversity monitoring initiatives, conserving both human and natural resources. Marine turtles are endangered globally, and their survival depends on national conservation efforts, scientific research, and community involvement. To support conservation efforts, most Mediterranean countries have established monitoring and conservation programs aimed at identifying areas of concentration, nesting, and feeding grounds, as well as the causes of mortality. Between August 2020 and August 2023, two citizen science tools were used to collect data on sea turtles stranded on Tunisian coasts: "e-Turtle," an Android mobile application downloaded by 5,000 users and developed as part of the Life MedTurtles project, and

"TunSea," a Facebook group with 53,000 members founded by young researchers to facilitate communication between the public and the scientific community, organizations, fishermen, and individuals involved with sea turtles. The two methods intersect in the types of data required from the user, including the date and the location of the stranding, the measurements, the physical condition of stranded turtles and the likely causes of stranding. The total number of turtles stranded on the Tunisian coast, collected by the two approaches, was 1302 (1265 *Caretta caretta*, 12 *Dermochelys coriacea*, 8 *Chelonia mydas and* 17 unknown species). Out of this total, 60% were collected via the "e-turtle" mobile application, while the remaining 40% were collected through the "TunSea" Facebook group. We were able to estimate the spatio-temporal distribution of stranding events using the data acquired using these methods which enables us to examine the potential reasons of stranding in relation with the fishing activity along the Tunisian coast, which appear to be the primary cause of this phenomena. The utilization of both citizen science tools during the same time frame converges and does not contradict one another in collecting data on sea turtle strandings. However, the disparity and variety of data acquired are influenced by the choices made by citizens who opt for either of these two approaches.

"WARRIORS OF THE RAINBOW" EDUCATING FUTURE LEADERS AND DECISION MAKERS*

Damaris Marin-Smith and Rozino Gene Smith

Campamento Tortuguero Ayotlcalli A.C, Mexico

Campamento Tortuguero Ayotlcalli A.C. is located in Playa Blanca, Zihuatanejo, Gro México. The area is an important nesting zone for three endangered species of marine turtles. Traditionally, in the past, it was a practice for people to consume eggs and meat of sea turtles. Also, the turtle fat and carapace were used for medicinal and ornamental purposes. In the 1960s, a German entrepreneur built a sea turtle sausage factory; millions of sea turtles were slaughtered, and the product was shipped to Europe. Fortunately, Europeans didn’t particularly enjoy the taste of the sea turtle sausage and eventually the factory closed. In 2011, Campamento Tortuguero Ayotlcalli was established in the area of Playa Blanca. The purpose was to protect the three species of marine turtles that nest within 15 kilometers of three beaches, Playa Blanca, Playa Larga and Barra de Potosi. The initial activities consisted of locating the sea turtle nests and transporting the eggs to a hatchery to protect them from poachers, stray dogs and high tides. All these actions are performed by local, national, and international volunteers. We realized that no transcendent change could be possible without properly educating the public. The community suffers from severe social problems, lack of education, high crime rate, inadequate infrastructure, and pollution. The idea of an educational program was developed. The first step was to provide educational presentations to visitors and local school children. Later, an annual summer camp for children was created, and “Warriors of the Rainbow” was born in 2017. It is a two-week program with the participation of 30 to 35 children between the ages of 7 to 12 years old. “Warriors of the Rainbow” is an integrated educational program which focuses on preparing local children as future leaders and decision makers. Utilizing the areas of reading, writing, math, environmental science, logical thinking, problem solving and values. Students are educated on the knowledge of their natural surroundings. Students understand that our planet is suffering from extreme and unconscious exploitation. Radical measures need to be practiced. The summer school group of 40 students are instructed by professional educators, volunteers and young leaders who have graduated from previous summer program. Since sea turtle conservation is the main area of concern, one of the most exciting activities for the students is to camp out one night and patrol the beaches in search of sea turtle nests and if found, relocate the clutches into the hatchery. On some occasions, female turtles have been spotted during the nesting process. The summer school program has been in place for eight (8) years. Several former students have become leaders in the program and practice what they learned. In average, 5 to 6 students return to serve as leaders. In conclusion, the summer program, “Warriors of the Rainbow”, has had an extraordinary impact on the education of local children. Our vision is to contribute to the formation of strong leaders and decision makers that protect the environment and while focusing on marine turtles.

MONITORING GREEN SEA TURTLES IN THE SAN GABRIEL RIVER OF SOUTHERN CALIFORNIA, USA*

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Effective conservation of endangered species relies on the characterization of habitat use and tracking of long-term population trends, which can be especially challenging for marine species that migrate long distances and utilize a diversity of habitats throughout their lives. Since 2012, citizen science volunteers at the Aquarium of the Pacific in Long Beach, California, have been monitoring an urban population of East Pacific green sea turtles (*Chelonia mydas*) that resides near the mouth of the San Gabriel River (SGR) in Southern California, USA, in order to gain insights about how the population uses this area. Here, we collate and analyze nine years of citizen science data, including observed sightings collected across 10 observation stations. Our results confirm that green sea turtles are frequently present around warm water effluent from power plants, similar to research results reported for other locations in the eastern Pacific Ocean. Importantly, observational data also show notable green sea turtle activity around the outfalls for a small wetland habitat bordering the SGR, highlighting the importance of wetland ecosystems as a key habitat and foraging area for this threatened population. Finally, our results showcase the benefits of using citizen science to monitor sea turtle populations in easily accessible nearshore habitats.

EVALUATION BY THE COMMUNITY ON EDUCATIONAL SIGNBOARDS FOR SEA TURTLE CONSERVATION IN CAMBODIA

Tharamony Ngoun, Chandara Tak, and Matthew Glue

Fauna & Flora, Cambodia

Educational signboards are a common tool utilised by conservation practitioners to spread awareness and education in target areas on conservation issues. Fauna & Flora and project partners have deployed many signboards in coastal communities in Cambodia. However, the effectiveness of these signboards, once installed in the community is poorly understood. Rather than investing additional funding into more sign boards, the Fauna & Flora team wanted to assess the effectiveness of sea turtle conservation signboards that had already been installed. An evaluation system was developed to enable community members to score the usefulness of the signboards and gauge the understanding of the message that had been conveyed. The evaluation system included a rating system with several questions about the content of the signboard, with community members answering these during group sessions. The results from this assessment were

then analysed by the team to ascertain key takeaways from the assessment. Communities responded that the signboard had improved their understanding of the importance of healthy marine ecosystems. However, important messages such as the sea turtle hotline were not memorable. The communities suggested that more awareness raising should accompany the signboards.

ADDRESSING ONLINE TRADE OF TURTLESHELL PRODUCTS IN INDONESIA

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Indonesia has a history of exporting turtle shell and stuffed hawksbill turtles (*Eretmochelys imbricata*) in large quantities. Despite the protection laws established since 1990 for all species of sea turtles, their parts and derivatives, the turtle shell trade continues to thrive within the country. Besides being offered in different kinds of markets and souvenir shops, nowadays, different types of jewellery (mostly bracelets and rings), and other products made from turtle shell can be found on online shopping platforms and social media. To gain a better insight into this type of trade, in 2019 and 2020, Yayasan Penyu Indonesia and Profauna conducted an online survey to understand the scale of the illegal trade of hawksbill products on these selling platforms. The findings were shocking: a total of 1,574 advertisements were found on 11 online platforms, amounting to a total of 29,326 items, with an estimated value of USD 340,000. Most offers were found on Instagram (739 advertisements) and Facebook (486 advertisements), while 349 advertisements were distributed over various popular Indonesian selling platforms. During the survey, the location of one major seller was identified on the island of Nias, North-Sumatra, who had accounts on 3 of the most relevant shopping platforms, holding a huge amount of turtle shell products in stock. Based on these results, two strategies were created to reduce the availability and purchase of products found online. Continuous and friendly contacts were made with the platform owners, asking them to remove the advertisements from their online shops. All platforms and online shops have a complaint mechanism and policies in place, that also mention the prohibition of trading illegal products, including wildlife. Through these mechanisms, users can report violations of the terms of use, but awareness of the fact that turtle shell products belong to the category of illegal wildlife products is generally low in Indonesia. Reports to the platform owners using these complaint mechanisms and through direct approaches by email were done, asking the platform owners to remove the adverts from their online shops. As a result, the number of advertisements decreased from 1,574 to 201 (87% decrease). In parallel, a campaign for potential buyers was launched, with the aim of initiating a change in behaviour and reducing the demand for turtle shell products. The approach was to create an emotional connection with sea turtles by informing the public that killing hawksbill turtles to obtain their shell is not only illegal, but also very cruel, because the turtles are peeled alive and will die a slow and painful death. Through regular posts on Yayasan Penyu Indonesia's social media platforms and the production of a television and radio advertisement, a substantial audience of approximately 20 million people across Indonesia could be reached. The campaign proved to be a success, but efforts must be maintained over an extended period. Continued action is essential to perpetuate the positive effects achieved, ensuring a change in buyers' awareness, leading to a reduction in the purchase of products made from turtle shell.

MITIGATING LOGGERHEAD TURTLE BYCATCH IN SOUTHERN PERU: A COLLABORATIVE 'FISHER SCIENTIST' INITIATIVE

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In the South Pacific, the loggerhead turtle (*Caretta caretta*) has experienced a significant decline in nesting population numbers at rookeries in Australia. Fisheries bycatch has been recognized as a major threat for loggerhead turtles not only around nesting and foraging areas in the southwest Pacific, but also on developmental grounds off Peru and Chile in the southeast Pacific, where these turtles migrate after hatching. Earlier studies have reported an annual capture of over 3000 loggerhead turtles in the small-scale longline fisheries in Peru. While a systematic assessment of loggerhead bycatch is still needed to understand the level of impact small-scale fisheries currently pose on loggerhead turtles, we recognize that for sustainable and impactful change, it is equally important to actively involve and create a sense of ownership within the fishing community. Thus, here we present our *'Fisher Scientist'* program aimed at involving small-scale longline fishers in southern Peru in sea turtle data collection and fostering a sense of ownership in marine wildlife conservation. This program, initiated in 2018, has successfully trained 150 participant fishers in safe sea turtle and handling techniques, and provided them with tools (e.g., measuring tape and dehookers) for sea turtle biometric measurement and safe release. Trainings were conducted in coordination with FONDEPES (Viceministry of Fisheries). Information gathered by '*Fisher Scientist'* volunteers were obtained via interviews at the end of their fishing trips and, while not as detailed as data collected by onboard observers, has proven valuable for acquiring location and biometric measurements of over 50 sea turtles, the majority of which were loggerhead sea turtles. To enhance community engagement, videos and photographs of safe release of turtles were shared with the broader community through various social media networks of the Peruvian non-profit ProDelphinus. Fishers are still reporting data, and these will be updated for the presentation next year. Our next steps include extending the reach of this program to small-scale fisheries in northern Chile in 2024 and promoting the exchange of fishers between these two countries. Ultimately, we hope that by actively involving fishers in scientific data collection, we not only empower the community but also strengthen the foundation for sustainable fisheries management and sea turtle conservation in the Southeastern Pacific.

"SHOW US THE TURTLE, LEARN THE STORY": AN INTERACTIVE PLATFORM FOR PERSONALISED ENGAGEMENT WITH SEA TURTLE CONSERVATION IN A MEDITERRANEAN TOURIST HOTSPOT

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Laganas Bay on Zakynthos Island, Greece, hosts one of the most important breeding sites for the Mediterranean loggerhead sea turtles and it also supports a year-round resident adult male and juvenile population. In 1999, the area was declared a National Marine Park. Zakynthos is also a popular tourism destination with more than one million visitors in 2023. Turtle-watching is a popular activity for the tourists who can see the turtles via organised boat tours, private hired boats and/or snorkelling. Previous research has revealed a high risk of turtle trauma or mortality especially to resident individuals, usually as a result of immense ecotouristic pressure as well as the frequent violation of the 6-knot speed limit, a key regulation of the park. In an effort to quantify this pressure, a viewing pressure measuring tool for individual turtles has been developed based on the frequency of their appearance in photos uploaded by tourists in social media (Instagram). Even though, the COVID-19 pandemic reduced the tourist pressure on turtles by 75% (2020), pressure intensified during 2021-2023. A 10-day monitoring of Laganas Bay during June 2023 (low tourist season) revealed that typically 4 boats observe a single turtle at a given time with aggregations of more than 7 boats observing a turtle occurring every day (max=10 boats). Furthermore, out of the 10 resident turtles observed in 2023, that have been recorded for the longest time within Laganas Bay (mostly males), 8 (80%) have sustained a boat collision. In order to engage visitors and tour operators towards responsible sea turtle viewing and to highlight this problematic situation, an interactive web-platform (https://zakynthosturtles.org) was recently launched. Through this platform visitors upload images of turtles that they have observed. These are identified via photo-ID, based on an existing 24-year-spanning photo-database and the visitors receive information about them in real time, including number of years since first documentation, interesting stories and behaviours. They further receive a quantification of the pressure that their observed turtle has been subjected to, as well as any injuries it has sustained, increasing their awareness about the extent to which it is threatened. Finally, visitors have the opportunity to comment on the ecotouristic activity that they participated in. The platform was launched in August 2023 receiving positive feedback both from tourists and tour operators. Up to 31 October 2023, 164 images were submitted and 46 unique turtles were identified. Notably, 43% of the visitors that submitted a photo taken during a boat tour expressed disappointment about their experience especially with regards to the number of boats aggregating around a single turtle. We anticipate that future scaling-up of the number of submissions will lead to a high number of tourists and tour operators perceiving the sea turtles as unique individuals, with their own life history and habits, eventually resulting to more responsible viewing behaviour. The proposed platform could be adapted for use for other charismatic wildlife frequently viewed at biodiversity hotspots globally, facilitating greater interactions between citizens and science and promoting responsible tourism.

IMAGINE THAT YOU ARE A SEA TURTLE: DEVELOPMENT OF AN EARLY CHILDHOOD LEARNING ACTIVITY

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To support a future sustainable planet, young children need to be engaged with environmental education; it influences their own relationship with nature, environmental literacy, and behaviours as an adult as well as the attitudes and behaviours of their parents. However, most programs focus on environmental education *in* nature with less emphasis on environmental education *for* and *about* nature. "*Imagine that you are a sea turtle*" is a learning activity that fills this niche. It guides early childhood learners (about 4-7-year-old) through stages in the sea turtle life cycle and sea turtle biology and examines human-sea turtle interactions and threats to turtles at different times and in different habitats. The development team included collaborators from across South and Southeast Asia and Australia with experience in early childhood learning and environmental education. Our goal was to apply culturally relevant teaching practices and incorporate regional examples and illustrations that reflect those of countries in South and Southeast Asia. Written prompts were prepared for educators to invoke physical and verbal responses from children and facilitate physical expression, critical thinking, and problem solving. While text was initially developed and refined in English, the activity is being translated into local languages and includes illustrations by local artists. This presentation will demonstrate the international collaborative process used in development of the learning activity and provide an opportunity for other educators from the region to become involved in translating the activity into additional languages. *Imagine that you are a sea turtle* will be available as an open-access resource online in formats that enable its' use in both online and face-to-face learning spaces.

IMPROVED KNOWLEDGE AND CAPACITY TO COMBAT SEA TURTLE ILLEGAL TRADE, CABO VERDE

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The Cabo Verde population of loggerhead turtles is one of the eleven most threatened populations in the world, yet it has grown in the last decade. As the size of the turtle population increases, illegal trade persists, mainly for consumption. However, the real impact of this trade remains still poorly known. To address this

challenge, a group of sea turtle conservation partners have implemented a nation-wide integrative approach that is:

i) Improving knowledge about the illegal trade and the consumer market by assessing the origin (terrestrial vs. marine) and entry points of turtle products into communities and profiling poachers, sellers and consumers through socio-demographic surveys;
ii) Proposing a roadmap of specific interventions to mitigate the impact of future reduction of illegal turtle products on vulnerable populations;
iii) Supporting the development and strengthening of the national sea turtle network (TAOLA), to become a strong actor linking governmental and non-governmental organisations to fight the trade in turtle products; and
iv) Testing detector dogs as an innovative method of law enforcement in identified trade hotspots.

This poster will share how, for the first time in Cabo Verde, a national coordinated effort is providing the necessary knowledge to design specific evidence-based strategies, involving a stronger network of conservation organisations and pioneering interventions, through an integrative approach that can be scaled-up and replicated elsewhere.

COMMUNICATING WITHOUT BORDERS OR HOW TO OVERCOME LANGUAGE, CULTURAL AND PROXIMITY BARRIERS TO INCREASE A PROJECT'S OUTREACH

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The importance of well-targeted communication activities in raising awareness of environmental issues and projects cannot be argued and with the rise of social media, the communication axis has become even more significant. One of the main challenges of environmental projects involving conservation activities in many countries is how to get their "messages through" and engage audiences in different countries of operation, taking into account the limited resources, the language, cultural and proximity barriers. The project "Conservation of Marine Turtles in the Mediterranean Region" aimed at reducing human induced direct mortality of marine turtles, through targeted research and conservation, policy, education and communication activities. Operating in 13 countries (Albania, Algeria, Cyprus, Egypt, France, Greece, Italy, Lebanon, Libya, Morocco, Spain, Tunisia and Turkey), the partnership of the project faced the challenge of how to engage audiences with different languages, cultures and awareness levels since the beginning. This poster aims to present the communication strategy that the partnership followed to try to overcome these barriers. *Think Globally – Act Locally*The communication team of the project embraced a *multi-dimensional strategy* including both overarching communication activities, as well as activities implemented in the specific countries. Smart *KPI's* (Key Performance Indicators) were developed to measure success.

- Beyond a simple translation of the communication material to local languages, specific activities were designed to target local audiences and were implemented with the participation of *local NGOs*. The aim was to engage *local communities* to marine turtle conservation.
- Engaging local communities in primary data collection through well-designed *"Citizen-Science*" activities and making them part of the solution.

- Embracing both *traditional media* and modern *social media* to increase the project's outreach and share of voice. Making an extra effort to promote the project's activities and messages to all countries.
- A *photo* is worth a thousand words and spreads the message beyond any borders. The project invested in producing professional audio-visual material to showcase its conservation efforts across the Mediterranean.
- Take the extra mile to establish, *open*, and *direct communication* with project partners. The project's success and the reach of communication activities depend on *disseminating the information* among project partners.
- *Good collaboration* is key, but it is not always the case.

Translating the communication material is not enough. Cross–border projects aiming to achieve a common goal should start thinking locally. Communication activities should be tailored to the unique characteristics of each country, maximizing effectiveness, and minimizing the risk of miscommunication or cultural insensitivity. This in turn involves the formation of a *communication task force* in constant collaboration and communication that will help guide efforts in each country.

SEATRU PUBLIC VIEWING LAB: BRIDGING SCIENCE AND SOCIETY

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The SEATRU Public Viewing Lab, established at The Taaras Beach and Spa Resort in Malaysia, represents a pioneering endeavour in integrating scientific research with public outreach and education in sea turtle conservation. This unique, glass-panelled laboratory, the first of its kind in Malaysia, enables the public to directly observe sea turtle research and the hatching process directly, thus fostering greater interest and awareness in turtle conservation. Initiated in 2018, the lab is a collaborative project between Universiti Malaysia Terengganu, Berjaya Hotels & Resorts, and supported by the Department of Fisheries Malaysia. It has engaged over 5700 individuals from various countries, demonstrating the effectiveness of combining tourism with conservation and educational efforts. The lab's activities, such as turtle hatchling release events, educational trips, talks, adoption programs, and merchandise sales, have significantly contributed to raising public awareness and participation in conservation efforts. The SEATRU Public Viewing Lab also functions as a vital link between the scientific community and the general public, facilitating knowledge transfer in an interactive and engaging manner. This initiative not only enhances the public's understanding of sea turtles but also underscores the importance of scientific research in conservation. Recognized for its impact, the lab received a Special Jury Award and a Gold Medal in a 2019 Invention and Innovation Competition, solidifying its role as a model for education, community, and social innovation.

VIVEMAR A SELF-SUFFICIENT COMMUNITY PROJECT WITH MORE THAN FOURTEEN YEARS PROTECTING SEA TURTLES ON OAXACA, MEXICO*

Cinthia Verónica Venzor Leyva

VIVEMAR ONG, Oaxaca, Mexico

Vivemar, a non-governmental organization founded as a cooperative society by people from the community in 2011, is located in Bajos de Chila, Oaxaca, Mexico, and is committed to protecting and conserving sea turtles, birds, and mangroves on 27km of coast, covering the main beaches of Puerto Escondido and San Pedro Mixtepec. Our activities include:

1. Conservation and protection of four species of sea turtles, *Lepidochelys olivacea, Chelonia mydas, Dermochelys coriacea, Eretmochelys imbricata*; PIT and metal tagging of *Dermochelys coriacea* for Proyecto de Altura; photo identification and monitoring using drones; and beach clean ups.
2. Bird banding.
3. Escuelita VIVEMAR: providing free environmental education in local schools promoting environmental awareness and the preservation of biodiversity through community participation, as leaders and mentors.
4. Organic Gardens: preserving native plants of the region, avoiding pesticides and genetically modified seeds, encouraging self-consumption.

Vivemar is committed to protecting and conserving sea turtles, birds, mangroves, and providing free environmental education in the local community, promoting a sustainable conservation model through community participation, being community leaders in the conservation of marine life and the coastal ecosystem. of Oaxaca, being mentors in the conservation of M.A.R. (Seas, mangroves, birds and reptiles) through sustainable community work that promotes environmental awareness and the preservation of biodiversity. Playa Palmarito is considered a high priority nesting beach for *Dermochelys coriacea*, *Chelonia mydas* and *Lepidochelys olivacea* have been present all year round since 2021, thereby increasing the number of clutches. *Eretmochelys imbricata* nest sporadically. The four species are protected by NOM 059 SEMARNAT, all of which are declared in danger of extinction, highlighting the leatherback and hawksbill as critically endangered. From 2016 to date, VIVEMAR has released into the ocean 666,989 *Lepidochelys olivacea* hatchlings, 46,354 *Chelonia mydas* hatchlings, 14,545 *Dermochelys coriacea* hatchlings and 406 *Eretmochelys imbricata* hatchlings. Hatching percentage is above 70% in all species. Since 2021 we have ringed more than 400 species of birds, being the first scientific bird ringing camp in Puerto Escondido, highlighting species *Passerina ciris Columbina inca, Icterus spurius, Vireo bellii, Volatinia jacarina, Saltator grandis, Myiarchus nuttingii, Passerina leclancheri, Setophaga petechia*, thanks to scientific banding we can conserve the migratory birds that visit us from the USA and CANADA as well as their habitats. We have provided free environmental education to more than 400,000 people who visit us through the release of turtles, volunteers and children and adolescents that we visit in primary, secondary and high schools, visiting 129 public schools at the moment.

CITIZEN SCIENCE PARTICIPATION IN MONITORING THE SEA TURTLE POPULATION OF FITZROY ISLAND, CAIRNS, AUSTRALIA THROUGH PHOTO-ID RECAPTURE TECHNIQUES*

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Traditionally the study and monitoring of sea turtle populations in Australia has been conducted through capture-mark-recapture methods, where turtles were individually tagged with unique identification codes provided either by metal flipper tags or by passive integrated transponders. Emerging technologies have made the individual identification process less invasive and equally effective. Sea turtles have a unique scale pattern which allows the implementation of high-resolution photography to identify characteristics and distinguish among individuals. Well known within the tourist industry as an easy place to spot sea turtles, Fitzroy Island, Cairns, Australia, is an area with a previously unmonitored sea turtle population. Primarily a foraging ground for both juvenile and adult turtles, the 'rodeo' method of mark-recapture would typically be the desired method of choice for such an area, however this method is resource heavy and skill dependent, something not all smaller-scale projects have access to. The shallow reefs surrounding the island, however, are accessible for snorkelling and thus photo-ID capture surveys are an emerging tool for monitoring which can be utilised at low cost, training volunteers and citizen scientists to gain an understanding of the local sea turtle population. Over the past three years, in-water photo-ID capture surveys were conducted monthly to collect video footage of sea turtles within the 'Welcome Bay', 'Coral Gardens' and 'Shark Fin Bay' sites surrounding Fitzroy Island. Volunteers used GoPro cameras to record video footage of sea turtle behaviour from within 1-3m of the target animal. For every encounter we aimed to register both facial profiles and the overall body composition, prioritizing images from the left side facial scutes to use these for identification. These images were then sorted and identified alongside the database to determine new records and recaptured individual turtles by trained groups of volunteers. An experienced staff member later confirmed the same identifications to mitigate the risk of false positives and negatives. Within the study period, 57 individual sea turtles were identified; 54 green turtles (*Chelonia mydas*) and 3 hawksbill turtles (*Eretmochelys imbricata*). 23% of individuals were identified in each year of study, 56% were seen consistently for over a year, 84% were seen more than once and 16% were only identified on a single occasion, which reflects the high fidelity of these populations to this particular area. For those seen more than once, the average time between sightings was 4.39 months (±4.3 SD). All 3 E. imbricata were seen consistently throughout the study period. Successful monitoring of sea turtle populations through photo-ID recapture is a simple and cost-effective approach to assess otherwise unstudied populations. Implementing simple surveys allows for the involvement of passionate volunteers who would otherwise not have access to the turtle monitoring process. With the continuation of this study, a more accurate representation of residency and migratory movements can be determined as the dataset increases, reducing the invasive components of traditional turtle monitoring practices. Future avenues of interest are the movements and bodily changes of the juvenile turtles who are abundant within this population.

TOO MUCH SCIENCE AND LITTLE COMMUNICATION: THE ART OF SHARING INFORMATION AND VALUES THROUGH STORYTELLING

Georgina Zamora Quílez

Sea Turtle Conservancy

In the sea turtle conservation world, we put a lot of effort and energy in designing, collecting, processing and analyzing data, but we usually forget about the most important part of this process: how can I share all this information in the most effective way in order to reach people's awareness. Translating scientific data into a visual format is a crucial strategy for raising environmental awareness, as it makes complex information accessible and engaging to a broad audience. Whether explicating intricate scientific concepts or elucidating the beauty of the natural world, the use of visual elements is an indispensable tool in enhancing comprehension and appreciation. In this context, visual communication acts as a universal language, transcending linguistic and cultural barriers, and fostering collaboration among researchers worldwide. Thus, visual communication, whether through single illustrations, infographics, or illustrated narratives, plays a significant role in shaping public perception and driving positive change in environmental awareness, behaviors, and policies. Communicators can distill intricate concepts such as climate change, biodiversity loss, and habitat destruction into easily understandable and emotionally resonant narratives. These narratives can evoke empathy and inspire viewers to engage with environmental topics on a personal level. In the present case, we will make a preliminary analysis of the current communication strategies existing in the conservation world by taking a look at a few case studies. Plus, we will expose basic concepts around design and human perception of the information, as well as highlighting the most common obstacles found by organizations when communicating. We will also analyse the current valuation existing around outreach and communication in the scientific world to, finally, take a look at different successful approaches that use illustration and storytelling in order to approach to society. All these in order to suggest effective and practical tools to the audience, so we can improve our present skills when communicating science, creating awareness among society.

FISHERIES AND THREATS

REDUCING TURTLE BYCATCH IN THE ADRIATIC SEA: TESTING THE EFFICIENCY OF FLEXIBLE TURTLE EXCLUDER DEVICES (TEDS) FOR MULTISPECIES TRAWLERS*

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Incidental captures in fishing gears are one of the greatest threats to sea turtles at sea. In the shallow waters of the Adriatic Sea bottom trawlers are among the most used gear. The Adriatic Sea is one of the two most important neritic foraging areas for Mediterranean loggerhead turtles (*Caretta caretta*), together with the Tunisian shelf. A high number of turtles are incidentally captured by trawlers every year in the Adriatic waters, a part of which ends up dying because of gas embolism and/or drowning. Reducing the time, a turtle is retained in the trawl is essential to reduce both direct and delayed mortality. To prevent retention in the nets, Turtle Excluder Devices (TEDs) have been designed and enforced in many fisheries of the world. In the Mediterranean, bottom trawlers target multiple species of relatively large size, hence it was thought that TEDs implementation would result in a higher commercial loss compared to traditional gears. Recent tests on a flexible TED provided promising results when used on multi-species trawls. The LIFE MEDTURTLE project (co-founded by the LIFE instrument of the EU) aims to evaluate and show to fishers the efficiency of this type of TED in the Adriatic Sea. Fishers play a key role in sea turtle conservation, therefore, considering their reticence to change the gear traditionally used, it is crucial to determine the optimal gear configuration that can benefit both commercial income and turtle conservation. TED trials have been conducted by collecting data onboard between November and March of 2021-22 and 2022-23in two known bycatch hotspots in the Adriatic Sea, the area facing Rimini in the North and the Gulf of Manfredonia in the South. In each haul, the number of bycaught turtles, the weight of target (commercial catch) and discard (species that have no commercial value and undersized or damaged individuals) were assessed. In total, 171 hauls were carried out (66 TEDs, 105 Control, i.e. the regular fishing net) and 15 turtles were captured alive. Standardised Target and Discard (kg per hour of trawling) were analysed with Generalized Linear Mixed Models to examine the influence of Treatment (TED or Control), DN (Day/Night) and Depth, across the various vessels. Target revealed a small but significant decrease with Depth, while Treatment and DN showed no significant effects. For Discard, TED Treatment had a small but significant decrease compared to Control, whereas DN and depth did not have a significant effect. We conducted a logistic regression to investigate the effects of Treatment, DN, and Depth on turtle bycatch. Treatment significantly decreased the likelihood of turtle bycatch, while DN and DEPTH did not demonstrate significant effects. These preliminary findings suggest that the use of this flexible TED can be promising in reducing turtle bycatch in the Adriatic Sea. However, they also stress the importance of raising awareness and actively involving the fishing community in conservation efforts for the effective implementation of conservation strategies and the sustainable coexistence of commercial fishing and marine wildlife conservation.

TEN YEARS OF MARINE TURTLE STRANDINGS IN PALAWAN, PHILIPPINES: FROM HISTORICAL DATA TO ACTION PLANNING

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The province of Palawan, Philippines hosts extensive seagrass beds, coral reefs, and sandy beaches along its nearly 2000 km coastline that are home to at least four species of marine turtles. Threats to these species come from natural and anthropogenic stressors, however, our understanding of the severity, frequency, and impact of these is still very limited, and hinders the implementation of targeted mitigation and informed management strategies. In this study, we analysed stranding data compiled through citizen science, online data mining, and government reports that occurred in Palawan between 2012 and 2022. A total of 574 individual marine turtles were reported stranded, consisting of 399 (70.4%) green turtles, 77 (13.6%) hawksbill turtles, 25 (4.4%) olive ridley turtles, 5 (0.9%) leatherback turtles. The remaining 61 (10.8%) individuals had no species information reported. Based on photographic evidence available for 179 reports, the species was identified correctly in approximately 70% of the cases. Reporting was biased both geographically and temporally by individual (agency, municipality or group) initiatives, as the information provided greatly depended on respondent competency and personal motivations. Only in 44% (254 cases) of the total incidents (567) the cause of the stranding was indicated in the available documentation and fishery interaction was reported as the predominant cause of stranding (98%, 249 cases). While this is partially biased by economic incentives provided by some municipalities to surrender and report bycaught turtles, 70% of the necropsies opportunistically conducted on carcasses code 2-3 across the last 5 years, identified signs of human interaction and reported fisheries as the main cause of death. When paired with

information coming from a rapid bycatch assessment conducted by co-authors in Palawan in 2022-23, where only 2% of the bycatch events were reported by the fishers to the authorities, the scale of these interactions and their potential impact exponentially increases. Similarly, worth noting that only 15% (85) of the incidents reported involved turtles recorded to have been found dead. These data currently do not include over 150 individuals reported but undocumented, that were stranded in carcass code 3-4 between May and August 2021, along the northwest coast of Palawan and further supports that the scale of the stranding and mortality of these animals is currently greatly underestimated. Despite the bias in the current reporting system and data acquisition, this study highlights the municipalities of Quezon, El Nido, and the city of Puerto Princesa, as priority areas for further investigation, and underlines the role of bycatch in small scale fisheries as the primary cause of stranding. Priority of areas of intervention have been identified as 1) the reactivation and enhancement of the Palawan Marine Wildlife Stranding Network 2) the need for an organised and centralised digital reporting system and data repository 3) enhance medical capacity and infrastructure for rehabilitation 4) awareness campaign and training in safe release procedures and reporting bycatch in small scale fishers 5) the needs to identify feasible and effective bycatch mitigation strategies.

INVESTIGATING TRENDS IN CAUSE-SPECIFIC SEA TURTLE STRANDINGS AND MORTALITY IN THE U.S. VIRGIN ISLANDS: 2018-2023

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While anthropogenic interactions are often accepted as the most common cause of sea turtle strandings and mortality in the U.S. Virgin Islands (U.S.V.I.), sea turtle stranding reports have not analyzed trends in cause-specific mortality in the last 25 years. In this study, we reviewed and compiled the last 5 years of stranding reports from multiple sources, including the U.S.V.I. Division of Fish and Wildlife and the Sea Turtle Stranding and Salvage Network. Our main goals were to (1) define recent trends in stranding and mortality both temporally and spatially and to (2) identify specific threats faced by recovering sea turtle populations. The U.S.V.I. provides nesting and foraging habitat to juvenile and adult populations of hawksbill turtles (*Eretmochelys imbricata),* green turtles (*Chelonia mydas*), leatherback turtles (*Dermochelys coriacea*), and occasionally loggerhead turtles (*Caretta caretta*). All species of sea turtle found in the U.S.V.I. are considered of interest to the government due to their global and local conservation status, and protection of their populations via local management and regulations are critical to their recovery. This study was conducted in part to fill data gaps in the U.S.V.I. on impacts of human activities (boating, fishing, etc.), in hopes of identifying major threats to these species. Preliminary review suggests that anthropogenic hazards such as boat strike and entanglement are leading causes of mortality among stranded turtles, signifying an urgent need for conservation actions such as mitigative measures from local government and community engagement.

FREQUENCY OF VESSEL STRIKE INJURIES IN SEA TURTLE STRANDINGS ALONG SANIBEL AND CAPTIVA ISLAND, FLORIDA, U.S.A.

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Vessel strikes affect sea turtles at various life stages and remain a significant threat to population recovery in many regions globally, including the southeast United States. In Florida, the Sanibel-Captiva Conservation Foundation (SCCF) documents strandings on the beaches and surrounding waters of Sanibel and Captiva, two barrier islands in Lee County, Florida, USA. For the past four years in Florida, Lee County had the third highest annual number of registered vessels, a metric used to correlate boating activity and vessel strikes. According to Florida Fish and Wildlife Conservation Commission, vessel strikes are also leading cause of stranding for sea turtles in Lee County in 2023 (Florida Sea Turtle Stranding and Salvage Network). In this study reports and photographs of strandings from 2010-2021 were analyzed to assess the incidence of vessel strike injuries (VSI) and identify patterns among species and size class. Approximately one-third of all strandings (n=627) documented in this analysis presented with VSI. Due to severe decomposition, 13.9% of strandings were indistinguishable for VSI. Of all identified vessel strike strandings, loggerheads (*Caretta caretta*) accounted for the highest number (n=125), followed by greens (*Chelonia mydas*: n=52), and Kemp's ridleys (*Lepidochelys kempii*: n=16). Curved carapace length measurements suggest that, on average, vessel strike-stranded loggerheads ranged from subadults to adults while stranded greens and Kemp's ridleys typically fell in the juvenile and subadult size range. Although loggerheads accounted for the highest total number of watercraft interactions overall, green turtles had the highest percentage of VSI (39.7%). Loggerheads stranded most often during summer months (June, July, August), but loggerheads with VSI were most commonly documented earlier (May, June). Loggerheads regularly nest in the study area and are most prevalent at the subadult and adult lifestages, accounting for the most strandings among the three species. The higher incidence of VSI in loggerheads during late spring and early summer may be a result of turtles spending more time nearshore and closer to the surface during mating. Conversely, Kemp's ridleys and greens nest less frequently in the study area. The frequency of juvenile and subadult strandings for these two species likely reflect the use of nearby neritic habitat as foraging grounds, and the monthly variation observed may suggest seasonal shifts in behavior. While roughly one-third of all analyzed strandings had VSI, this may be a conservative proportion as strandings were analyzed from reports and photos (which may not have always been high quality if present). Additionally, 228 strandings were documented in 2018 during an intense red tide event, and only 33 were observed to have VSI (the majority had no obvious injuries and were likely red tide related). This may have decreased the overall proportion of strandings with a VSI. Addressing and reducing mortality from watercraft interactions remains a recovery priority for loggerhead, green, and Kemp's ridley sea turtles. Data from the twelve-year period suggest vessel strikes are a significant cause of stranding in Lee County, Florida and reinforce the need for initiatives to reduce the number of watercraft interactions among sea turtles.

ILLUMINATED POUND NETS REDUCE SEA TURTLE BYCATCH*

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Pound nets are a passive fishing gear used globally that can lead to frequent bycatch of sea turtles and other protected marine megafauna. However, despite their global ubiquity and high bycatch, there are few tested solutions to reduce sea turtle bycatch in pound net fisheries. Net illumination is a sensory-based bycatch reduction technology that has reduced bycatch of sea turtles and other marine megafauna while maintaining target fish catch in multiple coastal gillnet fisheries worldwide. Given the success of gillnet illumination, we tested the effects of illuminating pound nets with green light-emitting diodes (LEDs) on sea turtle bycatch and target fish catch in a coastal North Carolina pound net fishery. We conducted 133-pound net trials (N = 72 control nets; 61 illuminated nets) across 3,153 hours of fishing effort, resulting in 93 sea turtles captured (N = 58 turtles in control nets; 35 turtles in illuminated nets). We fit generalized additive models (GAMs) to quantify the effects of illumination and environmental variables on sea turtle and fish catch rates. The best-fit GAM for sea turtles predicted a significant 28% decrease in bycatch rates (defined as the number of turtles caught per 24 hours of fishing effort) in illuminated versus control nets. Large turtles (> 40 cm, comprised of 94% loggerheads) were predicted to have a much greater reduction in bycatch rates (-46%) in illuminated nets compared to small turtles (-4%, < 40 cm, comprised of 65% green turtles and 35% Kemp's ridley turtles). Additionally, the predicted reduction in the bycatch of recaptured turtles (-52%) was greater than the reduction in bycatch for newly captured turtles (-15%). Best-fit GAMs also predicted a significant 64% reduction in shark and ray bycatch rates. There was no significant reduction in target flounder catch, although the trials were conducted outside of the typical fishing season and with different mesh size than is typically used in the fishery. Moreover, illuminated pound nets significantly reduced bycatch rates of sublegal flounder, which may have important implications for recovery of the stock. Our results suggest that pound net illumination using green LEDs may be an effective method for reducing sea turtle and elasmobranch bycatch. While this study was conducted using surface set pound nets, our results provide a global framework for submerged pound net fisheries with high sea turtle mortality.

INCIDENTAL BY-CATCH OF SEA TURTLES IN COASTAL AND OFFSHORE FISHERY IN KALPITIYA PENINSULA, SRI LANKA: ASSESSMENT OF FISHER KNOWLEDGE, PRACTICES AND ATTITUDES

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Of the seven sea turtle species in the world, five, namely, green turtles, olive ridleys leatherbacks, loggerheads and hawksbills, come ashore to nest in Sri Lanka. Despite their protected status, sea turtles are still under threat. The most serious threat faced by the turtle population inhabiting and migrating through the Kalpitiya Peninsula is incidental by-catch in fishing gears. This study investigated fishers' knowledge, practices, and attitudes towards incidental sea turtle by-catch in the Kalpitiya Peninsula through fisherman interviews. Eighty-two fishers from 10 villages were interviewed through phone and in-person using a pre-tested, structured questionnaire comprising 40 questions after obtaining verbal consent (snowball sampling method). Data were entered into a database, and the responses of the fishers were analysed. The main source of income for all participants was fishing. All interviewees stated that they had seen turtles; olive ridley (48%) and green turtle (37%) were seen more frequently. The majority (88%) of the fishers claimed that having turtles was important. Most of the respondents (77%) stated turtles do get entangled in their fishing gears; and all claimed that they release turtles without harming. Some fishers (34%) said that 10-50 turtles get accidentally entangled in their fishing gear and 38% admitted that ray nets catch the most number of turtles while 37% said all the types of nets catch sea turtles. More than half of the fishers (63%) claimed that they had consumed turtle meat, and few (15%) had consumed it recently. Some (62%) said that still there was a demand for turtle meat. Ninety percent of the respondents admitted that it is necessary to conserve turtles. The survey results show that although the turtle entanglement rate was high, the fishers were well aware of the legislation and therefore claimed that they release turtles without harming. Only a few fishers claimed that they had consumed turtle meat recently. This confirms that although fishers are well aware of the law, few people are consuming turtle meat if they could hide it. The survey shows that fishers have sufficient knowledge about sea turtle legislation and positive attitudes towards the conservation of sea turtles but claimed that their fishing practices lead to turtle entanglement and damage. This indicates incidental by-catch in fishing gear still exists in the Kalpitiya Peninsula and the turtle entanglement rate is very high. Although the fishers released the entangled turtles, the entanglement could harm the turtles, and hence this study confirms incidental by-catch in fishing gears is a severe threat to the sea turtles. Moreover, the information provided by the respondent during the study may not exact things happening in the sea especially concerning the release of turtles and consuming the meat. So it is highly recommended to continue the fishermen awareness programmes to encourage fishers to release the turtles without harm.

OVERVIEW OF A 16-YEAR LOGGERHEAD NESTING TREND, POACHING AND THE USE OF HATCHERIES IN RESPONSE TO INCREASING TOURISM AND RELATED THREATS ON SAL ISLAND, CABO VERDE*

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Loggerhead turtle conservation, nesting beach monitoring and data collection on Sal Island have been conducted uninterrupted since 2008, covering 16 nesting seasons. This rapidly growing loggerhead nesting aggregation has seen nesting numbers increase from an average of 1,081 nests in the first 5 years of the project to an average of 27,255 nests in the most recent 5 years. Poaching of nesting females, which has been recorded since 2008, has fluctuated with the number of nests laid. This has challenged the conservation effort which has expanded, in response to the increase in nest numbers, to cover 60% more nesting beaches, partly due to increased nesting on smaller, previously underutilised beaches. This increase in nesting has also amplified anthropogenic threats, both from tourism and poaching, and suitable nesting beaches have been compromised, resulting in increased implementation of nest relocations and the use of hatcheries. Hatchery use on the island has expanded from the use of one small hatchery in 2008, to six hatcheries throughout the island, one of which protected on average 1,200 nests in recent seasons (2018-2023). Addressing increasing threats in a growing population has dominated the conservation campaign's efforts and funding. The successes of turtle conservation on Sal Island will be presented, demonstrating how conservationists are coping with the growing demand for impactful conservation in a rapidly increasing loggerhead population, whilst facing reductions in suitable nesting sites, poaching, and increasing tourism. This will be the first time that this rookery is represented internationally at the ISTS after 16 years of constant conservation efforts.

BY-CATCH(ING YOUR HELP FOR THE PROTECTION) OF SEA TURTLES IN THE EAST CENTRAL ATLANTIC

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Conservation of highly mobile and migratory marine species requires comprehensive assessment of population trends and impacts at a large-scale. The East Central Atlantic Ocean (ECAO) is characterised by a high biodiversity of marine megafauna including endangered species such as sea turtles, and it serves as an important fishing area for over 50 countries. This overlap results in substantial risk of fishery bycatch, which is the main known anthropogenic cause of mortality to marine megafauna worldwide. Bycatch monitoring programs, involving on-board observers, remote monitoring systems and stranding networks, compile essential information for the understanding and quantification of impacts. Sufficient and representative spatial and fleet coverage as well as long time series are crucial to ensure adequate assessment of the impact of bycatch, and to support and monitor the development and implementation of

effective mitigation measures. We present a review of the sources of information on threats to sea turtles, and the available assessments of bycatch impacts in the ECAO, including the Macaronesian region and North-west Africa. We compile information on existing monitoring programs and the methods applied to understand and quantify bycatch impact. We focus particularly on the utility of data collected by strandings monitoring programs, which can contribute to the assessment of population status, trends and threats, including bycatch among others. Thus, we consider the organization and resourcing of the networks, their sampling strategy, the criteria used to diagnose mortality due to bycatch – and to distinguish it from mortality due to entanglement in abandoned, lost or discarded fishing gear, and the efforts to identify the fisheries responsible. We review evidence on bycatch mortality rates and on what might represent "safe" limits for bycatch mortality, as well as information on existing and proposed mitigation measures to reduce bycatch mortality. This will be an interactive presentation by which we will "bycatch you attention" and solicit input from the experts attending the International Sea Turtle Symposium, on past, present and planned sea turtle monitoring, research on bycatch impact, and conservation actions, to help us fill knowledge gaps on sea turtles in the region. We aim to facilitate future collaboration, including standardisation and optimisation of data collection for the assessment of population status and trends, in the context of current projects such as CIBBRiNA (Coordinated Development and Implementation of Best Practice in Bycatch Reduction in the North Atlantic region) and REDUCE (Reducing bycatch of threatened megafauna in the East Central Atlantic), and initiatives like the development of a European common stranding database.

FATAL SHARK ATTACK ON A LOGGERHEAD SEA TURTLE (CARETTA CARETTA) FOUND STRANDED OFF THE COAST OF THE STRAIT OF GIBRALTAR, SPAIN

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Injuries inflicted by sharks are a frequent occurrence in stranded sea turtles worldwide. Studies on interactions between large sharks and sea turtle strandings, however, have practically no reports along the Spanish coast. Shark predation can occur while the turtle is alive or may be post-mortem. Care should be taken during necropsy to differentiate between these wounds, by thorough analysis of the defect and the demonstration of tissue reaction to the injury. Scavenging of carcasses may also preclude a complete necropsy, obscuring the determination of the cause of death or stranding of the turtle. The animal was a subadult female loggerhead sea turtle found recently dead on a beach off the coast of the Strait of Gibraltar, Algeciras Bay, Cádiz. The turtle was in good nutritional condition, weighing 59.7 kilograms. The decomposition status indicated that it was freshly dead (code 2 of 5), and the curved carapace length (CCL) measured 56 cm, compared to the expected 73 cm when accounting for the depredation area of the carapace. Macroscopically, a large wound stands out, extending caudally from one end to the other of the carapace and penetrating completely, affecting from the surface of the carapace to the plastron. In this way, all the musculature, organs, and structure of the turtle become absent throughout the affected area. The injury was characterized by incised marks, triangular, measuring 4 cm by 3 cm each and with a semicircular arrangement, which correspond to the typical characteristics of a shark bite. Post-mortem examination revealed evidence of exsanguination and a freshly bleeding bite, with the absence of the right kidney.

Additionally, all the tissue from the caudal part of the carapace, starting from the fourth right lateral scute, was missing, exposing the coelomic cavity. Bite characteristics suggest that the great white shark (*Carcharodon carcharias*) could have been responsible for the death of the sea turtle, although further tests are needed. Previous studies in fisheries show that in the Mediterranean Sea, the white shark exhibits a broad diet. The most common prey found includes small cetaceans, tuna (*Thunnus* spp.), swordfish (*Xiphias gladius*), and loggerhead sea turtles. Previous studies in the southeastern USA found that injuries primarily involving the carapace were never observed in scavenging cases. Flipper amputations often were incomplete (>80% of the flipper removed), and some turtles had more than one amputation. In our case, the right flipper was completely removed. In this work, we emphasize the importance of conducting complete necropsies. It is crucial that these procedures are carried out by veterinarians with extensive pathology experience, supported by experienced pathologists who can perform histopathology analyses. Not only to determine the cause of death but also, in cases like these, to differentiate whether the attack occurred 'in vivo' or post-mortem. This case represents the first confirmed record of a loggerhead turtle's death possibly due to a great white shark attack in Spanish waters. Additionally, it also contributes to the limited records of this shark species in this area, thereby helping to generate more information regarding its distribution and abundance.

PLASTIC INGESTION IN MARINE TURTLES: INSIGHTS FROM DIFFERENT STUDY APPROACHES*

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Plastic ingestion is considered one of the main threats and a priority conservation concern for marine turtles. Understanding the impacts of plastic ingestion is crucial for assessing the vulnerability of marine turtles to this threat. The existing approaches for researching/monitoring plastic ingestion in marine turtles are numerous, and these essentially depend on (i) the source of specimens, dead animals (stranded and bycaught turtles) or live animals (turtles rescued from stranding or bycatch events and wild-captured turtles); and (ii) the sampling methods used to collect the ingested plastic (necropsy, fecal matter monitoring or gastric lavage). The aim of this study is to assess the strengths and limitations of these approaches based on a study of plastic ingestion by juvenile green turtles (N=237), *Chelonia mydas*, in Uruguayan waters from 2014 to 2020. The overall incidence of plastic ingestion was over 70% across all sources of specimens. All examined turtles exhibited a similar pattern of ingestion with respect to plastic characteristics; laminar soft plastics in clear/transparent and white colors were the most consumed type of plastic across all sources of specimens, accounting for 30% to 60% of the ingested plastic. However, the quantities of plastic registered on stranded dead turtles (mean ± SD = 260.1 ± 343.7 pieces of plastic) were at least 10 times greater in comparison to the other sources of specimens, also exhibiting a higher variability in terms of amounts and characteristics of plastic ingested. We conclude that stranded turtles (and potentially rescued turtles) collected opportunistically are subject to analysis biases because they may be in poor health conditions when encountered, consequently reflecting abnormal feeding behavior and/or habitat use. Nevertheless, these animals can provide valuable insights into the severity of plastic ingestion impacts on individual turtles. In contrast, bycaught and wild-captured turtles are generally more reliable indicators of a population's overall exposure to plastic ingestion if sampling is systematic over time. Regarding sampling methods, necropsy remains the most reliable technique, enabling the collection of all

digestive contents separately from oesophagus, stomach, and intestines. While faecal monitoring allows for the inclusion of live animals in this type of study, provided that the monitoring periods exceed the upper limit of ingestion passage time. Gastric lavages were found to be an inefficient method for collecting ingested plastic in this study.

WHICH TURTLE, AND WHERE? COMMUNITY SURVEY AND SATELLITE TELEMETRY IN SUMATRA, INDONESIA, TO SUPPORT PROTECTION AT SEA*

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The direct capture of sea turtles is a persistent threat to sea turtles in Southeast Asia. Indonesia remains a global hotspot for the exploitation of sea turtles, despite their protected status in Indonesia. Thanks to the cooperation of various stakeholders and the implementation of conservation programmes, egg harvesting has been reduced at some nesting sites. However, conservation at sea remains a challenge. In particular, the lack of information on sea turtle spatial behaviour and the unknown origin and demography of captured turtles challenge the implementation of at sea conservation. We conducted a questionnaire survey in two communities in Sumatra in March-April 2022 and May-June 2023, and collected information on sea turtle capture. We also identified the species and measured the carapace of sea turtles (n = 45) captured in the surveyed communities. In addition, we tagged four female green turtles (*Chelonia mydas*, Cm) with satellite transmitters in June 2023 after they had nested in two rookeries (n = 2 on Bangkaru Island/Aceh, n = 2 on TWP Pieh/West Sumatra) located near the surveyed communities. Our study provides insights into sea turtle capture, the demographics of captured sea turtles and preliminary results on the spatial behaviour of tagged green turtles. The main aim of our study was to inform the management of sea turtle conservation in Sumatra. Our results indicate that the most commonly captured turtles are green (91%) and hawksbill (65%, *Eretmochelys imbricata*, Ei), which are the most abundant species in the region. Turtles are captured using nets, spears or directly on the beach. Both incidental and accidental captures were recorded. Carapace measurements indicated that the majority of captured turtles were juveniles and subadults - Cm mean CCL = 75cm (n = 35), Ei mean CCL 53cm (n = 10). Given that juveniles and subadults are being targeted, we are concerned about the future recruitment of sea turtles and the threat of declining numbers of nesting females in the area. Satellite telemetry data provides evidence of connectivity between green turtle foraging sites. Although the rookeries were about 500 km apart, two turtles from Bangkaru Island and one from TWP Pieh moved to the same area in South Nias. The other tagged turtle from TWP Pieh moved along the Sumatran coast to the Bali area, travelling almost 2,000 km. These

patterns are consistent with previous studies on the spatial behaviour of green turtles, which have confirmed movements towards fixed foraging areas where different populations mix. We also used our questionnaire survey to identify areas at sea where turtles are at high risk of exploitation. Combining these data with satellite telemetry, we found that all turtles moved within the high-risk exploitation areas. The satellite telemetry results therefore highlight the need for increased protection at sea, as protection of nesting sites is limited to female nesting turtles.

THE USE OF CIRCLE HOOKS TO MITIGATE LOGGERHEAD BYCATCH IN BOTTOM LONGLINE OFF THE GULF OF GABÈS

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Interactions between fisheries and sea turtles, represent a global conservation issue, and mitigating the impacts of these interactions is a crucial step to ensure the sustainability of fisheries and the conservation of these reptiles. Among the various fishing methods used in the Mediterranean, bottom longlines are particularly harmful to sea turtles. This method, rooted in ancient fishing practices employing hooks and bait, poses a significant threat. In the gulf of Gabès, one of the most important foraging and wintering ground for sea turtles in the Mediterranean, bottom longlines is targeting mainly groupers and some bottom elasmobranchs. Loggerhead sea turtles interact also with this gear. This study, conducted within the framework of the EU co-funded LifeMedturtles project, aims to assess the effectiveness of circle hooks in comparison to traditional J hooks as an alternative method to reduce interactions between sea turtles and fishing gear in the Gulf of Gabès. A total of 36 sets were carried out using 23,176 hooks, which included 6,665 C hooks and 16,511 J hooks. These sets were conducted under identical conditions, including the same depth, weather conditions, and bait, in order to evaluate their impact on both target species and sea turtles. Preliminary results indicate no difference between the two hook types concerning the target species. However, a notable difference emerges concerning sea turtles. To be precise, all six sea turtle captures occurred with J hooks, resulting in a catch rate of 0.36 turtles per 1000 hooks, whereas C hooks registered no sea turtle captures. It appears that circle hooks may offer a promising alternative for reducing bycatch without compromising the catch of the targeted species. More investigations are needed for adoption of circle hooks as an alternative mitigation measure.

IMPACTS OF X-PRESS PEARL SHIP DISASTER ON SEA TURTLES AND THEIR HABITATS IN SRI LANKA*

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Sri Lanka is situated in the East West trade path of the Indian Ocean where over two thirds of world's oil shipments and one third of bulk cargo are transported. X-Press Pearl was a container ship registered in Singapore which arrived in off Colombo port on 19th May 2021 engulfed in flames. After burning for 12 days, finally the ship sank on 2nd June 2021 while towing to the deeper waters. The ship was carrying 1,486 containers including 25 tons of nitric acid, 42 different kinds of other chemicals, urea, cosmetics, low-density polyethylene (LDPE) pellets etc. The detrimental impacts to the marine environment, fisheries sector, tourism sector, wildlife conservation sector and day to day life of many coastal communities are yet to be fully assessed and recovery efforts may take long period to achieve the successful results. 433 sea turtles have died and washed up on Sri Lankan beaches. The carcasses include critically endangered Hawksbill sea turtle (*Eretmochelys imbricata*), endangered green sea turtles (*Chelonia mydas*), leatherback turtles (*Dermochelys coriacea*) and olive ridley turtles (*Lepidochelys olivacea*). In addition to the sea turtles, more than 20 dead dolphins and 7 dead whales have been recorded after the X-Press Pearl ship disaster. Since only small portion of the dead animals wash ashore (between 10-20%) and the rest could be sunk in the bottom of the ocean or carried away from the beach by the currents, the true numbers of affected and dead animals could be more than 2000. The Department of Wildlife Conservation (DWC) collects the carcasses and conducts the post-mortem and then sends same tissue samples to the government analysts department for post-mortem report. However, none of the post-mortem reports have been released and therefore, the exact cause of death is not yet known. We have observed some forms of chemical burning on the surfaces of the bodies of the dead turtles and dolphins, even dissolving their skins and shells. In addition, oral and cloacal bleeding was observed. Some chemicals and plastics that are reported to have been in the X-Press Pearl ship are commonly associated with toxic additives or monomers which are known to have impacts on the marine environment. Some of the monomers making up the polymers are intrinsically hazardous (e.g., Polystyrene, PVC). Additive chemicals are not strongly bound within the plastic matrix and therefore will tend to leach into the surrounding environment. Among the most hazardous additive types are brominated flame retardants, phthalates, and lead compounds. X-Press Pearl was carrying oil, petroleum and PCBs which can lead to marine pollution. Heavy metals such as lithium and cadmium could also cause the development of cancers among the marine fauna such as fibropapilomatosis in sea turtles. Impacts on ecosystem services from the marine environment, irreversible impacts on mangrove ecology, marine biodiversity, and coastal ecology - changes in marine water quality and the population dynamics of species composition needs to be fully investigated.

AN ASSESSMENT OF THE NURDLES POLLUTION AND ITS IMPACT ON SEA TURTLE NESTING ALONG THE COASTAL BELT IN SOUTHERN AND WESTERN COASTAL BELT IN SRI LANKA, DUE TO THE MARITIME DISASTER OF MV X-PRESS PEARL CARGO SHIP*

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The largest maritime accident to ever occur in Sri Lankan coastal waters happened on May 20, 2021, involving the cargo ship MV X-Press Pearl. The local population, the economy, and the fragile coastal ecosystems have all been profoundly impacted. Even while the environmental impacts appear severe, and review of the various studies shows that the long-term consequences are derived especially due to the huge amount of Nurdles, which are small, pre-production plastic pellets released from the wrecked ship. Most of the research has been focused only on the environmental, economic, and social impacts related with the shipwreck, but when it comes to biological issues, no in-depth study has been conducted to find the negative impacts of nurdles pollution on sea turtle nesting areas along Sri Lanka's coastline. Thus, the main goals of this study are to evaluate the pollution levels along the Western and Southern coastlines where the Nurdles (which are small, pre-production plastic pellets) pollution occurred and to determine the impact of the shipwreck of the X-Press Pearl on turtle nesting. In addition, strategies for restoring the ecosystems have been proposed along with an identification of the risks facing the turtles. Secondary sources were also given priority for gathering data. The research findings revealed that the western coastal belt was impacted to a greater extent than the southern coastal belt by the catastrophe. There has been one documented turtle death in the Southern coast since then, and 176 turtle deaths that washed ashore in the Western coastal belt by July 7, 2021, have been reported. Another striking finding was that 50% of the coastline belt of Western Province was affected by the Nurdles related environmental impacts and oil pollution. However, seasonal observations showed that the sea turtle nesting in the Southern coast was not greatly impacted. Additionally, investigation reports indicated that chemical and oil spills had caused significant impacts or influence on sea turtle nests in the Western coast. Specifically, the death rate of turtles along the Western coast has increased due to hazardous chemicals such as Nitric acid, Nurdles and oil as per the data gathered from government institutes, official interviews, and field observations. Furthermore, information obtained from those government research institutions and universities revealed that the ship accident may have triggered long-term negative impacts on the coastal ecosystems and the coastal community. As a result, this research has recommended appropriate solutions to protect the marine environment. These include, aware the public on the severity of the ocean pollution, implementing ecosystem restoration, and conducting ongoing education and awareness-raising campaigns. Similarly, conserving turtles ought to be given top priority, and ongoing beach clean-up campaigns to be implemented continuously.

MICROPLASTIC INGESTION BY SEA TURTLES AROUND TOKYO BAY: LEVEL OF WATER POLLUTION INFLUENCES INGESTION AMOUNTS*

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All seven species of turtles around the world have been reported to ingest microplastics (MPs), but their susceptibility to MPs is still unknown. Although studies on MP ingestion by turtles have taken place worldwide, only a few have investigated ingestion cases in the Northwestern Pacific Ocean. Sampling in such water basins is necessary to obtain a geographically comprehensive understanding of MP ingestion by turtles. Tokyo Bay, a Japanese bay facing the Pacific Ocean, is the gateway to the most industrialized region in Japan. The bay is highly polluted with MPs even compared to other bays in the world. The presence of rivers is one of the factors that drives MP pollution in ocean waters, but there is a critical knowledge gap regarding whether and how MP densities in the ocean influence the amount of MP ingestion by turtles. In this study, we investigated 22 bycaught/stranded turtles from inside and outside Tokyo Bay, where they faced high and low risks of MP exposure, respectively. We recorded the number of MPs inside their oesophagi and stomachs, bycatch/stranding locations, and straight standard carapace length (SSCL). Sixty-five MP particles were isolated from 8 out of the 22 subject turtles (36.4%). The particles were composed of 8 polymer types: polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), polypropylene (PP)/nylon compounds, styrene-butadiene rubber (SBR), cotton polystyrene, urea-formaldehyde (UF) resin, and unsaturated polyester (UP) resin. Thermoplastic (PE, PP, PET, and PP/nylon compounds) dominated the samples from the seven turtles in the high-risk areas, which was consistent with previous studies on MP properties in Tokyo Bay waters. Poisson regression, with the number of MPs and the bycatch/stranding locations as objective and explanatory variables, respectively, indicated that turtles in high-risk areas ingested significantly more MPs than those in low-risk areas. This result enhances our understanding of the dynamics of MPs in the environment. Inflows of MPs from major rivers influence pollution levels in the ocean, and contamination in local aquatic districts affects MP ingestion by wild turtles in that region.

ASSESSING MARINE TURTLE BYCATCH IN SMALL-SCALE MUNICIPAL FISHERIES IN NORTHERN PALAWAN, PHILIPPINES*

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Anthropogenic threats continue to impact marine turtle populations in the Philippines. As a country with an estimate of over 2 million small-scale municipal fishers across its archipelagic geography, it is difficult to monitor their catch and landing activities. Until recently, minimal attention has been given to the incidental take of turtles in these fisheries because of their perceived low ecological impact. Current data on non-targeted catch in small-scale fisheries is often inadequate and obscures our understanding of turtle bycatch and mortality. Rapid bycatch assessments through semi-structured interviews were used to gather baseline information on turtle bycatch in small-scale municipal fisheries in the Philippines. To date, surveys were conducted in 6 provinces, spanning 61 villages in 14 municipalities and 2 cities, and carried out a total of 1,694 household interviews, 128 key informant interviews, and 107 focus group discussions. For the preliminary results here, we focus only on characterizing turtle bycatch in small-scale municipal fisheries in Northern Palawan, Philippines. In this region, we completed 989 semi-structured household interviews in 17 villages across 3 municipalities and 1 city. Only direct experiences from the respondents within the last 3 years prior to the interviews were analyzed to reduce the effect of memory decay on the results. A total of 642 bycaught individual turtles were reported in the household interviews, with the most species being identified as green turtles *Chelonia mydas* (n=313) and hawksbill turtles *Eretmochelys imbricata* (n=119). Most of the bycatch incidents involved bottom-set gillnets (n=182), drift gillnets (n=153) and fish corrals (n=118). Most of the turtles found in the gears were reported as alive (n=633) and released, with 1 reported to be consumed; however, it is possible that mortality and consumption of turtles were underreported in the household interviews. Out of the 642-individual bycatch from the respondents, only 0.01% (n=9) were reported to local authorities. The initial findings in Northern Palawan underscores the utility of rapid bycatch assessment interviews in capturing data on the overlap between small-scale municipal fisheries and threatened species; particularly, in identifying priority sites for landing monitoring and bycatch mitigation, and in determining the fishing gears with high turtle bycatch incidence and their characteristics. Data collected from the rest of the sites will be important in filling in key knowledge gaps beyond Northern Palawan, thereby providing a better understanding of the ecological impact of incidental take in small-scale fishing operations within Philippine municipal waters, which is crucial in determining ways forward for policy and management.

SEA TURTLES, SEA USERS AND COLLISIONS: HOW TO IMPROVE MONITORING AND COHABITATION IN REUNION ISLAND, INDIAN OCEAN?

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Reunion Island is home to a significant number of coastal sea turtles, which have increased and then stabilized over the past 15 years. This foraging population consists of green (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*) at juvenile stages. The breeding population is very rare and relies on a single regular nesting female. The significant demographic growth of the foraging population has been accompanied by a considerable increase in human recreational activities along the coast. And unfortunately, since 2014, a growing number of collisions between turtles and vessels has been observed. Almost all of them were fatal. There is an urgent need for a better understanding of the threat and how it is evolving, particularly in order to improve awareness-raising materials for sea users and recommendations for supervising activities. After two pilot studies, an at-sea survey was initiated in 2022 to meet this need. Two transects were defined between the locations of L'Ermitage and Cap La Houssaye (west coast of the island) in the 300m coastal band, which is the most frequented by turtles and boats. A total of 14 transects (80 km covered) were carried out from a semirigid research vessel (5.7 m long with 70cv horsepower outboard engine) between January and October 2023, during which 43 turtles were observed (Cm=41, Ei=1, NA=1) at a frequency of 6.3 individuals per hour. The estimated length of the carapace of 56% of them was less than 50cm and that of 14% of them was greater than 1m. In total, 103 boats were encountered, with the average number of boats per hour varying between 7.1 and 23.9, depending on the time of day surveyed. The probability of encounter was highest between 10 and 11 a.m. The vessels encountered were mainly scuba divers (40%), passenger transporters (24%) and recreational vessels (9%). In 33% of cases, their estimated speed was greater than 5 knots, which is outside current regulations. After a first year of testing, it is recommended that the survey be continued, and the protocol completed in order to improve the robustness of the analyses and the accuracy of the spatial representations of the cohabitation of turtles and uses. It also emerged that counting and characterizing boats, as well as assessing whether practices comply with current legislation, depend on a certain amount of experience on the part of observers, and subjective judgements that need to be refined. However, the consistency of the monitoring parameters and their maintenance over time will make it possible to reduce bias and more accurately reflect the risk of collision and its evolution. The aim is to disseminate this knowledge to institutions and users to raise awareness on the need to respect navigational speed, as it is essential to limit this emerging threat to protect sea turtle populations, and in particular the relict population of breeding sea turtles of the island.

COMPARING PACIFIC LOGGERHEAD DISTRIBUTION MODELS DERIVED FROM SATELLITE TELEMETRY AND FISHERIES OBSERVER RECORDS*

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Fisheries bycatch is a primary threat to sea turtles globally. A key step to limiting sea turtle bycatch in commercial fisheries is understanding when and where sea turtles interact with those fisheries. These location data are often difficult to obtain, especially for pelagic environments. Fisheries observer records are one potential strategy for obtaining location-specific data on where interactions occur. Observer data can then be used to build distribution models, a common technique that combines species' presence or absence records with environmental data to develop predictive maps of species distributions. However, sea turtle bycatch in many pelagic fleets is a rare event and the resulting small sample sizes make it difficult to identify environmental drivers of bycatch and make inferences on new data. As a result, other sources of location information may be needed to supplement observer data. One potential source of data is satellite telemetry, although these data come with their own caveats. Satellite telemetry only provides information on where individual turtles are, not where they are not. This presence-only data requires researchers to generate pseudo-absences (i.e., random points that represent where animals could have gone, but did not) and the method used to do so can strongly affect results. In turn, using telemetry-derived models to predict bycatch neglects a key piece of the puzzle: fishers do not randomly sample the environment but bias their sampling towards some areas and environmental conditions in ways that telemetry-derived models do not account for. Finally, satellite telemetry data are not always available due to logistical reasons and developing methods to use fisheries-dependent data to accurately predict species distributions can increase ecological understanding at minimal cost. Our goal here is to attempt to reconcile fisheries-dependent and telemetry-derived models in order to increase our ability to use both data sources to predict the spatial distribution of both fisheries interactions and bycaught species in the future. We compared these two approaches for central north Pacific loggerheads using satellite telemetry data deployed on 428 loggerheads from 1997-2023 and fisheries bycatch records from the Hawaii shallow-set longline (SSLL) fishery from 2005 to 2021 (224 interactions out of 18,998 longline sets). We used Ensemble Random Forest (Siders et al. 2020), developed to predict rare events, to build the models for both datasets. Preliminary attempts to combine satellite telemetry data with kernel density-based pseudo-absences to predict SSLL loggerhead interactions have been mostly unsuccessful. However, we will explore new methods of pseudo-absence generation (e.g., correlated random walks), data subsetting, and environmentally-based weighting of longline sets to test whether these help reconcile the two data sources. Test data performance for observer record-based distribution models indicate better, but still relatively poor (mean area under the specificity/specificity curve: 0.65), performance that varies among years. We will discuss pros and cons of using each data source for distribution modeling and bycatch prediction, including the scope of inference for changing distributions with climate change, how to increase the utility of satellite telemetry data for predicting bycatch, and recommendations for future work.

BY-CATCH OF SEA TURTLES IN THE RAY NETS FISHERY IN THE GULF OF GABES, TUNISIA*

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Fisheries bycatch is considered one of the main threats to sea turtles. Previous studies in Tunisia recognized ray nets named Garrasia as one of the fishing gears with the highest levels of by-catch. In this study, 56 onboard observations were conducted with fishermen in the south of Tunisian coastal in ports of Zarzis and Jerba between 2018 and 2022. Eighty-three sea turtles were incidentally caught in fishing sets. All sea turtle captured were loggerhead *Caretta caretta* and 93.94% of individuals were dead. The majority of individuals caught were classified as sub-adults and adults (80.72%), with an average carapace length (CCL) of 67.33± 2.6 cm. The mean catch per unit effort (CPUE) is high: 0.46 turtles * net km^{-1} * 24 h^{-1}; 95% CI: [0.27-0.65] for Ray nets with seasonal variations. The highest CPUE being observed in spring (mean CPUE 0.62 ± 0.65 turtles * net km^{-1} * 24 h^{-1}) followed by autumn (CPUE = 0.46± 0.23 km-1 24 h-1) and summer (CPUE= 0.38± 0.24 km^{-1} 24 h^{-1}). Based on available census of active ray fisheries in Tunisia, the total capture by ray nets is estimated 1944.63 turtles per year (95%CI [1118.04 - 2691.58617]). The important interaction of sea turtles with Garrasia objectified in our study confirms that the gulf of Gabes is an important foraging area and developmental habitat for loggerhead turtles where fisheries interaction with sea turtle is high. Results emphasize the need of identification and implementation of mitigation measures to reduce sea turtle bycatch by small fisheries with particular attention for large meshes gillnets.

SPATIOTEMPORAL OVERLAP BETWEEN AIS-TRACKED LONGLINERS AND LOGGERHEAD TURTLE FORAGING HABITAT IN THE OPEN WATERS OF THE WESTERN INDIAN OCEAN*

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Sea turtles are largely impacted by industrial fisheries worldwide. Although strategies for at-sea risk mitigation exist, bycatch avoidance remains challenging because they are highly mobile and use a variety of habitats throughout their life cycle. To precisely identify the places and times where they might interact with fisheries, a thorough characterization of their habitat is required. We address this for large juvenile

loggerhead turtles (*Caretta caretta*) in the open waters of the Western Indian Ocean (WIO). In the WIO, loggerhead turtles use large oceanic areas to forage where they risk being caught by fisheries targeting large pelagic fish (e.g., drifting longlines and purse seines). Our study focuses on the spatiotemporal overlap between drifting longlines, using fishing hours of AIS-tracked vessels provided by the Global Fishing Watch, and loggerhead turtle foraging habitat. We identified foraging behaviour (1333 daily locations) along the tracks of 39 late-juvenile individuals (mean curved carapace length = 71.27 cm; SD = 5.89 cm) using Hidden Markov Models and we extracted a series of oceanographic variables (e.g., sea surface temperature, eddy kinetic energy, micronekton biomass) from global ocean reanalyses (accessed via AVISO+ and CMEMS) at those locations and randomly sampled ones (i.e., pseudo-absences). We used an ensemble modelling approach, combining 10 machine learning algorithms (e.g., Random Forest, multivariate adaptive regression spline, support vector machine, artificial neural network), to produce daily maps of foraging probability between June 2017 and May 2020. We found different overlap trends, measured as the percentage of fishing hours in core foraging area (i.e., foraging probability > 0.75), between the Northwestern Indian Ocean (NWIO) and the Southwestern Indian Ocean (SWIO). In the NWIO, we found a decreasing overlap with no clear seasonality whereas, in the SWIO, we found a consistent seasonal overlap with > 50% of fishing hours in core foraging area from April to mid-September and almost no overlap the rest of the year. In the NWIO, areas of high overlap are scattered across a wide latitudinal range (10°S to 20°N) whereas, in the SWIO, they are concentrated within a 10° latitudinal band (30°S to 40°S). By identifying periods and areas of high interaction risk, our study will prove useful to promote dynamic management of fisheries and reduce bycatch of loggerhead turtles in the WIO.

HARNESSING CITIZEN SCIENCE FOR ASSESSING INJURY AND RECOVERY PATTERNS OF GREEN AND HAWKSBILL TURTLES IN THE EGYPTIAN RED SEA*

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Green (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*) are frequently observed foraging and resting in the shallow, coastal bays, lagoons, and reefs of the Egyptian Red Sea coast. These areas also attract a substantial number of divers and snorkelers due to their accessibility from the shoreline and the calm, shallow waters they offer, therefore increasing the risk for marine turtles to be injured by boat strikes but also offering opportunities to collect information on these understudied species. Created in 2011, TurtleWatch Egypt 2.0 is a citizen science-based project that aims at collecting information on marine turtles in the Egyptian Red Sea to better understand their abundance, distribution and ultimately their health status. Here we focused on reports of injured turtles obtained throughout the years to better understand injury patterns and estimate recovery rates without treatment, due to the lack of rehabilitation facilities in the area. Over a twelve-year period (2011-2023), 717 unique turtles were registered, and 8480 sightings were reported. 39 turtles with injuries, sickness, or malformations were observed. Notably, 30 of those turtles were sighted multiple times, enabling in-depth case studies. One of these turtles was reported dead after injury while 26 other turtles exhibited remarkable resilience in recovering from severe injuries. In 41% of all injured cases, the cause of injury was attributed to boat collision, in 10% of cases we suspected predator attacks, in 28% of the cases we were not able to identify a unique cause of injury. The remaining 21% of injuries were attributed to a variety of factors, for example, genetic pathologies (8%), diseases (5%), cleaning activities (5%) and fisheries (3%). During the study period, we received reports from 212 sites, however injured turtles were registered only in 13 spots, with repeated reports predominantly from 4 sites: Marsa Abu Dabbab, Makadi Bay, Na'ama Bay and Hermes. At these sites, injured turtles represented 16%, 14%, 67% and 16% respectively of the total individual turtles reported for each location. In Na'ama Bay it was observed that citizen scientists tended to send more frequently information on injured turtles only, regular sightings of healthy marine turtles are likely under-reported from this location. This emphasizes the need for combining citizen science data with future, more scientific research conducted by the team. These findings stress the significance of directing conservation efforts toward sites with higher injury rates, as they are likely focal points for potential threats to the turtle population. This data yields invaluable insights for resource allocation and conservation planning in the region, particularly where more than three injured individuals were documented. In conclusion, this study sheds light on the health and conservation status of marine turtles in the Red Sea coastal region of Egypt. By emphasizing the human impact and identifying high-risk areas, it provides a foundation for targeted conservation efforts to safeguard these remarkable creatures and their habitats.

UBIQUITOUS PRESENCE OF PLASTIC ADDITIVES AND PERSISTENT ORGANIC POLLUTANTS IN SEA TURTLES FROM KOREAN COASTAL WATERS*

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Sea turtles can be an imperative bioindicator for anthropogenic chemical pollution due to their long lifespans, extended intestine passage time, and high trophic position, facilitating the accumulation of these chemicals. Persistent organic pollutants (POPs) are synthetic chemicals with a potential for low environmental degradation rate, long-range transport, bioaccumulation, biomagnification, and harmful effects on living organisms. Plastic additives, such as stabilizers and antioxidants, are added to enhance plastic properties, and as they are not chemically bound to the polymer, they are readily leachable. They have been detected in marine environments and marine organisms as plastic pollution becomes increasingly severe. In South Korea, the incidence of sea turtle bycatch is rising, and turtles exhibit high plastic ingestion frequency and quantity. Since the growing significance of biomonitoring of sea turtles in this region, we investigated the levels of POPs and plastic additives in the liver of sea turtle carcasses from the Korean coast. A total of 44 sea turtles were subjected to POPs analysis, consisting of 27 loggerheads (*Caretta caretta*), 13 green turtles (*Chelonia mydas*), 3 leatherbacks (*Dermochelys coriacea*), and 1 hawksbill (*Eretmochelys imbricata*). Among these, 21 were targeted for plastic additive analysis (9 loggerheads and 12 greens). The targeted chemicals included PAHs, PCBs, organochlorine pesticides (DDTs, HCHs, CHLs, and HCB), PBDEs, HBCDs, antioxidants, phthalates, UV stabilizers, and tire additives. Overall, plastic additives exhibited higher levels than POPs, except for tire additives. Loggerheads accumulated significantly more POPs (including DDTs, HCHs, and PBDEs) than greens (Kruskal-Wallis Test, $p < 0.05$). The prevalence of POPs in loggerheads may be associated with their omnivorous diet, contrasting with the herbivorous diet of green turtles. Loggerheads and greens had similar isomeric (or congener) profiles of POPs except for PBDEs. Three-ring PAHs, hexa-PCBs, DDE, β-HCH, trans-nonachlor, and α-HBCD were dominant. Interestingly, greens accumulated higher levels of antioxidants, phthalates, and UV stabilizers than loggerheads, although not significantly (Kruskal-Wallis Test, $p > 0.05$). Greens also showed a higher accumulation of PAHs than loggerheads (Kruskal-Wallis Test, $p < 0.05$). This is a meaningful finding as green turtles ingested more plastic than loggerheads (Moon et al., 2022). Phthalates, especially DEHP and DBP, were major components of plastic additives in both species, followed by UVMC80 (UV stabilizer), 2,4-DTBP (antioxidant), and IPPD (tire additive). Their diets and plastic ingestion quantities could influence the interspecies difference in the accumulation profiles of POPs and plastic additives.

PLASTIC POLLUTION AND HEALTH METRICS IN GREEN SEA TURTLES (CHELONIA MYDAS) IN ECUADOR: A COMPARISON OF PARKS AND THE MAINLAND*

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Marine vertebrates such as sea turtles are particularly susceptible to plastic pollution through ingestion or entanglement. Ingestion of plastic has been observed in all sea turtle species. In this study, 46 juvenile green sea turtles (*Chelonia mydas*) in two national parks (Galápagos and Machallilla) and a coastal bay in Mainland Ecuador were investigated to assess the prevalence of plastic in their faeces and compared with a suite of health metrics (vital signs, hematology, and blood chemistry). Fourier transform infrared spectroscopy (FT-IR) revealed that sea turtles had $\bar{x}= 4.4\pm5.2$ (range:0-19) microplastics (MPs)/g in faeces. Furthermore, these levels differed according to sampling location, with the most polluted samples found in the Galápagos Marine Reserve (GMR). Fibers were the most common type, $\bar{x}=3.8\pm4.5$ (range:0-16) MPs/g, and polyvinyl alcohol (PVOH), $\bar{x}=1.4\pm2.2$ (range:0-10) MPs/g, and polyacrylates (PMMA) $\bar{x}= 0.95\pm1.3$ (range:0-5) MPs/g, were the most common synthetic polymers identified by FT-IR. In tandem, we tested a complementary methodology for quantifying synthetic mass polymer concentrations within the same fecal matter: pressurized liquid extraction with double-shot pyrolysis-mass spectrometry gas

chromatography (Pyr-GC/MS). This method detected polyethylene (PE) $\bar{x}$= 367±1158 (range:0-6096) µg/g as the highest mass polymer concentration in faeces, and polypropylene (PP) $\bar{x}$= 155±434 (range:0-2944) µg/g was also abundant. The analysis also showed that the levels of plastics detected varied by location, with the most polluted samples being located in the GMR, but not in the same areas identified by FT-IR. We found that 98% of the sea turtles in our sample population had detectable levels of plastic pollution in their faeces, as identified by both techniques: FT-IR detected 70% and Pyr-GC/MS detected 83%. The discrepancies in the prevalent type of synthetic polymer and the most polluted animals in our samples, as identified by both methods, raise questions regarding the reliability of these techniques in comprehending plastic pollution. Nonetheless, both techniques indicated that the animals in the GMR were more polluted in our study populations. Health metrics showed that the animals were clinically normal, based on vital signs, morphometry, and blood values. However, animals in protected areas are more polluted, raising concerns about their future health.

ROLE OF VISUAL AND OLFACTORY CUES ON PREY RECOGNITION AND PLASTIC INGESTION IN SEA TURTLES*

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Marine plastic debris has emerged as a pervasive environmental issue affecting the world's oceans. Plastic pollution has become a serious concern due to its potential to adversely affect wildlife and aquatic ecosystems. Ingestion of marine debris is one of the primary threats to a variety of organisms. Numerous studies have provided evidence of plastic consumption by marine organisms, yet underlying reasons remain undiscovered. Sea turtles, in particular, are known to ingest a substantial amount of marine debris. The prevalent explanation is that sea turtles mistakenly ingest marine litter due to its visual resemblance to their natural prey. Additionally, the study of plastic ingestion driven by chemo-sensory mechanisms is a relatively recent area of research. If sea turtles indeed confuse plastic for prey and ingest it, it is essential to study the specific traits of marine plastic that drive sea turtles to consume it, and the mechanisms by which they mistakenly identify plastic as prey require further exploration. In this study, we aimed to assess the impact of visual and olfactory cues on prey recognition and plastic ingestion by sea turtles. Firstly, we investigated the response of sea turtles to odour solutions made from food, clean plastic, and bio-fouled plastic as compared to their reaction to odour solutions derived from pure seawater. The results indicated an increased biting frequency of the food and bio-fouled plastic odour sources as opposed to seawater odours, but these behavioral responses were not observed in the clean plastic. Secondly, we examined the use of sensory cues in sea turtles to evaluate the importance of visual and olfactory cues for prey recognition. To do this, we used four treatments: 1) visual-only (a horse mackerel decoy), 2) olfactory-only (horse mackerel pieces in a blue jar), 3) visual and olfactory combined (a horse mackerel decoy with horse mackerel odour), and 4) a control (a blue jar). The response of sea turtles was greatest for the olfactory-visual combined cue followed by the visual-only cue and olfactory-only cue. There was a complete absence of response to the controls. Overall, our findings imply a comparable attraction of food and bio-fouled plastic via olfactory sensory mechanisms, potentially explaining the frequent interactions of sea turtles with marine plastic debris. Our study suggested that sea turtles predominantly rely on visual cue for prey detection. Feeding cannot be triggered by olfactory cue alone, but these cues have a stimulating effect, enhancing motivation to forage.

ESTIMATING ANNUAL LEATHERBACK BYCATCH IN THE PACIFIC OCEAN BY FISHERY AND COUNTRY TO INFORM TARGETED CONSERVATION STRATEGIES*

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The Pacific Ocean supports two critically endangered leatherback sea turtle populations, both severely impacted from ongoing bycatch within small-scale and industrial fisheries. Conservation planning has included population viability analyses (PVA), which depend on accurate demographic inputs to yield realistic results for informing management decisions. PVA projections are based on the best available demographic data, which includes very limited data on small-scale fisheries bycatch, and has less than one percent observer coverage in industrial fisheries. As population recovery is dependent on reducing leatherback bycatch, it is critical that we know where, when, and how much bycatch is occurring. Here, we undertake a systematic review to aggregate existing estimates of leatherback bycatch within the Pacific Ocean for the purpose of creating the most contemporaneous and comprehensive estimate of Pacific leatherback bycatch. Searches through scientific databases and Google Scholar yielded 204 results which quantify bycatch for seven gear types in sixteen of the fifty countries fishing in the Pacific. New methods explore how much additional data can be captured with unprecedented literature review methods, such as searching in languages of all fishing countries, and using AI-translation of fishing reports for analysis. The final results will be presented to an expert elicitation group to determine certainty in literature estimates of bycatch, which will inform updated PVAs for both Pacific leatherback populations. Final PVA results will reveal the fisheries and countries that are most impacting the Pacific leatherbacks through their annual bycatch, and could help direct conservation efforts towards the most detrimental fisheries.

UNTANGLING THE UNKNOWN: MARINE TURTLE BYCATCH WITHIN A DATA POOR MEDITERRANEAN SMALL-SCALE FISHERY*

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Bycatch is globally recognised as a major threat to marine megafauna, with more recent recognition of the role played by small scale fisheries (SSFs). The Mediterranean fishing fleet primarily consists of SSFs and the sea is considered one of the most overexploited worldwide. Concerns regarding impacts of SSFs in the eastern basin, particularly that of marine turtle bycatch, have been shared for several decades, but to date relatively few detailed studies have addressed this priority research area. Here, we used a combination of strandings data, onboard observations, fisher self-reporting and opportunistic sampling over a four-year period to quantify the magnitude and identify key drivers of marine turtle bycatch within the Northern Cyprus SSF fleet. Across all sampling methodologies, 796 marine turtles were recorded as stranded

(n=623) or incidentally captured (n=173) including 411 green turtles (*Chelonia mydas*), 364 loggerhead turtles (*Caretta caretta*), and one leatherback turtle (*Dermochelys coriacea*). Most green turtles were of juvenile size (mean±SD=40.3±16.7 cm), whereas loggerhead turtles were mostly subadult and adult size (mean±SD=64.7±12.0 cm). Green turtle incidental capture rates were highest in trammel nets and shallower set fishing operations, whereas, loggerhead turtle capture rates were highest in gill nets and deeper set fishing operations. Bycatch probability in set nets significantly differed between green and loggerhead turtles and was largely driven by the effect of individual fisher behaviour, depth of fishing operation, and increasing mesh size. There was no clear influence of gear type, average soak time, time of day or effort. Although it is suspected that there are some synergistic effects of mesh size and soak time, with larger mesh sizes soaked for longer periods to target larger fish species which spoil less easily. We estimate over 5,500 marine turtles are captured annually across set nets and demersal longlines in this SSF, more than 4,500 green turtles and 1,000 loggerhead turtles, of which at least 55.5% and 42.8% are expected to be mortalities, respectively. This study provides the first comprehensive assessment of marine turtle bycatch and its drivers within the Northern Cyprus SSF, utilising a multidisciplinary approach to address key knowledge gaps in the Mediterranean for set nets and demersal longlines. Management strategies focusing on set nets, particularly trammel nets, which adequately consider the influence of individual fisher ability, heterogeneity of the fleet, and its operating behaviours will be key to addressing bycatch levels in this fishery which exceeded all previous estimates and those of other Mediterranean set net fisheries. Time of day and depth of fishing operations are clear candidates to explore for mitigation but require careful consideration to balance any trade-offs with other ecologically important species impacted by the fishery, such as elasmobranchs. Satellite telemetry studies focusing on evaluating diel activity patterns, spatial and depth utilisation for life stages present in resident marine turtle populations are required to complement the findings of the current study and ensure proposed targets for mitigation are sufficiently supported.

DEVELOPING BEST HANDLING AND RELEASE PRACTICES FOR FISHERS WITH FISHERS: THE IMPORTANCE OF DETAIL*

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Bycatch of sea turtles in fisheries is one of the main contributors of population declines globally. Mitigation techniques have been developed for some fisheries, but adoption of these techniques across fishing sectors is often precluded by gear configurations, vessel designs, operational characteristics, fishing methods or fisher cultures and customs across fleets. While more effective and fishery-specific mitigation techniques are under development, it is imperative to introduce fishers to handling and release methods to improve the survival of captured individuals after release. This is particularly critical in surface longline fisheries, where the use of best handling and release practices (BHRP) have been shown to reduce post-release mortality significantly. Many initiatives have already taken place in different countries to develop and implement BHRP of sea turtles, and several countries and fishery bodies have adopted regulations requiring fishers to complete trainings on BHRP, and to carry a set of tools on board. In the past 10 years, the authors have worked with different teams, and hand in hand with artisanal and industrial longline fisheries and authorities, in Spain and America (mainly in Mexico, Guatemala, Costa Rica, Panama, Ecuador and Peru) to help develop BHRP and carry out in-person trainings. This work has always included initial meetings with fishers and with authorities, and visits to fishing harbors when possible, to fully understand the fishery before making any recommendations or proceeding with trainings, and for mutual learning between professionals and fishers. 1,900 fishers and government authorities have been trained so far during this effort. This work has shown that, although general best practices for surface longline fisheries do exist and are commonly applied, they should not be used as such, since without refining they may even recommend practices or tools that are detrimental to sea turtle post-release mortality (e.g., recommending the use of long-handled line-cutters to a fishery that uses a steel leader) or that are not applicable in the condition of the fishery (e.g., obligatory use of a dipnet for small boats). There is no "one-size-fits-all" recipe. Instead, BHRP and national and regional policies should be tailored and adapted to the singularities of each fleet and fishery, or even community, based on factors such as fishing gear, vessels used, socio-economic situation of the community, availability of tools in the domestic market or fishing operations. Local ecological or traditional knowledge and co-design of the BHRP have proven to be a win-win solution for fisheries and conservation of sea turtles. This work has also identified the challenges to institutionalize the trainings and building capacities for the long-term.

NOT SKIPPING A BEAT: BEHAVIORAL RESPONSE OF LEATHERBACK TURTLES FROM CONTROLLED EXPOSURES TO A METRONOMIC MOBILE IMPULSIVE SOUND*

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The United States Atlantic Outer Continental Shelf is expected to undergo rapid development with the planned construction of offshore wind farms. Offshore wind data collection, construction, and operation is expected to alter the underwater soundscape due to geophysical seismic surveys, construction activities, vessel operations, and turbine generated infrasounds. The purpose of this study was to determine how leatherback sea turtles may respond to impulsive, low-frequency survey equipment associated with offshore wind leasing activities by the Department of the Interior's, Bureau of Ocean Energy Management. Leatherback turtles annually migrate and forage throughout the Northwest Atlantic shelf region, and regularly inhabit the waters of Southern New England, USA during the late-summer and early-autumn months. As a result, leatherback behavior could be affected by the construction of wind turbines planned for this region. To study the acoustic effects of impulsive sound on their nearshore swimming and foraging behavior, we equipped thirteen leatherback turtles, during the autumn of 2023, with short-term camera and telemetry tags and towed a seismic sparker behind a vessel to simulate a geophysical survey within Massachusetts state waters. Immediately post-tagging, turtles were left to acclimate for approximately one hour and then were exposed for 30 - 45 minutes to the active seismic sparker emitting a broad-frequency, high-intensity, impulsive sound at one second intervals. In addition to collecting video footage, GPS location, and dive behavior data, we also logged acoustic recordings throughout the deployment from each tagged turtle. Data collected were used to assess the received sound levels for each leatherback and categorize breathing events, foraging frequency, dive patterns, pitch, roll, and location prior to, during, and after the exposure. Preliminary results suggest no interruption to active foraging and turtles were present at the exposure site in subsequent days.

ANALYSIS OF POTENTIAL THREATS TO MARINE TURTLES IN VENEZUELA: A BIBLIOMETRIC ANALYSIS

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In Venezuela, several documented human-related threats to marine turtles pose a great conservation challenge. However, there are significant gaps in knowledge about some of these threats (level of knowledge and impact). In order to inform future research efforts, we conducted a bibliometric analysis of the available literature on marine turtle threats in Venezuela. We defined and categorized each threat in detail in any source. The categories were: fishery bycatch, take, coastal development, pollution and pathogens, and climate change. The references analyzed focused 13.51% of the times on take, followed by fishery bycatch (8.19%), then, pollution and pathogens (3.49%), coastal development (0.46%), and climate change (0.15%). On the other hand, 80.97% of the remaining studies focused on the biology and ecology of these reptiles (29.74%), nesting (23.37%) and conservation (34.29%). Furthermore, the analysis indicated that 39.45% of the references correspond to all spp., while among those where the studied species was identified we found that the most studied species are *Chelonia mydas* (36.42%), followed by *Dermochelys coriacea* and *Eretmochelys imbricata* and (26.1% and 25.34% respectively). In this sense, identifying and evaluating the least assessed threats to marine turtles in Venezuela is essential to understanding their real impact and designing more effective and needs-based conservation and monitoring strategies. This will also motivate continued recording and publication of the progress achieved by conservation programs in Venezuela.

SEA TURTLES IN THE NORTH PACIFIC GARBAGE PATCH: OBSERVATIONS DURING THE OCEAN CLEANUP OPERATIONS*

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Ocean plastic pollution causes numerous ecological impacts on thousands of marine species. Floating plastics can accumulate in subtropical gyres, and a very high concentration of this type of pollution is found in the eastern portion of the North Pacific subtropical gyre – an accumulation area known as the "North Pacific Garbage Patch" (NPGP). The Ocean Cleanup is a non-profit organization developing a cleanup system to remove plastic debris afloat in the NPGP. Cleanup operations began in these international waters in August 2021, and created a unique opportunity to collect biological data in the region, with continuous monitoring efforts to better understand the local environment and minimize potential negative impacts of cleanups on marine life, including sea turtles. In over 7,000 hours of towing operations conducted between August 2021 and November 2023 in the NPGP, we observed 75 sea turtles through different methods (above-water sightings, underwater observations through cameras, incidental capture and encounter of biological remains). The observed turtles included 33 loggerheads (*Caretta caretta*), 14 greens (*Chelonia mydas*) and 3 olive ridleys (*Lepidochelys olivacea*); in 25 observations, species identification was not possible. Most turtles were juveniles, with only one confirmed record of an adult (a female olive ridley turtle). Analysis of gastrointestinal tract contents of some individuals revealed 100% frequency of occurrence of plastic ingestion for the analyzed loggerhead (n = 10), green (n = 6) and olive ridley (n = 1) turtles. Individuals ingested from less than 10 to over 300 plastic items (with >1mm), primarily fragments and lines, with green turtles ingesting the highest numbers of items. Although no direct health effects (e.g. lesions, blockage) were noted in the turtles' gastrointestinal tracts, plastic ingestion could have contributed to their mortality through sub-lethal effects. In fact, most of the deceased turtles presented low fat reserves, atrophied muscles, and general signs of malnutrition. An additional impact recorded for sea turtles at the NPGP was entanglement, with 5 juvenile turtles observed entangled in ghost fishing gear. This shows that legacy plastic pollution in the North Pacific subtropical gyre impacts juvenile sea turtles in the region through ingestion and entanglement and reinforces the need for conducting cleanups at plastic accumulation areas. While the cleanup system has several mitigation measures in place (green LED lights, breathing areas, escape routes, emergency release mechanisms, operational strategies), efforts to further develop deterrent and mitigation measures that decrease the possibility of negative outcomes in sea turtle encounters are currently a priority.

BEHAVIORAL MEASUREMENTS OF SEA TURTLES INTERACTING WITH LIGHTED GILLNETS*

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Fisheries bycatch is the greatest threat to sea turtle populations worldwide. Recent work has shown that the use of artificial green light on fishing nets has considerable potential to reduce sea turtle bycatch. To understand how green lights lead to reduced bycatch of sea turtles, we conducted experiments in a controlled setting to detail the effect of green lights on entanglement behavior. We recorded interactions of wild-caught juvenile green and loggerhead turtles within experimental treatments including modified gillnets and/or green LED lights in a test tank at the St. Lucie Nuclear Power Plant in Jensen Beach, Florida. Our night-time binary choice trials consisted of a green-LED illuminated gillnet vs. a control (unlighted) gillnet, an illuminated gillnet vs. a green LED light, and an activated green LED light vs. a deactivated green LED light. Netted treatments included a pathway with a gillnet fully blocking it, and netless treatments included an open pathway, either with an activated or deactivated green LED light. We compared binary choices made by turtles between treatments and measured turtles' avoidance and escape behaviors. Our data showed that loggerheads tend to become entangled sooner and more frequently than green turtles. Behavioral observations and treatment choices indicated that both species were attracted to green LED lights. Illuminated nets did not reduce entanglement as much as field studies have reported. This could be due to mixed effects from lighting, including a light trapping effect. Further testing is necessary to determine whether turtles are more likely to become entangled directly under the light due to a light trapping effect or if a larger net creates a different stimulus than our smaller modified gillnets.

A SCOPING REVIEW ON THE IMPACT OF BEACH PLASTICS ON SEA TURTLES, EGGS, AND HATCHLINGS

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Since early concerns about the impacts of plastics on sea turtles were published, plastic pollution has been categorised as one of the five major threats to sea turtles and their habitats worldwide. Sea turtles can potentially be affected by plastics (macro- and micro-) in the marine environment (usually though entanglement and ingestion) and the nesting environment (including impacts on nesting success, nest substrate properties, hatching success, hatchling sex ratios, and hatchling survival). The potential effect of plastics in the nesting environment on sea turtles is less studied than that in the marine environment and there is a need to understand key knowledge gaps and standardise methods to focus research on this threat and prioritise appropriate conservation and management efforts. To facilitate this, we are conducting a scoping review following the methods of Tricco et al. (2018) to identify the spatial and temporal

distribution of study locations, focal research areas, and method being used. The study is ongoing, and our presentation at the symposium will include all relevant literature published to 2023. We have examined 40 papers to date following standardised scoping review methodology. Studies of plastics on nesting beaches are being conducted in many regions of the world where nesting occurs, with more studies conducted in USA than other countries and few to no studies in Australia, and countries in Southeast Asia and East Africa. Study locations encompass nesting areas of all species except the flatback turtle. The most common research focus is quantification and categorisation of macro- and microplastics in the nesting environment and prediction of sources on nesting beaches. Other, less common, research foci are plastics as obstacles and potential entanglement threats to nesting sea turtles and hatchlings, and the influence of microplastics on nest substrate properties. Key knowledge gaps at this time are understanding if plastics on the nesting beach change nest substrate properties and adversely impact hatching success and hatchling sex ratios at the population level, and management options to remove current plastics and minimise further pollution. Different approaches are used across the same research focus area, including sampling and isolation methods, categorisation, and estimation of weight, abundance, and/or density. The absence of standardised approaches when sampling, isolating, quantifying, and categorising plastics on nesting beaches makes it challenging to compare findings among studies but does provide baseline data for specific study locations. Given the threat of plastic pollution to sea turtles in their terrestrial environment- for example, microplastic abundance on beaches is believed to have tripled over the last twenty years and is projected to quadruple by 2050- findings presented in this poster can inform future research directions and priorities.

DIRECTING CONSERVATION ATTENTION INTO THE WATER: IDENTIFYING MARINE TURTLE BYCATCH HOTSPOTS IN IRAN*

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Iran is among the top fishing nations in the northwestern Indian Ocean. The capture fisheries production in the Iranian waters of the Persian Gulf and the Gulf of Oman has been steadily increasing and has more than doubled over the last two decades from ~261k tonnes in 2001 to 672k in 2022. The area includes critical habitats for green and hawksbill turtles that are dominant, olive and loggerhead turtles that occasionally, and leatherback turtles that rarely occur. Consequently, bycatch, the unintentional catch in fishing gear, occurs where the critical habitats and fishing grounds overlap. While marine turtles are nationally protected, and their nesting beaches in the area are relatively well-known with ongoing protection efforts, the turtle bycatch hotspots along the national waters are entirely unknown. This study used an interview-based investigation as a cost-efficient approach to fill this knowledge gap. We interviewed local fishers and collected information about where they observe turtles and where they fish, which were marked on easy-to-use maps at different scales printed on dry-erase surface sheets. The interviewees were asked to mark places by drawing polygons on the maps, which were transcribed electronically to Google Earth and saved as KML files. Finally, QGIS was used to process spatial data and develop hotspot maps. The output layer values on the maps were subdivided into five levels, each representing the degree of overlap between a fishing pressure (i.e., all gears, gillnet, trawl, longline) and turtle distribution, including Light (<20%), Medium Light (20-40%), Moderate, (40-60%) Medium Heavy (60-80%), and Heavy (>80%). Maps were drawn based on information collected by interviewing 264 fishers from 47 fishing communities. The results showed that whilst in-water turtles are distributed along the whole coastline, they are mainly abundant in coastal waters surrounding the Persian Gulf's islands, notably Larak, Hengam, north of Qeshm, Lavan, Nakhiloo, Khark, and Kharko. All these places include shallow, relatively sheltered coral reef habitats and seaweed and seagrass beds, which are probably more suitable feeding grounds for marine turtles than the usually exposed coastal waters of the Gulf of Oman. These biologically productive coastal areas, however, are also extremely attractive to fishers. Therefore, it is unsurprising that for all gears together, and for gillnet, the most widespread fishing gear used in the area, precisely the same places, were identified as bycatch hotspots (i.e., medium to heavy values). Although not as severe as gillnet, longline, and trawl appeared as threats around Nakhiloo, Khark, and Kharko islands. In conclusion, fisheries in Iranian waters impact marine turtles surrounding nearshore islands of the Persian Gulf, and gillnets are the primary source of risk. These findings show the high-risk turtle habitats in the area for the first time, focusing future management efforts from the vast over 2250 km Iranian coastline to much smaller and more manageable units.

CHARACTERIZING FISHERIES BYCATCH OF MARINE TURTLES IN THE PACIFIC WATERS OF PANAMA AND COLOMBIA THROUGH RAPID ASSESSMENT SURVEYS*

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The Pacific waters of Panamá and Colombia are home to four species of sea turtles (leatherback, hawksbill, olive ridley, and green turtles). All these species are susceptible to injury or death due to their interactions with fisheries. The impact of fisheries bycatch on marine turtle populations is a product of a combination of fisheries features, such as fishing effort, gear and distribution, and biological factors like the life history of sea turtles (e.g., late maturity, long life span) and life-cycle traits (e.g., distinct ontogenetic habitats, separate breeding and feeding grounds). Fisheries bycatch is a particular challenge in developing countries because most fisheries are artisanal, and the relatively small size of the boats and lax management of the fishing activities makes it difficult to deploy observers. Panamá and Colombia are considered data-deficient regions regarding bycatch risks for sea turtles. We conducted a standardized port-based survey to provide accurate information on the magnitude and nature of bycatch and fishers' perception of management measures and laws for sustainable fisheries in a regional frame. Surveys were timed to coincide with peak fishing activity based on available government data. Between 2016 and 2019, we administered 966 comprehensive bycatch assessment surveys in 29 fishing ports (Panamá: n = 308 fishers, 17 ports; Colombia: n = 658, 12 ports). In Panamá and Colombia, bycatch events were more frequent when using hook gears (longline and hand line) and seine, and gillnet and hook gears, respectively. We used multinomial models to assess the relationship between the bycatch of the different turtle species and multiple fishing gears, seasons, and latitudes. We found the model that best fitted our data and explained the bycatch in the area includes fishing gear and latitude (Df = 1499, P = 3.0976E-64, AIC = 2790, Accuracy 0,64). Also, the posthoc analyses showed the variables gear ($p<2.2e-16$) and latitude ($p<2.2e-16$) were significant; however, there were no significant differences among the fishing gear types. Bycatch events were extrapolated across fishing fleets to estimate 7,885 marine turtles caught annually in Panamá, and 5,289 marine turtles caught annually in Colombia. Our results highlight the relevance of continuing work on bycatch mitigation programs in both countries. Our research is the first of its kind in Panamá and Colombia and will lay the groundwork for additional studies and outreach activities. It was also the first step to establishing contacts within artisanal fishing communities and forming collaborations with government fisheries agencies and the Ministries of Environment.

PLASTIC MARINE DEBRIS IN STRANDED SEA TURTLES IN FLORIDA, U.S.A.

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Over the years, plastic production has increased to an astonishing volume and is predicted to continue. Sea turtles are known to mistake plastic for prey, which can result in gut compaction, gut perforation, and chemical leaching. Over time, environmental plastic will degrade into smaller microplastics, which sea turtles also ingest and may affect sea turtle health through chemical leaching of toxicants. Chemicals associated with plastics have been identified in tissues of sea turtles, and some are suspected to be endocrine disruptors. This study examined plastic ingestion in stranded sea turtles from around Florida, U.S.A., to identify the types of plastic most ingested. We collected the contents from the gastrointestinal tract of freshly euthanized or dead sea turtle carcasses. This study included sixty-five gastrointestinal tracts from loggerheads (*Caretta caretta*) (n=12), greens (*Chelonia mydas*) (n=48), hawksbill (*Eretmochelys imbricata*) (n=1), and Kemp's ridley (*Lepidochelys kempii*) (n=5) sea turtles. The contents were digested with 10% KOH for up to 10 days and then filtered through a 2mm size metal filter. The plastic was then categorized and imaged. Thirty-nine of the sixty-five sea turtles (60%) had marine debris (2mm or larger) in their gastrointestinal tract. Most samples were from female, juvenile, green sea turtles, but marine debris was found in all species and age classifications that were sampled. We recorded 1782 pieces of plastic debris, including one green sea turtle washback with 779 pieces of plastic in the gastrointestinal tract. A female, juvenile green sea turtle had the longest piece of marine debris at 463.7cm in length, which was monofilament (fishing line). Clear marine debris was the most common color noted. Hard and filament marine debris were the most common marine debris ingested. There was no significant correlation between size and the number of plastic pieces ingested, but this could be due to having primarily juvenile sea turtles. Data is continually being collected to expand the size range and species to allow better conclusions to be made. This study will also be expanded to investigate if plastic additives are leaching into sea turtle tissues and identifying their potential to be endocrine disruptors. The long-term impacts plastic ingestion can have on sea turtle physiology is still unknown. This work is essential not only to sea turtles but also to all organisms.

NINE YEARS OF STRANDING DATA FOR SEA TURTLES IN THE NORTHERN GULF OF MEXICO

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The Gulfarium C.A.R.E. center is a non-profit organization that was founded in 2015 to specialize in sea turtle rescue and rehabilitation. Over the last 5 years we have seen an exponential increase in the number of live stranded sea turtles in the northern Gulf of Mexico. In 2023, we received 117 sea turtles ranging from juvenile to adult, comprised of Kemp's ridley, greens, and loggerheads. 94 % (n = 110) of the 117 sea turtles we received in 2023 were brought in as incidentally captured individuals. Of those incidentally captured individuals 96% (n = 102) were captured from local fishing piers, only 4% (n = 4) were caught by fisherman from the beach. There are four semi-local fishing piers that are actively incidentally catching sea turtles; however, one pier, Navarre Beach Fishing Pier, has the highest catch rate in the state of Florida. In 2023, Navarre Beach Fishing Pier successfully rescued 54 sea turtles, accounting for 46% of our incidentally captured turtles. Our busiest months coincide with nesting season, May – October. Over the last three years we have seen an increase in recapture events. In 2023, we noted 45 recapture events, this includes individuals recaptured in the same year, across years, and individuals being caught three or more times. Here we provide summary of the last nine years of strandings in the northern Gulf of Mexico.

SEA TURTLE EGG HARVESTING IN TAMBELAN (INDONESIA) AND POSSIBLE SOLUTIONS*

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The history of sea turtle egg harvesting in Tambelan Islands (Indonesia) dates back to decades ago when legislation not yet in place. Initially, the utilization was only locally but later becoming a trade commodity and source of subsistence in the late 1980s. Eggs were traded outside the islands even to neighboring countries such as Singapore, Malaysia, and Thailand. Later, sea turtle protection regulations were released in 1990 that prohibited all forms of utilization. However, this does not seem to affect significantly in Tambelan up to now. Rapid surveys were conducted in February and August 2023 to assess current conditions on population density, utilization, and illegal trade of sea turtle eggs, and to explore key stakeholders in the area. During the nesting beach survey, we collected data on sea turtle species, amount of eggs harvested, and its economic value. In addition, identification of local trades and key stakeholders is also carried out. Of a total of 56 islands, there are at least 22 islands where sea turtles frequently nest, of which there are four major nesting sites, i.e., Nangka Island, Genting Island, Uwi Island and Menggirang Besar Island. It is known that green turtles (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*) nest at Nangka Island, while at Genting Island, mainly hawksbills, while at Uwi Island, is green turtles. During the survey in February, there were 29 clutches containing a total of 3,858 hawksbill eggs and 176 green turtle eggs harvested by the landowner from 3 nights of nesting at Genting Island. While survey in August found 9 green turtle clutches (919 eggs) from two nesting nights at Uwi Island. Record in Genting Island during May – September 2022 showed that there were at least 43,729 ($\bar{x} = 8{,}656 \pm 4{,}628$) eggs harvested. The local price of an egg varies based on season and trade chain ranging from IDR 600 – IDR 3000 (≈ 4 - 20 cents) and might be higher when reached overseas. Thus, the estimated income earned by landowners per month on average can reach IDR 5 million and share 30% for the egg collector which is then cut by 30% for hiring egg collectors. This baseline information along with identified key stakeholders and law enforcement agencies are critical essential for WWF Indonesia in developing sea turtle conservation strategies in this area aiming and simultaneously to reduce egg harvest (poaching threat) by to at least 30%. The fact that the sea turtle egg trade is still a lucrative business and a source of subsistence for locals might render raising awareness challenging unless we offer alternative livelihoods for local communities. Thus, a feasibility study of sea turtle-based tourism will be carried out amongst other conservation strategies that should also integrate with the holistic approach of marine conservation, such as propose the area to be a new MPA for Indonesia, such as strengthening law enforcement and raise awareness. Moreover, collaborative efforts with others, such as WWF Malaysia and WWF Singapore, are also highly useful in combating illegal trade, especially in bordering areas.

SEA TURTLES OF THE SAUDI ARABIAN RED SEA: CURRENT RESEARCH AND THREATS*

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In the Saudi Arabian Red Sea, two of the seven species of sea turtles are known to nest and forage along the coast, the hawksbill turtle (*Eretmochelys imbricata*) and the green turtle (*Chelonia mydas*). Under Saudi Arabia's Vision 2030 and the recent opening of its borders to recreational tourists, the country aims to develop several large-scale projects along the Red Sea coast, locally known as "giga-projects". Thus, imminent pressures from coastal development highlight the urgency needed for multi-country cooperation in protecting sea turtles in the region. Importantly, turtles in the Red Sea are largely understudied, and we are lacking data on their main threats and heath status. This presentation will discuss broadly the current research status of turtles in the region, and some of the threats turtles are facing. Specifically, threats from climate change, plastic ingestion, heavy metal contamination, and coastal development. Hatchling success was found to be low (37%) in the northern Red Sea, likely due to high temperatures and low moisture. This raises concern with projected rising temperatures with climate change. Plastic ingestion was found to be a moderate threat, with 4 out of 10 turtles necropsied found with plastic particles > 1 mm in their digestive tract. Heavy metals also present a threat because the largest nesting site in the Red Sea is located next to a cement factory. Sand was collected at four nesting beaches near the factory and we found that heavy metal contamination was higher at the nesting beaches upwind compared to downwind. Major data gaps remain in the region, including identifying the cause of low hatching success. Coastal development will be a major threat in the future, and care should be taken to maintain and improve current foraging and nesting habitats.

DO LOGGERHEAD SEA TURTLE (CARETTA CARETTA) GUT CONTENTS REFLECT THE TYPES, COLORS AND SOURCES OF PLASTIC POLLUTION IN THE SOUTHWEST INDIAN OCEAN?*

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Plastic pollution is steadily increasing and entering the oceans, with harmful effects on the environment and marine species through ingestion or entanglement. Once in the ocean, they accumulate in subtropical gyres known as "garbage patches". The North Pacific garbage patch is the largest and the one that has attracted the most attention. However, the garbage patch of the Indian Ocean, which could be the second largest according to predictive models, is less studied. For this reason, it is very important to provide a baseline for the abundance and characterization of plastic found in different compartments, such as the shoreline (beaches), ocean (sea surface/water column), deep sea and marine biota (bioindicator species).

In this case, we analyzed plastic debris ingested by loggerhead sea turtles (*Caretta caretta*) from longliner bycatches between 2007 and 2021 in the Southwest Indian Ocean (SWIO). Loggerheads were undertaken by the Kelonia sea turtle rehabilitation center on Reunion Island. We also studied plastic debris accumulated on 3 beaches of the east coast of Madagascar as a proxy for ocean plastics, in order to compare the characteristics of beached plastics and plastics ingested by turtles. More than 22,000 plastic debris were counted, measured, weighed, and sorted by category and color. Furthermore, we conducted a "brand audit" of the plastics to determine their country of origin. And an ocean circulation model was used to identify the most likely sources of plastics in the SWIO. In total, 202 of the 266 loggerheads analyzed had ingested plastics. The frequency occurrence increased from 25% in 2007 to 78% in 2021. Mean average of plastic debris ingested was 56.83 ± 4.59 plastic debris per turtle. Plastics categorized as "hard" and "white" were equally dominant in loggerheads and on beaches and "selectivity tests" confirm that there is no selectivity in diet. Both the brand audit and circulation modeling demonstrated that Southeast Asia is the main source of plastic pollution in the region. The model highlighted a second origin from South Africa and a connection from maritime input between the Pacific and Indian Oceans. This study demonstrates that loggerheads have a high rate of plastic ingestion, equivalent to the ingestion rate in the North Pacific and can be used as bioindicators of plastic pollution in the SWIO. Observations in situ, combined with dispersal models, can help to better understand the circulation and location of the garbage patch in the Indian Ocean. Additional research is needed to improve our understanding of the impact of plastic debris on loggerheads and on the environment (marine and terrestrial).

INCORPORATING FISHER METRICS IN ASSESSMENTS OF SEA TURTLE AND OTHER MARINE MEGAFAUNA BYCATCH REDUCTION TECHNOLOGIES*

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Bycatch, the incidental capture of non-target species, is among the greatest threats to sea turtle populations worldwide. Numerous studies have found sea turtle bycatch to be highest in small-scale fisheries (SSF). To reduce these rates, bycatch reduction technologies (BRTs) have been developed to improve the sustainability of SSF and conserve vulnerable marine species, especially sea turtles. We compiled peer-reviewed studies to determine how BRTs are assessed in small-scale passive fisheries of developing nations worldwide for sea turtles and other air-breathing marine megafauna. We assessed 34 experiments from 24 published studies that tested seven BRTs in gillnets (n = 25), longlines (n = 8), and a trammel net (n = 1). Most studies report the use of net illumination (n = 13), acoustic deterrents (n = 8), and circle hooks (n = 7). These technologies either reduced or had no impact on bycatch rates while maintaining or increasing target catch rates. Few BRTs experiments assessed target catch market value. Over half of the BRTs were for sea turtles (61.8%), followed by cetaceans (41.2%), and seabirds (5.9%). Bycatch declined 85.7% of the time for sea turtles, 57.1% for cetaceans, and 100% for seabirds. Additionally, 11 experiments (32.4%) included at least one quantified assessment of fisher metrics and eight experiments (23.5%) included at least one anecdotal assessment of fisher metrics, such as BRT expense, change in operational efficiency, change in ease of use, effects on fishing gear, effects on fisher safety, or other benefits and costs. Our findings highlight the need for researchers testing BRTs to include a broader range of socio-economic and fishery efficiency metrics to better assess and improve the adoption potential of these tools for sea turtles and other marine megafauna worldwide.

SPATIO-TEMPORAL DISTRIBUTION AND ASSOCIATED THREATS OF LOGGERHEAD TURTLE STRANDINGS IN URUGUAY (2000-2023)

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Loggerhead turtle (*Caretta caretta*) is one of the most abundant sea turtle species in Uruguayan waters, one of the main feeding and developmental area in the Southwestern Atlantic for large juveniles and adults. These individuals come mainly from Brazilian rookeries, and they prey on mollusc, crustaceans and fishes. Base on previous studies their main threat is the industrial fisheries, mainly trawlers. But more information is need it to understand the spatio-temporal distribution and possible changes in the last decade. In this line, the objective of this work is to update the information of stranding distribution, size, life stage and associated threats of this species in Uruguayan waters and to improve the knowledge of this endangered species in the Southwestern Atlantic Ocean. A total of 1277 stranded Loggerhead were recorded between 2000-2023, from which only 591 were measured (mean ± SD CCL=73.8±14.6 cm, range= 8.0-123.0 cm; median=71.5 cm). Most turtles were found dead, with only 4.07% found alive (alive=52; fresh=184; rotten=393; very rotten=460). Regarding the life stage 60.7% were large juveniles (Adults=222; Juveniles=775; small juveniles (CCL<40 cm= 6; no identified=274). Based on tail size (adults individuals) or gonad examination, there were 132 females and 72 males identified (no identification, n=1071). Loggerheads were observed during all seasons, although only 44 turtles were documented in the Winter, with 61% registered during 2023. The highest percentages of strandings were recorded during the Summer (n = 691, 54.1%) and Fall (n = 359, 28.2%). The spatial distribution showed that the highest number of strandings occurred in the oceanic zone (OZ; 72.7%, n = 928), followed by the outer estuarine zone (OEZ; 25.6%, n = 327), and the inner estuarine zone (IEZ; 0.9%, n = 12). Cause of death was difficult to identified, only in 4.7% of the cases the cause of death was determined. The main threat identified in the area is fisheries interaction but most of the carcasses observed were badly decomposed; nevertheless, in the last years other threats have arouse raising concern such as marine debris interaction and vessel collision. Taken together, these findings reinforce the importance of the large juvenile and adult Loggerhead turtle South American foraging areas (south of latitude 33º S). Additionally, the need to determine regional habitat use as well as migratory routes across the Southwestern Atlantic Region in order to develop effective conservation measures to mitigate threats both at nesting beaches and foraging areas was highlighted from this study. The next step will be to analyze the stranding seasonality and spatial distribution together with the industrial fishing fleet operating in the Common Fishing Zone between Argentina and Uruguay (ZCPAU, from its name in Spanish) and the ones operating in Uruguayan territorial waters.

BEACH CLIFFS AS AN EMERGING HAZARD TO NESTING SEA TURTLES IN THE FACE OF SEA-LEVEL RISE

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Climate change is a significant threat to sea turtles, affecting their reproductive success through warming temperatures impacting hatchling viability and sea-level rise leading to increased beach erosion and flooding risks. We raise attention about an emerging hazard directly impacting nesting sea turtles: the potential expansion of cliffs due to beach erosion, an issue previously overlooked concerning sea-level rise. Our study presents evidence of mortality of green turtles (*Chelonia mydas*) that fell off cliffs at Jazirat Mashabah, situated along the Saudi Arabian coast of the Red Sea, observed between 2019 and 2023. We carried out on-site visits and used satellite imagery analysis to determine the map the extent of cliffs and incident locations. We recorded 9 incidents of deceased turtles, and one found alive on her back. The limestone composition of the island has historically formed raised coral terraces along the coast during sea level transgressions. In their current state, these cliffs pose lethal challenges for nesting green turtles during their return to sea, especially in high-density nesting areas adjacent to cliffs. In addition, the accelerating rate of sea-level rise in the northern Red Sea amplifies concerns about the long-term impact of this hazard in nesting beaches. A better understanding of local sea-level rise scenarios through predictive models coupled with restoration efforts like beach nourishment and strategic barrier placement are crucial to sustain these habitats and ensure the continued survival of nesting sea turtles in the region. This study emphasizes the need to address unanticipated threats faced by sea turtles due to changing coastal landscapes, advocating for proactive conservation strategies to ensure their survival amidst escalating global climate change.

THREATS AND PRESSURES FACING AN ENDANGERED POPULATION OF LOGGERHEAD TURTLES IN BOA VISTA, CABO VERDE*

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Boa Vista is the easternmost island of the Cabo Verde archipelago, located approx. 600 km off the coast of Senegal, West Africa. In 1979, it was identified as an important nesting site for loggerhead turtles. By 2012, it was estimated that 3,700 females were nesting on Boa Vista alone, solidifying Cape Verde as the third largest nesting site for this species in the world. In 2021, Cabo Verde documented a record number of 156,299 loggerhead turtle nests. Notably, while loggerheads nest on all ten Cabo Verde islands, Boa Vista plays a pivotal role, hosting between 60% to 70% of the total. However, turtle meat has long been a source of food, income and cultural delicacy in Cabo Verde. As recently as 2007, 1256 nesting female turtles were killed on Boa Vista. This along with increased habitat loss had an unsustainable and devastating impact on the population and led to this sub-population being listed as 'endangered' by the International Union for the Conservation of Nature (IUCN). In response to the dire consequences of uncontrolled poaching, local authorities and non-governmental organizations have tirelessly strived to curb poaching and shift attitudes towards turtle conservation. These collective efforts significantly reduced poaching on Boa Vista, plummeting from 29% of the annual nesting population in 2007 to less than 0.2% in recent years, even as nesting numbers drastically increased. The threat of poaching now appears to be well under control on Boa Vista through continued and diverse conservation efforts. As a result, we can now focus on the evaluation and addressing of other existing pressures. These include:

Entrapment and "natural" mortality: In 2021 alone, 841 adult female turtles (2.7% of that year's nesting population) were rescued during nesting activities in Boa Vista Island due to being lost, dehydrated or trapped/entangled with a further 43 recorded as dead. For this reason, our conservation efforts have also been focused on trying to reduce the number of turtles exposed to dehydration, using drones to identify and support lost turtles back into the ocean before the rising heat causes them to perish.

Plastic pollution: A recent study found that plastic pollution on the beaches of Boa Vista has negatively affected turtle nesting behaviour, with increased density of rubbish correlating with a decrease in successful nesting events. Furthermore, an increase in the amount of plastic around turtle nests was negatively correlated with hatching success.

Tourism: The significant development of Boa Vista as a tourist destination has many positive impacts such as employment, but also harmful indirect effects such as unregulated interference by tourists, increased vehicle traffic on nesting beaches, which contributes to further obstacles for the turtles and artificial light pollution, which disorientates both nesting females and hatchlings.

As local NGOs, we are working tirelessly to combat these evolving threats in a variety of ways, combining new technologies and approaches, building relationships, increasing capacities, promoting law enforcement campaigns and contributing to the improved protected area management.

MARINE TURTLE BYCATCH IN SIX FISHING BASES IN INDONESIA: STATUS AND RELEASE-HANDLING APPROACH*

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In Indonesia, bycatch poses a significant threat to marine endangered species, including sea turtle populations, mainly where purse seine and gillnet fishermen are regularly operated. Because most bycatch data is not well recorded, there are numerous information gaps in various areas with a high potential for bycatch due to the number and operation of specific fishing gears. Typically, fishermen do not report data due to apprehension about interacting with law enforcement officers, or it is ignored because it is not a target catch. By involving about eleven local champions who are a combination of observers, crew members, and captains, monitoring was conducted from January 2022 to June 2023 in 6 locations in Indonesia include Muncar (East Java), Pekalongan (Central Java), Paloh (West Kalimantan), Derawan (East Kalimantan), East Flores (East Nusa Tenggara), and Alor (East Nusa Tenggara) with a total of 3.568 trips (524 gillnet trip and 3,044 purse seine trips) with a total of 123 turtle individuals consisting of *Chelonia mydas* 73,9% (n=91), *Eretmochelys imbricata* 10,57% (n=13), and *Lepidochelys olivacea* 15,44% (n=14) and unidentified species 4,06% (n=5). About 106 individuals (86.18%) of turtles were reported released by fishers. The factor of turtle release was done because fishermen realized that the species had been protected by the national regulation of Law No. 5 of 1990 concerning the Conservation of Natural Resources and Ecosystems. In addition, bycatch handling training was also conducted for around 494 people during the monitoring period. However, in-depth research related to post-release bycatch needs to be conducted to determine the resilience of the turtles, and the role of local champions in releasing bycatch can more effectively benefit the turtle population in Indonesia.

IN-WATER BIOLOGY

INTER- AND POST-NESTING MOVEMENT PATTERNS OF LEATHERBACK SEA TURTLES (DERMOCHELYS CORIACEA) NESTING IN SOUTHEASTERN FLORIDA, USA*

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Satellite telemetry is often used to track sea turtle movement patterns because transmitters can be configured to monitor and collect valuable information including environmental and behavioral (i.e., dive profiles) data of tagged individuals. These data can then be related to horizontal and vertical movement patterns to understand how tracked individuals interact with their environment at specific locations. Leatherback sea turtles (*Dermochelys coriacea*) nesting in southeastern Florida remain one of the few stable or increasing leatherback aggregations in the northwest Atlantic (NWA) RMU since 2000. The U.S. Northeast Shelf is one of the most globally productive marine ecosystems which may contribute to the success of this nesting aggregation, but declining NWA nesting stocks from other areas also use similar foraging grounds. Environmental conditions specific to this nesting aggregation may further contribute to the stability of southeastern Florida leatherbacks; however, no published studies have described movement patterns and environmental conditions encountered at high-use habitats for this aggregation since 2000–2002. Here, we aim to monitor female leatherback turtle movements with satellite transmitters to collect and relate environmental data with movement patterns and geographic locations. Thirty adult female leatherbacks were tagged after nesting with Wildlife Computers, Inc. SPLASH10-295I (N=26) and Sea Mammal Research Unit CTD/Fluorometer Oceanography Satellite Relay Data Logger (N=4) satellite transmitters during 2022–2023 on Juno Beach, Florida, USA (26.9433N, -80.0708W) using direct carapacial attachment. An optimized hot-spot analysis revealed that inter-nesting habitats in Florida covered approximately 12,694 km^2, ranging from Cape Canaveral southward to West Palm Beach. Post-nesting movements indicate that southeastern Florida leatherbacks tend to migrate north along the Gulf Stream before dispersing to four distinct foraging regions: Mid-Atlantic Bight (ranging from North Carolina to New Jersey), northeast Canada (ranging from Nova Scotia to the Gulf of St. Lawrence), northeast United States (ranging from Cape Code, Massachusetts to the Gulf of Maine), and pelagic waters (ranging from Sohm Plain to the New England Seamounts). Only one tagged turtle is currently foraging in the South Atlantic Bight. To date, one satellite transmitter deployed in 2022 remains active 513 days after initial deployment, and 18 transmitters deployed in 2023 remain active (mean ± SD: 183 ± 87 days). A space-state switch model allowed us to determine when and where leatherbacks switched from migratory to foraging behavior, and tracks will be compared to leatherbacks tagged on Juno Beach from 2006–2011, allowing us to see if inter-nesting and post-nesting movement patterns have changed over time. Results will provide insight on the movement patterns and current locations of high-use habitats of southeastern

Florida leatherbacks. Future work will help establish baseline data regarding how environmental conditions influence leatherback distribution and behavior. These data can then be incorporated in future studies to examine and help predict how leatherback distribution and dive behavior will be affected by ongoing and future changing environmental conditions, most notably those related to climate change.

DISPERSAL OF NESTING MARINE TURTLES FROM NEOM ISLANDS, SAUDI ARABIA, AFTER BREEDING

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Marine turtles are highly mobile and face multiple threats across their habitats. Green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles nest in the Red Sea, but little is known about their re-nesting success, intervals, or post-breeding displacements. NEOM Islands are priority zones for protecting marine turtle rookeries, as they account for 95% of turtle nesting evidence in the northeastern Red Sea. This paper aims to calculate the distances between nesting beaches and feeding grounds, and to identify migratory pathways and their duration. We focused our survey efforts in Shusha and Walah Islands, where we attached Platform Terminal Transmitters (FastGPS and Argos) to 17 marine turtles (11 hawksbills and six greens) in one season for each species. We then identified and mapped inter-nesting habitats, feeding grounds, and migratory pathways. Six feeding grounds (four within Saudi Arabian localities and two within Egyptian waters) used by NEOM nesting turtles were identified. Expanding existing or creating new marine protected areas in the Red Sea coastal zone could benefit marine turtle conservation for both studied species during and after their reproductive episodes. Our findings suggest that green and hawksbill turtles from the NEOM Islands share migratory routes and foraging areas with other green and hawksbill turtle rookeries in the region. More research is needed to fill in the gaps in our knowledge about these threatened species, but presented results can already be used to inform conservation actions and management plans for NEOM Islands in the short, medium, and long term.

HABITAT MODEL OF JUVENILE LOGGERHEAD SEA TURTLES (CARETTA CARETTA) IN THE NORTH ATLANTIC*

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The life cycle of loggerhead sea turtles (*C. caretta*) is complex and includes neritic and oceanic stages. In the North Atlantic, most loggerheads hatch along the south-eastern coast of the USA and then enter the Gulf Stream and disperse into the open ocean. Following this oceanic stage, that lasts 7-14 years and is often referred to as the “lost years”, they return to neritic foraging grounds in the western North Atlantic. The oceanic juvenile stages are particularly relevant for the conservation of this species, but there is a lack of information about their habitat use during this period of their life. To better understand the habitat use of juvenile loggerheads in the North Atlantic, we gathered tracking data from multiple research teams working in the basin. We assembled a unique and extensive dataset with tracking data collected from 105 individuals (after filtering), tagged from 1994 to 2012. The individuals were captured and released in the Azores (42), in the Canary Islands (24), in Madeira (10) and in the Central North Atlantic (29). The size of the individuals ranged from 32.4 to 74.0 cm CCL (51.9 ± 8.3 cm). Most of the individuals (76) were equipped with Argos PTTs (Wildlife Computers), while the remainder (29) were equipped with archival tags (MiniPAT, Wildlife Computers) that transmitted light-levels and Argos locations. Tracking duration ranged from 5 to 760 days (183 ± 164 days). Tracks were filtered, interpolated at a 24h interval (R package “AniMotum”), and used to generate pseudo- absence tracks (correlated random walks). For all the locations obtained (both presence and pseudo-absence) we extracted several environmental variables, such as sea surface temperature, productivity, ocean currents and eddies proximity. We found a possible correlation of turtle presence to sea surface temperature, proximity to anticyclonic eddies, and an avoidance of shallow waters (<20 m). Boosted regression trees (BRTs) were used in an iterative process to build a basin-scale habitat model for loggerheads in the North Atlantic. This habitat model is important to understand the ecology and space use of juvenile loggerhead sea turtles in the North Atlantic. The model is also a key tool to evaluate and address the impact of anthropogenic pressures, such as incidental bycatch in oceanic fisheries and marine traffic, in support of their conservation.

HABITAT MAPPING REVEALS RESIDENT AREAS AND MOVEMENT PATTERNS OF NESTING LEATHERBACK SEA TURTLES (DERMOCHELYS CORIACEA) IN ST. CROIX USVI

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Understanding patterns of movement and distribution is essential to identify potential threats and creating effective conservation plans. For highly migratory species such as the leatherback sea turtle (*Dermochelys coriacea*), it is critical to have a comprehensive knowledge of the areas used by these animals to ensure their protection. This is particularly true for the Northwest Atlantic Regional Management Unit (RMU) of this species, which has experienced population declines since 2009. In this study, our objective was to identify nesting patterns, home range, and habitat use of leatherbacks in this RMU during their nesting season. We deployed 20 satellite-linked transmitters (SPLASH 10, Wildlife Computers) on adult female leatherback turtles nesting at Sandy Point National Wildlife Refuge (SPNWR), St. Croix, USVI from 2020 – 2023. We processed Fastloc GPS-derived locations in the Wildlife Computers data portal and complemented these data with observations of haul-outs and night-time nesting surveys, to identify nesting events. We estimated the home range of each turtle with the Autocorrelated Kernel Density Estimation (AKDE) approach in R using the ctmm package. Most leatherbacks returned to nest every 9 to 10 days, but a few individuals chose to skip one or more nesting events, leading to average nesting intervals of 18 to 25 days. During the nesting season, leatherbacks spent most of their time near SPNWR, typically within 15 kilometers of the nesting beach. However, turtles also traveled to the northern side of St. Croix, the deeper oceanic region between St. Croix and Puerto Rico, and the southeastern coast of Puerto Rico. Notably, one individual also spent some time near the northern side of Culebra during the nesting season. By mapping home ranges in this manner, we identified offshore areas that could be critical habitat used by these turtles in April and May each year.

A FINE-SCALE HABITAT-BASED DENSITY MODEL FOR LEATHERBACK TURTLES FORAGING IN NEARSHORE WATERS OFF CENTRAL CALIFORNIA, USA*

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Adult and sub-adult western Pacific leatherback turtles (*Dermochelys coriacea*) forage in diverse ecoregions of the Indo-Pacific region, including temperate nearshore waters off central California, USA.

The greatest leatherback densities in this region are found in oceanographic retention areas between about Bodega Head (38.3°N) and Monterey Bay (36.6°N). Aerial surveys have been conducted regularly since 1990 to assess the abundance, distribution, and habitat of leatherback turtles that forage within shelf waters during summer and fall. These surveys have documented an 80% decline in the abundance of leatherbacks since 1990, corroborating a similar decline of adult female leatherbacks at Birds Head Peninsula, Indonesia, and revealed interannual variability in the availability of foraging habitat and leatherback abundance. In this region, leatherbacks are vulnerable to vessel strikes and entanglement in fisheries. Species distribution models have successfully been used to assess the risk of entanglement or ship strikes to whales, and to assess potential interactions between leatherback turtles and offshore fisheries throughout the California Current Ecosystem and central North Pacific. However, the resolution of the leatherback models (10-25 km) is too coarse for management in the small nearshore foraging area off central California. To support management and conservation of leatherback turtles within this key foraging ground, we have developed a dynamic, fine-scale (1-km) spatial density model for leatherback turtles from a subset of the aerial survey data (2002-2022). The surveys were conducted using standard line-transect methods, at 170-185 km hr^{-1} airspeed and about 200 m altitude, in twin engine, high-wing aircraft outfitted with bubble windows and a belly port. Potential habitat covariates that were available at a sufficiently fine-scale resolution included bathymetric depth (ETOPO-1, 1 arc-minute), sea surface temperature (Multi-scale Ultra-high Resolution Sea Surface Temperature (SST) at a daily 1-km resolution), and standard deviation of SST within 9×9 km and 25×25 km regions (proxy for frontal regions and mesoscale features). Year was included to account for the previously documented population decline. Models were developed using well-established methods within a generalized additive modeling framework that estimates animal density as a function of habitat covariates within a line-transect framework. Corrections for detection parameters including effective strip half-width, ESW, and the probability of detecting a leatherback on the transect line, $g(0)$ were included in the model to provide absolute estimates of animal density and abundance. The selected model included four significant variables: bathymetric depth ($p<0.001$), SST ($p=0.002$), the standard deviation of SST at a 25×25 km scale ($p<0.001$), and year ($p<0.001$). Depth and SST exhibited unimodal relationships, with density peaks at 40-70 m and 14-16°C, respectively. The standard deviation of SST was positively correlated with density. Modeled spatial density maps for the peak foraging season (September – October) successfully captured interannual variability in the location and extent of high-density regions, as was observed during the 2002-2022 aerial surveys. Thus, these dynamic models can help assess leatherback presence and distribution while foraging off central CA, providing a new tool for managing risks to leatherbacks and optimizing future survey effort in areas most likely to support leatherbacks.

A MULTIDISCIPLINARY APPROACH GIVE INSIGHT ON LOGGERHEAD TURTLE (CARETTA CARETTA, LINNEUS 1758) TROPHIC ECOLOGY IN THE TYRRHENIAN SEA (CENTRAL MEDITERRANEAN)

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Marine turtles are key indicator species of ecosystem function and environmental health, however, many of their life-history features remain cryptic. The understanding of their year-round feeding habits is critical to establish the effect of contaminants exposure through the marine food web and their adverse health consequences. Here, the results of a long-term study on wild-caught alive loggerhead turtles in the Tyrrhenian Sea (Central Mediterranean) were reported. Primary, isotope stable δ13C and δ15N were determined in blood and epidermis samples as well as concentrations of metals and plastic additives. Then, antibiotic resistance of gram-negative bacteria and polymer composition analysis of plastic debris (FTIR-ATR) were analysed in faecal samples. Finally, epibionts and microbial communities which colonized carapace scutes were assessed. The results of Bayesian mixing models suggested that, generally, turtles sampled in Sicilian waters prey at low trophic levels but high concentrations of different chemical elements were found as a result of plastic ingestion. The presence of antibiotic-resistant strains also in healthy animals confirmed the role of the loggerhead sea turtles in spreading antibiotic-resistant bacteria. The differences in microbial diversity and composition between anterior vs posterior carapace scutes may be related to the different macroalgae settlement or growth at these locations as a consequence of the health status (hydrodynamics) of the individual. Our results support the utility of a multidisciplinary approach from wild-caught alive animals to investigate simultaneously different ecological features of sea turtles. Further studies should aim on investigating animals in both good health and with detectable disease issues, to understand how much different threats and healthy status can influence Mediterranean loggerhead turtles' feeding ecology.

OVERVIEW AND OUTCOMES OF THE SEA TURTLE FOR OCEAN RESEARCH AND MONITORING (STORM) PROGRAM IN THE SWIO*

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STORM (Sea Turtle for Ocean Research and Monitoring) is an international, multidisciplinary, telemetry-based research program to study the five species of sea turtle living in the west tropical Indian Ocean, while also collecting key in-situ observations of ocean properties. With over 110 sea turtles (juveniles, nesting females, males) equipped with Argos and GPS environmental tags (depth, temperature, salinity, fluorescence) from January 2019 to January 2023 (including 75 tags released in the Mozambique Channel from January to March 2021 during the 2021 nesting season), the STORM dataset is probably one of the most remarkable of its kind ever obtained in this part of the world. The STORM program is centered around three interconnected and highly complementary components aiming at: i) studying the ecology of the 5 species of sea turtle inhabiting the South-Western Indian Ocean (SWIO) region, with emphasis on their interactions with the oceanic environment, ii) studying the surface and in-depth physical properties of the tropical Indian Ocean, particularly in the vicinity of tropical cyclones, and iii) implementing educational and communications actions aimed at stepping up the science-society dialogue on the subject of biodiversity conservation. After a brief overview of STORM's main objectives, we will present some results of the research work carried out to date on sea turtle ecology (ecological connectivity, migration corridors, feeding areas, navigation processes), based on the analysis of tracking data collected by individuals equipped from the French islands of Europa, Tromelin and Réunion (loggerhead, green and olive ridley turtles), iSimangaliso Wetland World Heritage Site (South Africa; loggerhead and leatherback turtles), Moheli National Park (Comoros; green and hawksbill turtles) and Aldabra World Heritage Site (Seychelles; green turtles). Finally, as the sea turtle nesting season in the SWIO corresponds to that of the tropical cyclone season (November - April), we will also briefly assess the behavior of animals trapped in the immediate vicinity of tropical cyclones encountered during their migration in the open sea.

GREEN TURTLE PHOTO-IDENTIFICATION IMPROVES MARK-RECAPTURE EFFORTS AND PROVIDES EVIDENCE OF HABITAT CONNECTIVITY AND FINE-SCALE ONTOGENETIC SHIFTS

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Photo identification (PID) is an efficient and increasingly popular tool that uses natural or acquired markings unique to an individual to track wildlife for population or ecology-focused studies. Issues of tag loss and capture-stress associated with traditional capture-mark-recapture methods may be resolved using PID. The accessibility of photographic equipment and photo identification tools also allows for data to be collected by both researchers and citizen scientists, which can be shared in collaborative databases. In prior sea turtle studies, PID has proven useful in the identification of individuals because scales on either side of the faces of green, hawksbill, and loggerhead turtles, as well as the pineal spots of leatherbacks have been found to be distinct and consistent to individuals. Green turtles (*Chelonia mydas*) have highly migratory behaviors, making it difficult to track individuals across multiple life stages. Additionally, external tags may foul or be lost, and internal tags (PIT tags) can be cost prohibitive and go undetected without tag-specific detection equipment. Western Atlantic green turtles may be too small to tag when they recruit to benthic foraging habitats at approximately 20 - 25 cm SCL. Thus, PID offers a potential technique to determine fine scale habitat use in neritic habitats for juvenile and subadult green turtles as they use coastal foraging grounds. We tested the use of PID as a supplement to physical tagging using photographs of juvenile and subadult green turtles in tidal creeks and nearshore seagrass meadows off Abaco Island, The Bahamas. We compared data from physical Inconel flipper tags to outputs from HotSpotter, an automated photo identification software, across 314 captures between 2013 and 2019. Out of 1,230 images, we manually verified matches and found HotSpotter to have at least a 92% match rate between the software output and a human observer for a subset of 90 test photos. However, match rates increased to 100% when image backgrounds were removed, leaving only the turtle head for matching. In addition to external tag-identified recaptures, HotSpotter correctly identified five recaptures, of which four were previously unrecognized as recaptures. This included one individual recaptured in a geographically distinct habitat

and subsequent size class 1,786 days later, who also displayed a distinct color change at the recapture site. Another individual was recaptured after 2,191 days, but in the same habitat and at a different size class, however it did not display a notable color change. We further investigated the importance of size class and movements on color variation in juvenile green sea turtles. Our results suggest that PID is a useful supplement to physical tagging methods and a key tool for identifying drivers of color pattern variations across size classes and habitats. Our results elucidate fine-scale ontogenetic shifts across interconnected habitats with implications for a multi-ecosystem conservation approach.

ACTIVE SELECTION OF NATIVE SEAGRASS IN HALOPHILA STIPULACEA-DOMINATED MEADOWS AMONG JUVENILE GREEN SEA TURTLES (CHELONIA MYDAS) IDENTIFIED USING FINE-SCALE ACOUSTIC TELEMETRY IN U.S.V.I.*

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The invasion of *Halophila stipulacea* across Caribbean seagrass meadows has caused concern amongst management agencies due to its high resilience to disturbance, including costly removal strategies. Investigating how large megaherbivores like green sea turtles influence seagrass ecosystem dynamics can help these agencies predict how the invasive seagrass will progress or decline over time. Additionally, the drastic change in green turtle foraging habitat, from *Syringodium filiforme* and *Halodule wrightii*-dominated beds to dense, monotypic *H. stipulacea*, could impact their future habitat use and resource partitioning, information that conservation and management agencies use to implement protective guidelines for this endangered species. This project, part a subsection of a larger Master's thesis, encompasses a fine-scale tracking study of green turtles' movement patterns in Brewers Bay, St. Thomas to investigate their foraging selectivity in the mixed-species seagrass beds. A fine-scale positioning system (FPS) acoustic receiver array was deployed across the ~1.5 km^2 of the bay, which includes seagrass, coral reef, and sand/rock benthic habitat. 17 juvenile green sea turtles were tracked with acoustic transmitters that provided positions with an estimated accuracy of ± 2 meters. The native and invasive seagrass composition was mapped in the highest trafficked daytime area to pair with the turtles' foraging locations. Turtle movements were linked to seagrass composition within the sampling grid using resource selection functions (RSF) to estimate turtle selection towards each seagrass species in Brewers Bay. Turtles actively selected the two native species present, with no selection towards the invasive seagrass despite its high abundance. This coincides with findings from similar studies suggesting that green turtles are foraging preferentially in native grasses, allowing *H. stipulacea* to thrive without top-down pressure. Interestingly, three individuals utilized foraging areas in deeper water with monotypic invasive seagrass, which was outside the sampling grid and not suitable for analysis in this study. This pattern of space use has not been observed in past studies of Brewers Bay and could be evidence of turtles beginning to recognize *H. stipulacea* as a viable food source. These results highlight the need to better understand *H. stipulacea* as a dynamic factor in green turtle foraging, as developing foraging pressure on the invasive seagrass may help combat its continued spread.

NUMERICAL MODELS UNVEIL THE "LOST YEARS" OF LOGGERHEAD SEA TURTLES*

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Advances in satellite telemetry and remote sensing have greatly improved our understanding about the spatial ecology of adult sea turtles. However, a significant gap remains regarding the early sea turtle life history, commonly referred to as "The Lost Years". Neonates, measuring just a few centimeters in length, enter the ocean and are rarely observed until they reappear years later as subadults and adults near their natal beaches or within foraging habitats. Numerical models have emerged as powerful tools to shed light on these cryptic years. The Sea Turtle Active Movement Model (STAMM) significantly advances our understanding about the dispersal of sea turtle hatchlings and juveniles, by simulating their movements under the influence of oceanic currents (passive drift) and habitat-driven swimming movements (active dispersal). STAMM has been previously calibrated to simulate the dispersal of leatherback turtles, but our research is dedicated to adapting it for loggerhead populations. Our calibration effort aims, through sensitivity studies and parameter estimates, to consistently simulate the general dispersal patterns and features of loggerhead sea turtles by successively studying passive and parameterized active dispersal, allowing us to separate the impacts of the local oceanic configuration from the intrinsic impact of swimming activity. This presentation seeks to unveil preliminary findings from the ongoing STAMM loggerhead modeling efforts, emphasizing our first results on passive dispersal of juvenile loggerhead turtles originating from southeastern Florida (USA), and Cape Verde nesting sites. Our early investigations highlighted differences between passive dispersal patterns from both nesting sites but also already identified new potential dispersal areas in the Sargasso Sea, the Caribbean Sea and the Gulf of Mexico, specific to juveniles from the poorly understood Cape Verdean population. By employing STAMM, we aim to fill a critical gap in sea turtle research and contribute to the delineation of loggerhead Regional Management Units, incorporating the juvenile stage dispersal information. This knowledge is pivotal for informing decision-making processes related to implementation of effective sea turtle conservation and management measures.

THE JOURNEY OF LOGGERHEAD TURTLES FROM THE NORTHWEST ATLANTIC TO THE MEDITERRANEAN SEA ACCORDING TO THE STABLE ISOTOPE RATIOS OF C, N AND O OF THEIR BONES*

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Loggerhead turtles, *Caretta caretta*, born on the nesting beaches of the Northwest Atlantic Ocean undertake a long transoceanic migration immediately after birth, traveling eastward in association with the Gulf Stream. Most of them reach the coasts of Europe and northwestern Africa when two or three years old and 20-30 cm in curved carapace length (CCL) and remain in the oceanic foraging grounds of the eastern Atlantic for several years, before migrating back to the western Atlantic when 40-60 cm CCL. On the other hand, some of these loggerhead turtles enter the Mediterranean Sea during their developmental migration, but the timing of that entry and the length of the period spent inside are poorly known. Here, we combined skeletochronology with the analysis of the stable isotope ratio of oxygen ($\delta^{18}O$), carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) in the cortical bone of the humerus of 31 juvenile loggerhead turtles of Atlantic origin found dead stranded in the Balearic Islands. We sampled different incremental layers (n = 74) to assess the timing of the entry into the Mediterranean basin and the existence of any ontogenetic change in the diet. In addition, we used the positive and linear correlation between sea surface salinity and $\delta^{18}O$ to analyse the habitat use and identify individual movements between water masses. The surface waters of the Mediterranean Sea are salty and enriched in ^{18}O due to a negative water balance, and hence, the entry into the basin could be traced by the $\delta^{18}O$ values in the incremental layers of the cortical bone of skeletal elements such the humerus. The studied turtles measured between 28.00 and 80.64 cm CCL and the estimated age of the sampled layers ranged from 3 to 15 years old. Thus, the incremental layers corresponding to the first years of life have been reabsorbed and, as a result, the $\delta^{18}O$ values corresponding to the years spent in the Gulf Stream were missing in all individuals. Nonetheless, the broad variability found in the $\delta^{18}O$ values of the remaining incremental layers suggest that juveniles moved between water masses with different salinity levels before stranding in the Balearic Islands. The observed range of $\delta^{18}O$ values encompassed those from the eastern Atlantic Ocean, the western Mediterranean basin, and the much saltier eastern Mediterranean basin, without any consistent temporal pattern. This suggests that the entry into the Mediterranean Sea may happen at any time during their stay in the eastern Atlantic Ocean and, once inside, these juvenile loggerhead turtles can follow a diversity of trajectories across the entire basin. Nevertheless, upon reaching ten years old they consistently settle in low salinity areas such as the southern Algerian Basin or the Alboran Sea, likely preparing for their return towards their natal beaches in the western Atlantic Ocean. Finally, the changes observed in the $\delta^{13}C$ and $\delta^{15}N$ values of the analyzed incremental layers were small, and did not indicate any ontogenic change in the diet of juvenile loggerhead turtles during their journey through the eastern Atlantic Ocean and the Mediterranean Sea.

IDENTIFYING THE FORAGING GROUNDS OF NEW LOGGERHEAD TURTLE NESTERS IN THE WESTERN MEDITERRANEAN*

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The western Mediterranean Sea has traditionally served as a primary foraging ground for juvenile loggerhead turtles from three distinct regional management units: the Northwestern Atlantic, the Mediterranean, and Cape Verde. Nesting activities were only sporadic. Recently, nesting activity on the beaches of Spain, France and Italy has increased, due to warmer sand and water temperatures during the summer months. Genetic analysis has revealed an admixture of parents from Mediterranean and Atlantic origins on the nesting beaches of the western Mediterranean, but the foraging grounds used by those adults are unknown. This study has integrated satellite telemetry data from seven adult females nesting in Spain with stable isotope analysis of carbon (C), nitrogen (N), and sulfur (S) in the epidermis of hatchlings from 16 nests found in Spanish beaches and 58 dead individuals stranded along the coasts of two distinct basins (the Balearic Sea and the Algerian Basin), to identify those foraging grounds. Both satellite telemetry and stable isotope analysis indicated that the majority of the adult females nesting in Spain foraged oceanically in the Algerian Basin. Nevertheless, one of the satellite-tagged females spent 3.5 months foraging also in the central Mediterranean Sea and two hatchlings exhibited distinct stable isotope signals, tentatively associated with the foraging of their mothers in shallow coastal areas of the central Mediterranean Sea. In any case, the dominance in this new population of oceanic foragers using the Algerian Basin is noteworthy, given the prevalence of neritic foraging in adult females nesting in the central and eastern Mediterranean Sea and the Algerian Basin's oligotrophic nature. It should be noted, however, that the Algerian Basin is the foraging ground used by most of the juvenile loggerhead turtles of Atlantic origin reaching the Mediterranean. In any case, the use of the Algerian Basin as a foraging ground for adult loggerhead turtles exposes them to bycatch from drifting longlines. In the 1990s, Spanish drifting longlines captured as many as 20,000 loggerhead turtles annually, mostly at the Algerian Basin, and posing a significant threat to these turtles in the region. Over the past decade, a dramatic reduction in bycatch levels has occurred in the western Mediterranean Sea driven by operational changes in the Spanish longline fleet, which shifted its focus from bluefin tuna to swordfish as their main target species due to new regulations. The authorities should refrain from increasing the bluefin quotas imposed on longliners in the Algerian Basin unless the fishery avoids using squid as bait and agrees to deploy hooks deeper than 25 m to reduce loggerhead turtle bycatch. Otherwise, the ongoing colonization of the beaches in the western Mediterranean Sea would be jeopardized by the incidental capture of these oceanic adults.

FISHERY DISCARDS AND LONG-TERM CHANGES IN THE DIET OF LOGGERHEAD TURTLES (CARETTA CARETTA) IN THE WESTERN MEDITERRANEAN AS REVEALED BY GUT CONTENTS AND BULK AND COMPOUND SPECIFIC STABLE ISOTOPE ANALYSES

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Loggerhead turtles (*Caretta caretta*) larger than 40 cm curved carapace length (CCL) have skulls adapted to crush hard-shelled invertebrates, which explains why molluscs and crustaceans usually dominate their diets. However, several recent studies provide evidence of a more varied diet, often including variable amounts of fish. Fishery discards are often assumed to be the main source of fish for loggerhead turtles, but the actual relevance of fishery discards is poorly known, as loggerhead turtles can also capture healthy fish by themselves. Fishing fleets and fishery discards have declined steadily in the Spain's Mediterranean coastal waters since the late 20th century. Accordingly, if scavenging on fishery discards was their main source of fish, the contribution of fish to the diet of neritic loggerhead turtles inhabiting the region would have also decline. Here, we analyzed the gut contents of 94 juvenile loggerhead turtles ranging 29-67 cm CCL and captured incidentally in neritic habitats off the Mediterranean coast of Spain in two different periods (1991 and 2010-2017) to assess the contribution of fish to their diet over time. We also used bulk and compound-specific stable isotope analyses of proteins and amino acids (CSIAA), respectively, of a subsample of the same turtles to assess their trophic positions in three periods: 1991, 2007-2009 and 2015-2017 (n=10 in each period). Gut content analysis revealed a shift in the dominant diet items, from fish, crustaceans and tunicates in 1991 to bivalves, tunicates and gastropods in 2010 and 2017. The $\delta^{15}N_{bulk}$ of turtle bone also dropped from 1991 to 2007-2009 and remained low in 2015-2017, suggesting a drop in trophic position as the contribution of fish to the diet declined. However, $\delta^{15}N_{Phe}$ values indicated that 52.5% of that temporal variability in $\delta^{15}N_{bulk}$ was due to a baseline shift, previously reported on the basis of the $\delta^{15}N_{bulk}$ values in seagrasses. Surprisingly, CSIAA did not confirm the drop in the trophic position of loggerhead turtles suggested by gut contents analysis; indeed, TP_{CSIAA} increased significantly from 1991 to 2007-2009, and decreased again in 2015-2017. Such disagreement could be caused by temporal changes in the contribution of terrestrial C3 plants and phytoplankton to the base of coastal food webs, as TP_{CSIAA} is highly sensitive to the actual proportion of vascular and non-vascular primary producers as sources of organic matter. Furthermore, alternative habitat use which may differ in N biogeochemical cycling may explain some of the variability in the $\delta^{15}N_{Phe}$ values. Finally, the overwhelming dominance of tunicates in the diet of loggerhead turtles might mask any change in the contribution of other prey to the trophic position of loggerhead turtles. In conclusion, fish consumption by loggerhead turtles inhabiting the Mediterranean coast of Spain is partially dependent on fishery discards, but bulk and compound specific stable isotope analysis fail to track temporal shifts in trophic position because of the combination of several confounding factors.

INTER-NESTING AREA USE, MIGRATORY ROUTES, AND FORAGING GROUNDS FOR HAWKSBILL TURTLE*

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The hawksbill sea turtle, *Eretmochelys imbricata*, has been identified as a species at serious risk of extinction for more than 40 years and is still listed as critically endangered. While nesting beach protection is important for hatchling production, identifying in-water habitats— inter-nesting, migratory, foraging— is crucial for mitigating threats to population recovery. Here, we report the use of satellite telemetry to monitor the in-water movements of 15 hawksbill turtles Western Caribbean. Transmitters were deployed on nesting turtles at Pumpkin Hill Beach, Honduras (2012 n = 2; 2017 n = 3), Tortuguero, Costa Rica (2000 n = 2; 2014 n = 1; 2015 n = 1; 2021 n = 1), Gandoca-Manzanillo National Wildlife Refuge, Costa Rica (2018 n = 4), and Chiriqui Beach, Panama (2017 n = 1). General patterns suggest that hawksbill inter-nesting habitats were adjacent to the nesting beach and ranged between 0.0004 and 0.25 km^2 (core 50% utilization distribution) for the 15 – 70 tracking days recorded in this study. Subsequently, these turtles engaged in migrations that covered 74.58 – 577.00 km and lasted between 5 – 45 days to reach foraging grounds, with an average speed of 11.51 ± 3.99 km/d. During migrations, turtles regularly altered their direction relative to ocean current direction resulting in an average movement that used with-current movement to counteract against-current movement (cosine similarity: −0.002 ± 0.107). Foraging habitats were not beach specific and hawksbills from multiple beaches congregated in the same foraging habitat, despite nesting in different years. Turtles in this study foraged in previously identified habitats along the coastal and continental shelf of Nicaragua, Honduras, Belize, and Mexico. Foraging ground area use was generally smaller than inter-nesting area use (n = 8), with only 3 turtles having larger foraging area core utilization distributions, indicating that foraging habitats provide necessary resources without requiring the turtles to traverse large areas to find food and resting areas. Alternatively, some inter-nesting habitats were adjacent to a narrow continental shelf with strong ocean currents, and turtles must actively search for suitable habitats. These data help us better understand inter-nesting and foraging habitat locations, core area use within these habitats, and migration routes between the two. Together this provides vital information to mitigate potential in-water threats to critically endangered adult hawksbills along Central Western Caribbean migration corridors.

DOES SEAGRASS GRAZED BY GREEN TURTLES RETAIN HABITAT VALUE FOR FISH?*

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Seagrasses are foundation species for highly productive ecosystems that support fisheries vital to global food security. Green turtles (*Chelonia mydas*) are specialized grazers that maintain grazed seagrass areas by repeatedly cropping nutritious new growth. Effects of green turtle grazing were largely absent from Caribbean seagrass ecosystems prior to green turtle population increases in recent decades. As population recovery continues, seagrass meadows are returning to more natural levels of grazing. Because canopy height is substantially reduced, the habitat value of grazed areas has been compared to unvegetated substrate, with attendant predictions about loss of fisheries production. Though seagrasses and associated fauna have coevolved with green turtles, green turtle culling has been proposed as a management approach to protect globally declining seagrasses. As such, improved understanding of how green turtles affect seagrass ecosystem function is critical to inform management. Using remote underwater video (RUV) systems, we investigated effects of green turtle grazing on fish abundance and diversity at two seagrass meadows on the east coast of Eleuthera, The Bahamas. As part of a concurrent study, we mapped the meadows using ground-truthed aerial imagery. Green turtles at both sites maintained mosaics of ungrazed and grazed seagrass, with edges at the interface of these structurally distinct patches. We generated RUV deployment points in a stratified random design with five replicates per microhabitat (bare sand, ungrazed seagrass, edge, grazed seagrass) per site. At each point, we conducted two 4-hour RUV deployments during daytime high tides in June–July 2018. From 283 hours of 4K footage, we extracted relative abundance (MaxN) as maximum number of each fish species observed in a single frame and species richness (S) as number of unique species observed. To evaluate variation in fish abundance and diversity among microhabitats, we (1) summarized microhabitat structural characteristics (PCA of primary producer and grazing intensity metrics); (2) constructed accumulation curves of MaxN and S for each site x microhabitat (vegan R package); (3) evaluated site and microhabitat as predictors of MaxN, S, and Simpson's Diversity Index (PERMANOVA); and (4) compared fish assemblage composition among microhabitats (NMDS ordination; PERMANOVA), both for taxa and functional entities assigned based on body size and diet (rfishbase R package). Habitat selection by fish is the product of a food-risk tradeoff—maximizing foraging success and minimizing predation risk—mediated by habitat structure. Given grazing does not result in uniformly simplified seagrass structure, structural characteristics of grazed areas are distinct from unvegetated substrate, and edge represents heterogeneous habitat that may optimize the food-risk tradeoff, we predict fish abundance and diversity will be highest at edge, intermediate in grazed and ungrazed seagrass, and lowest in bare sand. We predict fish assemblage composition at edge will include dominant taxa from both grazed and ungrazed seagrass, and composition will differ between grazed seagrass and bare sand. Our study provides new insight into effects of green turtle grazing on habitat value for seagrass-associated species and contributes to an improved understanding of how seagrass ecosystems functioned before overexploitation by humans led to green turtle ecological extinction.

EXPLORING THE POTENTIAL OF DIETARY DNA METABARCODING IN SEA TURTLES*

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Characterising diet is important for elucidating trophic webs and understanding ecological roles. Changing environmental conditions are influencing trophic webs and foraging behaviours in the oceans, necessitating technologies that can effectively and rapidly monitor diet. In the sea turtle, whose diet is now recognised to be more variable than once thought, it is important to understand and optimise diet analysis among species, life stages or geographies with varying diet complexities and environmental conditions. Sea turtle diet analysis has traditionally been conducted via observational studies and gastrointestinal tract analysis, with stable isotope approaches becoming frequent in the last two decades. While these methods are still valuable, molecular approaches are allowing researchers to overcome some of their associated limitations (e.g., morphological stomach content analysis can underrepresent gelatinous prey). DNA metabarcoding is a particularly promising tool with the potential for facilitating wide-scale, non-invasive diet studies in sea turtles. To assess the potential of dietary DNA metabarcoding analysis in sea turtles, we conducted a systematic review of DNA-based diet studies on marine vertebrates. Overall, studies suggest that DNA metabarcoding can improve the taxonomic resolution of prey species identified, particularly in combination with traditional methods, and its incorporation in diet analysis can lead to the identification of a greater number of prey taxa. However, there were consistent biases and considerations to be made for optimising results and designing future studies (e.g., primer selection, presence of host DNA, inability to distinguish secondary/incidental prey). Dietary DNA metabarcoding studies in sea turtles are limited (n=3 since 2021), but we expect further studies could reveal underrepresented prey species in sea turtles, particularly in terms of harder-to-study diets (e.g., consumption of gelatinous species) or life stages (e.g., immature individuals from remote locations). This review calls for the scaling up of sea turtle dietary DNA metabarcoding studies and the optimisation of methodology. Multi-faceted, comprehensive approaches to dietary analysis will help to characterise variations in sea turtle diet and effectively monitor changing trophic ecology in response to environmental changes such as rising sea temperatures and displacement to alternative foraging grounds.

TESTING THE THERMAL CORRIDOR HYPOTHESIS: DOES EL NINO WARMING OF THE NE PACIFIC ALLOW JAPANESE LOGGERHEADS TO GO TO MEXICO?*

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The North Pacific loggerhead sea turtle, *Caretta caretta*, undergoes one of the greatest of all animal migrations, entering the sea as hatchlings from nesting beaches in Japan and appearing years later along foraging grounds off Baja California Sur, Mexico after spending several years or more living in the Central North Pacific (CNP). The mechanisms that connect these distant habitats have remained poorly understood but are crucial for managing this endangered species. This is especially true given recent spatial shifts associated with warm water events. Our research group analyzed 15 years of data from satellite-tagged juvenile loggerheads released in the Western and Central North Pacific and proposed the Thermal Corridor Hypothesis (TCH) based on observations that turtles in the CNP can transition eastward to the North American coast as a function of unusually warm conditions. To test this hypothesis, we have initiated the first-of-its-kind experimental oceanographic approach for a top marine consumer, deploying satellite tags on cohorts of 25 juvenile loggerheads in the Eastern North Pacific high seas across four years with variable environment conditions (2023-2026). Here, we discuss the hypothesized movements of loggerheads from the 2023 cohort, with the expectation that turtles will move eastward towards the North American coast given the El Niño conditions, which will likely result in the opening of a thermal ‘corridor’ of warm water bridging these two regions. The outcome of this work has critical implications for conservation and management. As the North Pacific continues to undergo unprecedented changes in the Anthropocene, understanding how sentinel species such as sea turtles will respond and adapt to climate variability is imperative to effectively maintaining and managing healthy ecological connections across their entire North Pacific habitat.

RESIDENCE OF MALE BLACK SEA TURTLES (CHELONIA MYDAS AGASSIZII) AT NESTING AREAS IN MICHOACAN, MÉXICO

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The black turtle population in Michoacán is the most abundant in the eastern pacific, breeding adults aggregate during the months of September to January when courtship and copulation interactions occur. breeding females exhibit polyandrous mating behavior and no intra-sexual sexual selection is observed among breeding males. the reproductive behavior of breeding males has been studied for a decade and they exhibit intense competition for females throughout this period. it has been observed through satellite tracking that males do not make long-distance movements as females do to their breeding areas in Central America and northwestern Mexico (Sinaloa, Sonora and the Baja California peninsula). Once the nesting season declines in the ANP Colola sanctuary (the main nesting site for the black sea turtle population in the American Pacific), the males make movements to the south of the coast of Michoacan on the border with the state of Guerrero where a thermoelectric power plant is located, where some males enter the plant's refrigeration channels, apparently in search of warm water. On the other hand, through the study of stomach contents in breeding males, it has been observed that they use a variety of food resources found in the coast of Michoacan, among which are jellyfish, algae, diatoms, sponges, sea grasses and others. Captures of copulating and courting males and photographic records in continuous years have yielded information suggesting that male black sea turtles do not follow females to feeding areas for several reasons: 1) The reproductive condition in terms of receptivity of males ends once the females leave the nesting area and begin migrating to feeding areas in Central America and northwestern Mexico. 2) The males do not follow females to feeding areas in Central America and northwestern Mexico, 3) Males do not require considerable energy inputs for sperm production, 4) The reproductive cycles of females in the black turtle population in Michoacán are three and five years, while males reproduce continuously once they reach sexual maturity. Evidence accumulated from a decade of studies on the reproductive behavior of adult breeding black turtles in Michoacán suggests that males are resident in the nesting areas of Michoacán, which encompass approximately 80 km of coastline.

FORAGING BEHAVIOR OF LEATHERBACK SEA TURTLES (DERMOCHELYS CORIACEA) OFF MASSACHUSETTS, USA: INSIGHTS FROM ACCELERATION DATA LOGGERS*

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Leatherback sea turtles (*Dermochelys coriacea*) travel thousands of kilometers to temperate feeding habitats off the northeast United States and Atlantic Canada to forage on gelatinous zooplankton. Their seasonal (May – November) presence in coastal Massachusetts waters coincides with several active fisheries and a peak in vessel activity. This overlap results in an increased risk of entanglement and vessel strike, which is supported by leatherback strandings in the region. To assess leatherback behavior relative to these risks, we deployed custom biologger tag packages on 13 free-swimming, feeding leatherbacks and one disentangled leatherback during September and October 2023. Tags were attached to the turtles with suction cups using a carbon fiber pole or by hand from small (<8 m) research vessels. Tagging locations included waters south of Nantucket Island (n=7), Nantucket Sound (n=6), and Cape Cod Bay (n=1). Two of the tag packages detached prematurely (<10 min) and were collected and redeployed on different turtles on the same day. Of the remaining 12, we successfully recovered 11 tag packages using satellite and VHF telemetry while one tag package could not be located due to satellite tag failure. We collected 196 hours of archival data with 7 overnight deployments, and individual attachment durations ranged from 1.8 to 29.8 hours (mean ± SD: 17.6 ± 9.6). On average, turtles spent just over 20% of their time at the surface, with percent surface time higher south of Nantucket (mean ± SD: 24.9 ± 2.8) and in Cape Cod Bay (23.0) compared to Nantucket Sound (mean ± SD: 17.2 ± 2.4), and surface bouts were brief across all individuals (mean 1.7 min). Turtle dive durations were also brief (mean ± SD: 6.2 ± 2.0 min) and average dive depths were relatively shallow (<10 m), with the exception of the disentangled turtle that had an average dive depth of 19.2 m. Preliminary assessment of sensor data showed that foraging turtles had lower nocturnal activity levels (measured as the turtle's overall dynamic body acceleration (ODBA)) compared to daytime hours, but the disentangled turtle's activity level was consistent day and night. The disentangled turtle also dove deeper than the foraging turtles, but this may be due to study site bathymetry, with Cape Cod Bay having deeper water access compared to Nantucket Sound and the waters just south of Nantucket. Further analysis of the accelerometer data and, for some tags, corresponding video, will provide additional insight into leatherback foraging behaviors that may increase their risk to human activities. Future field work will focus on increasing data collection from disentangled turtles.

SHORT-TERM EFFECTS OF BIOLOGGER ATTACHMENT ON THE BEHAVIOUR OF JUVENILE GREEN TURTLES ASSESSED USING ANIMAL-BORNE CAMERAS AND UAVS*

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The increasing use of animal-borne bio-loggers has revolutionized the study of marine megafauna, yet there remains a distinct paucity of research concerning the behavioral and physiological impacts of handling stress and bio-logger attachment. Here, we used 55 animal-borne cameras (referred to as TurtleCam to assess short-term (up to 3 h) changes in the behavior and breathing rate of juvenile green turtles in The Bahamas immediately following capture and bio-logger deployment. The turtles were pursued by boat in shallow waters and snorkelers grabbed them at the base of the front flippers and brought them onboard the boat. Onboard, the turtle was tagged if needed, the carapace size was measured, and the TurtleCam was attached within 15-30 min. A VHF radio transmitter (MOD-050-2, Lotek, USA) and a buoyant foam were attached to a dive camera (DiveCamera+, Paralenz, Denmark), which it was deployed by using 5-min epoxy (KwikWeld, USA) to affix three pieces of 4x4 cm plastic mesh with a galvanic timed releases (AA2, International Fishing Limited, New Zealand) attached. The animal was later released back into the water within 100 m of its original encounter location. Equivalent data were collected from non-handled animals via Unoccupied Aerial Vehicles (UAVs; model DJI Mavic 2 Pro) by flying the unit at an altitude of 15 m, in the same general creek systems and at similar times as TurtleCam surveys. UAVs would record for a minimum of 10 min with the turtle within the center of the image. This was repeated up to three times per day per creek, avoiding using the exact same creek on the exact same day as TurtleCam surveys, to ensure that no filmed individuals were handled by us in the past 24 hours. Finally, we investigated the effect of body-size by comparing the responses of these 55 turtles above and below 500 mm Straight Carapace Length (SCL), where 28 were below 500 mm SCL and 27 were above 500 mm SCL. The animal-borne camera footage revealed that after release turtles spent a high proportion of their time swimming (70 to 80 %), but this showed a continual decrease over time, alongside an increase in resting and feeding behavior until plateauing 90 mins post-release. While this may suggest that turtles have resumed typical behaviors within 90 mins of handling, the mean apnea durations (used as an indicator of dive capacity) increased steadily until the end of the 180 min sampling period. Furthermore, mean apnea durations increased faster for larger turtles even though UAV data suggests similar mean apnea duration under normal conditions. In conclusion, while the effects of handling stress on the behavior of juvenile green turtles may largely diminish within 90 mins, we propose that other physiological stressors may still be affecting metabolic rate and dive capacity for several hours longer.

IN-WATER RELATIVE ABUNDANCE AND DISTRIBUTION OF SEA TURTLES ALONG THE EAST COAST OF SOUTH AFRICA*

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South Africa holds a significant portion of the Southwest Indian Ocean (SWIO) loggerhead and leatherback sea turtle populations underpinned by long-term research and conservation efforts on nesting beaches. However, the in-water biology of these species and non-nesting green turtles and hawksbills in adjacent neritic habitats remains cryptic. This study provides the first in-water estimates of relative abundance, demographics and spatial distribution of sea turtles in two Marine Protected Areas (MPAs); iSimangaliso and Aliwal Shoal, on the east coast of South Africa. Over a two-year period, a total of 1057 sea turtle sightings were recorded from timed research surveys (supplemented by voluntourism), citizen science contributions and opportunistic sightings in the two MPAs, from which 227 individual sea turtles were photo-identified (green turtles: n = 120; hawksbills: n = 46; loggerheads: n = 61). Mean (± SD) sightings per unit effort (SPUE) from timed research surveys was highest for green turtles at all sites (iSimangaliso: 2.2 ± 4.47 turtles/hour, n = 263; Aliwal Shoal: 1.2 ± 1.98 turtles/hour, n = 60). Hawksbills had a higher mean SPUE at Aliwal Shoal (0.8 ± 1.35 turtles/hour, n = 48) than iSimangaliso (0.2 ± 1.20 turtles/hour, n = 32) whilst loggerheads had similar mean SPUEs (iSimangaliso: 0.5 ± 1.54 turtles/hour, n = 65; Aliwal Shoal: 0.5 ± 1.16 turtles/hour, n = 36). Reefs supported aggregations of mixed size classes; green turtles ranged from juvenile- to adult-sized with straight carapace lengths (SCLs, measured using paired-laser photogrammetry) of 44.9–99.2 cm, hawksbills were mostly juveniles or subadults (SCL range: 37.4–73.4 cm) and loggerheads were mostly adult-sized (SCL range: 66.9–81 cm). Based on visual estimates, the sex ratios of adult-sized green turtles and loggerheads were slightly female-biased but not significantly different from 1:1. The longest minimum residence periods recorded to date for individual subadult green and hawksbill turtles (676 and 675 days respectively) and adult-sized loggerheads (621 days) were highly indicative of residency. Green turtles, hawksbills and loggerheads displayed strong site fidelity with individuals resighted up to 19, 10 and 11 times respectively on the same reef over the two-year study period. Citizen science data were particularly useful in revealing a wider distribution of sea turtles along the entire South African coastline than currently recognised. This study highlights the importance of the SWIO rookery output in influencing neritic habitats along the east coast of South Africa and provides novel insights into in-water sea turtle biology for understudied populations. The findings form the foundation on which a long-term in-water monitoring programme may be established to expand research efforts along the southern African coastline that may inform effective species-specific management and conservation strategies.

COMING OUT OF THEIR SHELLS: REPEATABLE SOCIAL PREFERENCES IN GREEN SEA TURTLES, CHELONIA MYDAS

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Social behaviours are prevalent across the animal kingdom and can have significant implications for species survival and fitness. This study focuses on the associations and preferences of green sea turtles at a key resting site in the Maldives. Employing photo identification, the study explores individual engagement in social behaviour at the dive site Hithadhoo Corner, Laamu Atoll, Maldives. Over a three month period 76 surveys were carried out at the dive site, and each turtle resting was individually identified. The location of each individual was recorded, with reference to the 6 specific coral bommies at the site. Over the survey period we identified 51 individuals across 332 encounters, across all coral bommies. Individuals were split into life-stage, adult and juvenile, based on size less than or greater than 65cm, estimated by eye. In adults the observation of a tail extending past the carapace placed them in the male category. To see if there was presence of grouping and sociality we used the Gambit of the Group approach, whereby individuals resting on the same bommie in the same time period were considered to be associating. Using this approach, the study found an inclination towards grouping (62%), where it is more likely to encounter multiple individuals on a bommie than just one. With a closer examination of sex and life-stage influences using a Bayesian analysis approach; it is highlighted that males have a higher propensity to participate in group behaviour. Repeatable social associations were also evident in some individual turtles, with certain pairs observed on 8 occasions. With insights from social behaviour studies in other species, this study works to shed light on potential mechanisms and motivations that underlie the observed social behaviours in sea turtles. Our study challenges the historical non-social generalisation placed on this species and contributes to the growing body of research on sea turtle social behaviour.

DETECTING RESIDENCY AND HABITAT FIDELITY OF GREEN TURTLES IN TAIWAN*

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Algal-dominated reefs of Liuchiu Island is regarded as the primary foraging habitat of hundreds of green turtles in Taiwan. The island provides easy access to these turtles via snorkelling or SCUBA diving, which has attracted many domestic and international tourists. It has also significantly raised awareness of conservation concerns. To better understand the abundance of sea turtles around the island and how they utilize this habitat, we conducted intensive seasonal surveys at 2 hotspots over a 2-year period. We captured images of turtles during the survey, and then used a photo-ID method to identify individuals and track their occurrence rates. In total, we accumulated around 4260 sightings and identified more than 500 unique individuals. 70% of individuals had a high repetitive sighting rate as well as high fidelity to their foraging habitat. Shifting of individuals among foraging sites has been observed but rare. The number of individuals recorded with our intensive systematic survey method was three times higher than a single time survey. We believe these findings are important towards improving our knowledge on green sea turtle population dynamics and habitat fidelity, as well as our ecological understanding of these precious animals. Further, the methods applied in this study have potential in other fields concerning habitat monitoring and community-based projects with limited resources.

FIRST ISLAND WIDE SURVEY OF HAWKSBILL SEA TURTLES, ERETMOCHELYS IMBRICATA, IN THE WATERS OF ST JOHN, U.S. VIRGIN ISLANDS

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In-water estimates of hawksbill sea turtle abundance and size distribution are critical to understanding the potential growth or decline of the population. However, these measures can be difficult, costly, and time-consuming. The ephemeral nature of their sightings, the cost of boating operations, and the difficulty catching these turtles are factors in why this data is often unavailable. The size structure of the juvenile population can be a powerful predictor of population growth or decline. To assess the population in the waters of St John, USVI, a team of trained volunteers spent 11 days over two weeks in the summer of 2023 catching and tagging hawksbill sea turtles. Typically, a team of four free divers spent 6 to 8 hours per day

swimming much of the shallow waters (1m to 15m) of the approximate 65km of St John's coastline searching for sea turtles. Seventeen individuals were captured, tagged, and released. The turtles' SCL ranged from 21.2cm to 67.9cm (mean 47.1 ± 16.5) and 1.1kg to 37.6kg (mean 16.7 ±13.1), reflecting that most, if not all, were juvenile or subadult individuals. None of the turtles showed evidence of previous tagging (no PIT or flipper) despite tagging programs occurring on the neighboring islands of St Thomas and Tortola. Structuring the data into 10cm size classes, which likely reflect age classes, produced a population pyramid that could be used for population growth predictions on larger data sets. The small population sample, n=17, showed an hourglass shape, with most turtles being over 60cm (n=7) and the second largest size class being 20-29 cm (n=4). A population pyramid with large young populations can predict population growth in the future. The small sample size from this first-ever island-wide survey is too small for accurate predictions of population growth. Still, it is an example of the effort required and the potential value of intensive in-water tagging efforts.

THE UNDERLYING FACTORS DRIVING VARIATION IN SOCIAL INTERACTIONS BETWEEN JUVENILE GREEN TURTLES (CHELONIA MYDAS) IN BREWERS BAY, ST. THOMAS, USVI*

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The social behaviors of marine turtles outside of courtship and reproduction are an emerging topic of study in marine turtle biology. Nevertheless, the underlying factors driving variation in social behaviors remain relatively unknown. This study aimed to determine which factors influence social interactions between resident juvenile green turtles (*Chelonia mydas*) in Brewers Bay, St. Thomas, U.S. Virgin Islands. Specifically, we investigated relationships between the type of interaction, the habitat in which it occurred, and the relative body size of the turtles. We collected videos of juvenile green turtles interacting through opportunistic underwater snorkelling surveys via handheld cameras. Snorkelers followed and recorded turtles in rocky substrate and seagrass meadows during different times of day to record any social interactions. We expanded upon interaction ethograms from past behavioral studies, categorizing interactions as aggressive or passive and then further grouping behaviors into specific types of turtle contact and association. Aggressive interactions can best be understood as dominant behaviors like physical altercations, while passive interactions are understood to be interactions without a display of dominance or possibly acting with curiosity. Juvenile green turtles in Brewers Bay display a range of social behaviors, largely mirroring those documented in past behavioral studies. These included aggressive behaviors such as biting, contact, and displacement and passive behaviors such as inspection and head touching. We discuss behavioral patterns in relation to previous studies on green turtles as well as loggerheads (*Caretta caretta*) and hawksbills (*Eretmochelys imbricata*). Our study adds to the understanding of marine turtle sociality by providing evidence of environmental variables influencing potentially complex social behaviors that are contrary to a widely accepted paradigm that reptiles are generally non-social.

FORAGING PATTERNS OF MORE NOURISHED GREEN SEA TURTLES (CHELONIA MYDAS) MIGRATING TO HIGH LATITUDES IN JAPAN

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Juvenile green turtles are generally considered to be primarily herbivorous and occupy narrow ranges in neritic areas. However, some previous research revealed that they perform seasonal long-distance migrations. Juveniles in the high latitudes of Japan where they forage during the summer also migrate hundreds of kilometers. These turtles are known to migrate south when water temperatures drop in autumn or winter. Such polymorphism in the behaviors and life histories of organisms is important to reveal diversity within the same species. In this study, we compared prey items and foraging behavior of the migratory turtles in the temperate region with resident turtles in the subtropical region and evaluated the effect of these differences on morphological and nutritional status. During 2013-2023, field studies were conducted in summer at Kuroshima Island, a small island with a diameter of about 4 km (24°14’13” N, 124°00’35” E, subtropical region), and the Sanriku coastal region, which spans approximately 150 km (38°55′-39°40′ N, 141°40′-142°05′ E, temperate region) in Japan. We investigated feeding behaviors using animal-borne data loggers attached to the turtles. They were released near the capture site or about 4 km (in Kuroshima) / 10-30 km (in Sanriku) away from the capture site. The feeding ratio was calculated as the ratio of feeding time to video logger recording time. Body Condition Index (BCI) was calculated as the ratio of body mass to straight carapace length (SCL), and nutritional status was examined through blood chemical analysis, including total protein (TP), albumin (ALB) and total cholesterol (T-CHO). Twelve turtles (SCL: 47.4-72.8 cm) were released in Kuroshima. All six turtles released at the capture sites stayed there spending most of their time foraging. Five out of the six turtles released at different sites returned to the capture sites. The feeding ratio during their return was low (0-2.0%), but it increased after returning (11.7-33.1%). They fed on macroalgae and seagrass. On the other hand, sixteen turtles (SCL:43.4-60.4 cm) were released in Sanriku. Nine out of eleven turtles released at different sites moved in the opposite direction of the capture sites, while the other two turtles returned near the capture sites. Two out of five turtles released at the capture sites left the area. The feeding ratio during migration was relatively constant (0.7-9.3%) and they also fed on gelatinous prey in addition to macroalgae and seagrass. BCI was significantly higher in migrating Sanriku turtles (1.11-1.97, median:1.46) compared to resident Kuroshima individuals (1.05-1.59, 1.33). TP, ALB and T-CHO levels were significantly higher in migratory turtles (TP = Mean±SD:4.2±0.7 g/dL, ALB = 2.1±0.3 g/dL, T-CHO = 263.5±88.4 mg/dL) than in resident individuals (TP = 3.6±0.4 g/dL, ALB = 1.2±0.2 g/dL, T-CHO = 150.6±40.0 mg/dL). It seems to be important for turtles to not only feed on macroalgae and seagrass within a specific area but also on gelatinous prey while migrating to obtain more nutrition. Although the high latitudes of Japan serve as a summer-restricted foraging area, it is suggested that they provide a better foraging environment for the growth of green turtles.

PHOTO-IDENTIFICATION AND LASER PHOTOGRAMMETRY OF GREEN (CHELONIA MYDAS) AND HAWKSBILL TURTLES (ERETMOCHELYS IMBRICATA) FORAGING IN SEMPORNA, SABAH*

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Endangered green turtles (*Chelonia mydas*) and critically endangered hawksbill turtles (*Eretmochelys imbricata*) are under anthropogenic threats exacerbated by their long-distance migrations. The lack of in-water studies, especially at sea turtle foraging habitats in Malaysia, largely limits the understanding of their population dynamics for the management of the species. Semporna, Sabah, is a major foraging ground for green turtles, yet little is known about the aggregations and thus, the viability of the populations with increasing in-water threats. Therefore, I conducted an in-water mark-recapture study at six sites of northeast Semporna islands between November 2018 and September 2020. Photo-identification was used to recognize individuals within aggregations using their stable facial scute patterns, while straight carapace length (SCL) measurements were obtained through laser photogrammetry. These non-contact, thus minimally invasive techniques were successful in characterizing sea turtle aggregation demographics in Semporna. Results from 90 field surveys, within a depth range of 1-20 m, yielded 822 sightings of 400 green turtles and 30 sightings of 25 hawksbill turtles. A highly disproportionate ratio of hawksbill to green turtles illustrates the lack of hawksbill turtles in Semporna, which is a concern for the species' viability. The highest (24.2 inds/hr) and lowest (2.6 inds/hr) green turtle encounter rates were observed at Timba Timba Island and Baturua, respectively. No inter-island movement was recorded, as sea turtles displayed high site fidelity to their neritic habitat. This is reflected by the high recapture percentage of green turtles (63.2%) at Pom Pom Island, corresponding to a higher sampling effort at this site. SCL measurements of green turtles ranged between 39 cm – 96 cm; however, the adult size class (SCL > 80 cm) was significantly underrepresented in this study at only 16%. My findings suggest that green turtles utilize Semporna foraging grounds as their permanent neritic habitat, a key area for replenishing regional sub-populations. Body condition assessments of these aggregations show that they are visually healthy; however, there is evidence of human-induced threats that should be managed through stakeholder engagement. This research highlights the feasibility of using non-contact research methods to fill knowledge gaps in in-water sea turtle aggregations for species management and conservation.

DECODING THE MYSTERIOUS DISTRIBUTION PATTERNS OF JUVENILE GREEN TURTLES DURING THEIR "LOST YEARS" THROUGH THE APPLICATION OF SPECIES DISTRIBUTION MODELLING*

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As rapid environmental changes continue to affect marine ecosystems, understanding the distribution of juvenile marine turtles in their dispersal stage is crucial for conservation and management. The "lost years" life history stage of green turtle development is difficult to study due to logistical constraints of accessing and studying small, pelagic individuals. While theoretical and captive-reared approaches have contributed to our understanding of dispersal stage green turtle behavior, wild-caught individuals provide essential insights into natural dispersal and habitat utilization that cannot be gained by other methods. To address this knowledge gap, we must develop a comprehensive understanding of the drivers behind movement and habitat selection in dispersal stage juvenile turtles. We focused on the Gulf of Mexico (GOM), where the sea surface temperature is warming at a rate roughly double that of the global oceans. Satellite tracks from 77 juvenile green turtles were used to plot turtle presence in the GOM from 2011-2022. The average tracking duration for turtles in this study was 31.3 (±13.61) days providing 7,394 green turtle locations in the GOM. Environmental variables associated with sea surface convergence zones (including sea surface temperature, eddy kinetic energy, etc.) were used to inform species distribution models (SDMs) created in the R package Biomod2. Area under the curve (AUC) and the true skill statistic (TSS) were used to determine which model performed the best. We identify previously undocumented habitat for juvenile green turtles in the Northern and Eastern GOM based on the predicted distribution. The results of our SDM provide a template for identifying essential habitat in the GOM for juvenile green turtles. Future models can be used to determine the distribution of dispersal stage green turtles elsewhere, or extend to other life-stages. Identifying the distribution of this cryptic life stage is essential for understanding how juvenile turtles interact with their environment and for predicting how they may respond to rapid climate change.

DISPERSAL CORRIDORS OF NEONATE SEA TURTLES FROM DOMINANT ROOKERIES IN THE WESTERN INDIAN OCEAN*

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Identifying dispersal pathways and critical habitats is essential to evaluate risks and inform effective management strategies of migratory marine species during all life stages. This is especially true for sea turtles that are conservation-dependent and for which management needs usually precedes comprehensive

data collection. The aim of this study was to model dispersal pathways (representative of individual behaviour) and compare potential dispersal corridors (representative of population-level behaviour) of hawksbill, loggerhead, leatherback, and green sea turtles from key rookeries in the Western Indian Ocean (WIO) with different dispersal strategies. We used the Sea Turtle Active Movement Model (STAMM) to simulate post-hatchling dispersal under the combined effects of ocean currents and habitat-driven movements. Simulation results confirmed the high connectivity between hatching sites and developmental areas in the WIO; dispersal is mostly driven by ocean currents but differs among species and years with habitat quality also differing among species. Active swimming appeared to have little influence on their dispersal patterns during the first year. We then analysed simulation results using a movement-based kernel density estimation to identify dispersal corridors for each species. There were three distinct dispersal corridors: among equatorial Indian Ocean Islands (hawksbills); along East Africa (green turtles); and around southern Africa (loggerheads and leatherbacks). These results provide a first estimation of the dispersal pathways used by neonate turtles, that are usually lacking in conservation assessments. The results can also assist to develop more targeted management measures like RMU designation or marine spatial planning for the lost years.

FORAGING GREEN TURTLES (CHELONIA MYDAS) IN SOUTHERN CALIFORNIA: NUTRIENT FLOW AND HABITAT STRUCTURE CHARACTERIZED BY ESSENTIAL AMINO ACID $\delta^{13}C$ FINGERPRINTING*

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Habitat complexity and productivity are two key elements that dictate species richness and resilience in coastal ecosystems. Protected green turtles (*Chelonia mydas)* form large foraging aggregations in coastal southern California (USA) ecosystems that are often fueled by seagrass (*Zostera marina*) and macro-algae. Seagrass ecosystems in southern California and around the world are adversely impacted by anthropogenic threats such as habitat destruction and contamination, which may impair the ecological functions of these diverse ecosystems. Seagrasses synthesize essential amino acids (AA_{ESS}) differently than co-occurring micro and macroalgae, which creates unique AA_{ESS} $d^{13}C$ profiles or 'fingerprints'. These 'fingerprints' avoid isotopic alteration as they move through food webs. Many animals including green turtles cannot synthesize AA_{ESS} de novo, requiring that they obtain AA_{ESS} from their diet. Thus, AA_{ESS} $d^{13}C$ profiles of green turtles can elucidate the importance of eelgrass and marine algae in supporting nutrient flow in these systems. From 2018–2019 we analyzed skin from 24 green turtles residing in two established southern California foraging habitats; San Diego Bay (SDB; n=14) and Seal Beach National Wildlife Refuge (SBNWR; n=10). We conducted $d^{13}C$ analysis of individual AA_{ESS} (Ile, Leu, Phe, Thr, Val) on green turtle skin and potential food sources (n= 25) including, seagrasses and macro-algae. Linear discriminant analysis (LDA) was applied to green turtle skin and habitat AA_{ESS} $d^{13}C$ profiles to model primary production influence in mediating nutrient flow in green turtle trophic interactions. In SDB, LDA indicates 79% (n= 11) of sampled green turtles obtain the majority of their AA_{ESS} from seagrass-based trophic pathways and 21% obtain AA_{ESS} from macro-algae-based trophic pathways. In SBNWR, most green turtles (60%) obtained the majority of their AA_{ESS} from macro-algae-based food chains with the other 40% utilizing seagrass-based pathways. We found that green turtle size and age class influenced their tendency to feed in eelgrass vs macro-algae trophic pathways. For example, 67% of all turtles assigned to seagrass pathways were sexually mature adults. Moreover, every turtle larger than 69.0 cm straight carapace length had an assignment to seagrass nutrient pathways. These findings underscore the value of green turtles as sentinels of trophic pathways and ecosystem structure, and suggest that as green turtles grow and mature in southern California, they increasingly rely on seagrass nutrient pathways. At a time when green turtle numbers in southern California are increasing, their strong reliance on seagrass ecosystems highlights the value of this habitat resource for endangered species. Thus, stemming the ongoing degradation of this habitat type throughout this region should be a conservation priority.

MAPPING POTENTIAL FORAGING AREAS FOR LOGGERHEAD TURTLES IN THE MEDITERRANEAN SEA: THE ROLE OF CLIMATE CHANGE AND BIOTIC FACTORS*

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The effects of global change on biodiversity become notably conspicuous when examining species engaged in extensive migrations. Their significant mobility allows these species to exploit various areas with suitable characteristics for different phases of their life cycle, including reproduction, migration, and foraging. While it is widely acknowledged that climate change has the potential to modify the distribution of sea turtles, there is a limited number of studies that investigate whether and how climate change projections might impact the distribution of potential foraging habitats on a broader scale. Traditionally, abiotic factors are typically regarded as the main drivers, while biotic factors receive limited attention. Moreover, the few studies that consider biotic factors often rely on proxies for trophic resources. Here, we used a combination of state-space models and habitat suitability models to show how climate change will influence the distribution of foraging habitats for loggerhead turtles in the Mediterranean basin. We sampled a total of 80 adults from satellite telemetry data collection from 2000 to 2022. We calibrated and projected to the future scenarios three habitat suitability models (HSMs): one considering both biotic and abiotic variables (biomass-HSM), one with a proxy for trophic resources (sea chlorophyll concentration) (chl-HSM), and the last one with abiotic variables only (climate-HSM). All models gave AUC > 0.9, with higher values in biomass-HSM compared to the other ones. Turtles are likely to choose calm waters with lower pollution levels, lower salinity, and temperatures around 18-20°C, along with a high benthic biomass. The neritic zone of the foraging grounds was found to cover 80% of the suitability, increasing in future scenarios. We get significant spatial discrepancy among all models, mainly in the Adriatic Sea, Tunisian Plateau, Aegean Sea, and along the French and Spanish coasts. Prey availability is a major biotic factor determining the actual use of a potential climatically suitable area. We highlighted the importance of including both climatic factors and species-specific trophic ecology to assess the potential impacts of global change more thoroughly on feeding grounds and implement targeted conservation measures.

MIGRATORY BEHAVIOR AND FORAGING ECOLOGY OF HAWAIIAN HAWKSBILL TURTLES*

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Hawksbill sea turtles (*Eretmochelys imbricata*) inhabiting the Hawaiian Islands (known as honuʻea or just ʻea in Hawaiian) are genetically isolated and represent one of the smallest distinct sea turtle populations on the planet. Despite their endangered status and recent advances in understanding their biology, many data gaps remain. The post-nesting migrations of this population were previously presented during ISTS41. Here, we attempt to further describe their migratory behavior by incorporating inter-nesting data, along with insights into their foraging behaviors throughout the Hawaiian Islands. We deployed satellite tags on a total of 14 post-nesting hawksbills that collected information on Argos and GPS locations, as well as dive parameters (time at depth, maximum dive depth, and dive duration), with an emphasis of deploying tags early in the nesting season. Additionally, we collected tissue samples from 4 nesting females and conducted bulk tissue and amino acid (AA)-specific stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope analyses. We also collected gastrointestinal tracts from 14 necropsied hawksbill turtles for gut content analyses to gain further insights into the diet of this population. The majority of turtles migrated to the coast of Maui (n = 7; 50%) with only two off the coast of Molokaʻi (14.3%), one remained within Hawaiʻi Island (7.1%), and one off the coast of Oahu (7.1%). No final location was transmitted for two turtles, and the transmitter failed on the remaining turtle. Nevertheless, they all demonstrated relatively short-distance migrations and remained within the Hawaiian archipelago. Throughout their inter-nesting intervals, they also remained in close proximity (i.e., <2 km) to their nesting beach while exhibiting a U-dive pattern, utilizing deeper depths between nesting presumably to find a suitable resting place. Hawksbill turtles are considered spongivores in the Caribbean but data from the Eastern Pacific suggests they consume a wide variety of prey. Bulk stable isotope values from Hawaiian hawksbills ranged from -15.0‰ to -13.9‰ and 9.9‰ to 11.6‰ for $\delta^{13}C$ and $\delta^{15}N$, respectively. These findings align with those in the Eastern Pacific, suggesting that hawksbill turtles in the Hawaiian Islands likely have a diverse diet, consuming a range of prey items. AA-specific $\delta^{13}C$ and $\delta^{15}N$ isotope analyses as well as gut content evaluations are currently being analyzed and will help verify these preliminary results, as well as additional potential insights into diet. The results of this work will be shared during the symposium. This study represents the first attempt to provide insights into the inter-nesting movements and foraging habits of Hawaiian hawksbill turtles, filling an important knowledge gap in their ecology and behavior. Determining actions to mitigate threats and designate protected areas is essential, particularly for a population that relies on a limited geographic area throughout its entire lifecycle. We aim to gain a comprehensive understanding of this highly threatened population, including the identification of movement patterns, foraging habits, and habitat preferences.

OLIVE RIDLEY INTERNESTING BEHAVIOUR IN NORTHEAST BRAZIL BASED ON HIGH RESOLUTION TRACKING DATA

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In Brazil, the Sergipe and Bahia states comprises the main nesting grounds of olive ridley (*Lepidochelys olivacea*). To evaluate the specie internesting and post-nesting movements we deployed 22 FastGPS Platform Transmitter Terminal-PTT (SirTrack FastGPS F6G 376A). The deployment occurred from August 2018 to August 2019. The PTTs FastGPS sample rate was one location every 30 minutes. 10 olive ridleys started their post-reproductive migration immediately, 2 turtles stranded dead and 10 remained in the internest area for 34 days (average), ranging from 10 to 119 days. The average internesting core has 176km^2 (72 to 324km^2). Two females were recaptured, and locations were downloaded directly. The internesting core area was defined as 50% Kernel Density Estimation contours (KDE 50%). The internesting interval, distance and movements were described. The first nest of olive ridley #57952 was recorded on 08/16/2018, and after, the female traveled 11 km in 8 hours, reaching to the Port of Sergipe, and starting restricted movements for 9.6 days. For this phase, the internesting core area totalled 22 km^2, located between 20 to 30 m depths, about 6km from the coast. After the restricted movements, the turtle returned to the area near the previous nesting site. This movement lasted 7 days with 47 km traveled. For 48 hours, the turtle remained within 2 km from the coast, with a false crawl, followed by a successful nesting on 09/04/2018, after 18 days. The internesting distance was 6 km. The first nesting of olive ridley #57986, was recorded on 04/02/2019, when the PTT was attached. Then, the turtle moved along the continental shelf for 6 days, until reaching the Port of Sergipe area, located 12 km south of the first nest. The restricted movements totalled 5 days, with an internesting core area of 9.5 km^2, located at 3.5 km from the coast, between 10 and 15 m isobaths. The active search for second nest area totalled 7 days with a distance traveled of 62 km. The second nesting occurred on 04/20/2019, after 19 days, with an internesting distance of 8.6km. The results indicated that the internesting interval identified (18 and 19 d) is like the pattern described for the species in Sergipe (20 d), however the internesting distance was slightly higher (6 and 8 km vs 4 to 5.5 km). The present analysis shows a variation in the size of the internesting core (KDE 50%) when estimated only for the restricted movement phase (KDE 50% = 22 and 9.5 km^2), in relation to the value obtained for the total set of locations (96 and 72km^2). PTT direct download is an efficient way to get the high-resolution locations, critical to identify different movements performed during internesting. Of the 860 FastGPS locations directed downloaded, only 17% (149) were remotely transmitted. Accurate habitat identification during internesting is relevant, especially if use areas overlap threats such as fishing, ports, and hydrocarbon exploration. The identified movements demonstrate the susceptibility of olive ridley to interact with shrimp fishery, since the identified internesting area overlap the fishery ground.

DECADES-LONG MONITORING OF AN INDIVIDUAL MALE LOGGERHEAD SEA TURTLE: AAJ723

Annessia Marie Michaels, Michael Bresette, Jeff Guertin, and Cody Mott

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Biologists have been studying sea turtles at the St. Lucie Nuclear Power Plant in St. Lucie County, FL, USA since its operation began in 1976. Nearly 50 years of research has been conducted on more than 20,000 turtle captures including loggerhead, green, leatherback, hawksbill, olive ridley, and Kemp's ridley turtles. Loggerhead sea turtles are the most abundant species observed at this research site, accounting for more than 11,000 captures. A small number of individuals (7.7%) have been captured multiple times at this site with only 4% being turtles that were caught ten or more times. However, there is a single loggerhead that has been captured a record 53 times. Originally flipper tagged AAJ723, "AJ," is an adult male loggerhead that was first captured in 1989. In a 34-year span, we have been able to monitor this individual's growth rate, as well as his health and overall body condition. Although undersized, AJ was thought to be a maturing male at the time of his original capture. It was not until 2009 that he demonstrated physical adult male characteristics including a long tail that extends past the carapace, curved front flipper claws, and a soft, concave plastron. To date, AJ is still below the generally accepted size for an adult loggerhead (straight carapace length (SCL) of ≥ 85 cm), where his SCL has remained 78 cm over the last decade. To our knowledge, this turtle is one of the most studied, wild-caught, male loggerheads around the globe. In addition to our long-term monitoring of this individual, AJ has been sampled as part of several collaborative studies helping to answer questions on stable isotope analysis, the presence of fibropapillomatosis in loggerheads, and antibiotic resistance in sea turtle microbiomes. While this is only one individual turtle within the population, the data we have collected over such an extended period has been paramount to sea turtle conservation efforts. Further research could give insight into population dynamics such as the benefits of having a long-lived male in the highest-density nesting grounds and the extent of his paternal linkages across Florida's beaches. Additionally, we could examine size at sexual maturity and whether it has been habitually overestimated for adult male loggerheads. It is our understanding that AJ can continue to aid in sea turtle conservation for many generations.

TRACKING POST-RELEASE MOVEMENT PATTERNS OF NEW YORK'S REHABILITATED SEA TURTLES PROVIDES INSIGHTS INTO THEIR UTILIZATION OF NEW YORK WATERS*

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This project monitored the post-release movement pattern of 31 sea turtles rehabilitated at the New York Marine Rescue Center (NYMRC). The NYMRC rescues and rehabilitates all sea turtles stranding along the extensive coastline of New York. Sea turtles strand for various reasons including entanglement, vessel interaction, malnourishment, debilitation, and cold stunning. Many of the stranding cases can be linked to

human activities in this region which overlap with sea turtle habitat. Between 2019 and 2023, NYMRC attached satellite (Wildlife Computers - SPLASH and SPOT) tags to 31 of the 194 sea turtles that were rehabilitated and released (16%). Three different species of sea turtles were tagged as part of this project: Kemp's ridley (*Lepidochelys kempii,* n=10*)*, Atlantic green (*Chelonia mydas,* n=8*)* and loggerheads (*Caretta caretta*, n=13). Data collected from these tags supports the rehabilitation efforts of NYMRC by illustrating the post-release movement patterns and survivorship of successfully rehabilitated sea turtles. Preliminary data shows southern-coastal and offshore movement patterns that have previously been associated with preferable (i.e., "normal") post-release behavior. Tag duration ranged from 29-606 days, with more than 80% of tags transmitting at least 100 days, with an average tag life of 226 days. Of the 31 released turtles two restranded following release and one turtle was found deceased with evidence of vessel interaction. Data from these turtles provides crucial information on local foraging areas used by these species in New York state and federal waters in the late summer and early fall. On average, released turtles spent about 70 days (6-150 days) within state waters before navigating south or offshore. To further understand sea turtle behavior within state waters, Customized Animal Tracking Solutions (CATS) tags were implemented in 2023. Data obtained from both tags will provide a more complete understanding of New York's sea turtle population.

HABITAT SELECTION OF POST-NESTING LOGGERHEAD TURTLES IN THE NORTHWEST PACIFIC

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Loggerhead turtles, *Caretta caretta*, in the North Pacific nest only in Japan. This population experienced a rapid increase in the number of nests in the early 2010s and is ranked as Least Concern in the current IUCN assessment. However, the number of nests has shown a gradual downward trend in recent years and conservation should continue. Loggerheads spend most of their time in foraging areas except for breeding seasons that occur every few years. Increased adult mortality and decreased quality of foraging habitat may be causing the decline in the number of nests. Therefore, it is important to investigate the foraging ecology of this species to better understand the factors that are contributing to its decline. Previous studies have shown that the Japanese loggerhead population is dichotomized by size, but little is known about the relationship between foraging distribution and the marine environment. In this study, we attached satellite transmitters to nesting females at Tanegashima Island, one of the largest nesting sites for loggerheads in Japan, and analyzed the relationship between the locations used by post-nesting females and associated environmental factors to clarify habitat selection by females and the factors that influence it. We attached satellite transmitters on 23 turtles (SCL: 866 ± 41 mm, mean ± SD), and analyzed habitat preference using six environmental factors: sea surface temperature, sea surface salinity, sea surface current velocity, chlorophyll-a concentration, seafloor depth, and slope. The tracking period was divided into two seasons, summer and winter, and the environmental factors at the seasonal locations were compared to the environmental factors of entire home ranges to determine the characteristics of each high-use area. Our tracked loggerheads showed seasonal differences in spatial distribution, using a limited area near Tsushima Strait, Jeju Island, and Taiwan in the summer, and a wider area within the East China Sea (ECS) in the winter. The summer habitat had relatively slower currents than the surrounding waters, while the winter habitat had faster currents but was temperate. Indices of primary productivity such as salinity and chlorophyll-a did not affect habitat selection. We conclude that the post-nesting females of the Northwest

Pacific loggerheads select habitats in the ECS that conserve energy and have comfortable water temperatures. The ECS is an important area not only for loggerheads but also for humans, especially as it is the best fishing ground for east Asian countries. Therefore, loggerheads in the ECS face competition for resources with fisheries and are at risk of bycatch. The results of this study may be useful in establishing protection and management measures for loggerheads in this area.

VOLUNTARY FEEDING OF GRAVID GREEN TURTLES DURING THE REPRODUCTIVE PERIOD: IMPLICATIONS FOR BREEDING STRATEGY OF MARINE REPTILIAN HERBIVORES*

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Sea turtles are marine ectotherms and have commonly been considered capital breeders who use energy stores accumulated at an earlier time for reproduction because the energetic costs associated with storage and use of body reserves prior to reproduction are lower. Only in several green turtle (*Chelonia mydas*) populations, there have been reports of feeding by gravid females during reproductive period, indicating they all are not simply capital breeders, but some may use the energy gained concurrently for reproduction. However, it is still unknown whether such feeding is voluntary or opportunistic, how they feed on prey, and how they allocate the time spent on energy intake and energy-saving behaviors. Herein, we deployed videos, head-mounted acceleration, and GPS loggers on nine gravid green turtles nesting on Ishigaki Island, Japan, to monitor their feeding behavior during the reproductive period. Our results clearly demonstrate that gravid turtles are voluntary benthic herbivores with clear diel rhythms twice a day. Most of the benthic feeding occurred around the algae/seagrass meadows and in the vicinity of the resting sites, indicating that gravid turtles need almost no energy to shuttle between the feeding and resting sites. Moreover, they incur little energy for prey searching because of the immobility of algae/seagrass. These advantages in terms of the cost of energy intake may allow them to feed voluntarily. Our results indicate that gravid green turtles employ mixed capital–income breeding strategy that females mostly rely on capital, but partially use the concurrent intake for breeding when abundant food are available.

SEAGRASS MEADOW COLLAPSE DUE TO OVERGRAZING GREEN TURTLES IN THE RYUKYU ISLANDS, JAPAN

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Green turtles (*Chelonia mydas*) have reportedly been recovering their abundance in several populations worldwide over the past few decades. In Japan, major nesting populations have shown an increasing trend, whereas foraging aggregations in the seagrass/seaweed meadows have also been reported to increase in abundance. Concurrently, with the rise in green turtle abundance, many seagrass meadows in the subtropical Ryukyu Islands, located in the southwestern part of Japan, have been reported to suffer collapse or severe degradation. To assess the current condition of green turtle and seagrass abundances, comprehensive surveys were conducted in seagrass meadows in Ishigaki (Fukido estuary) and Kume Islands (Maja and Ou coastal areas), which are part of the Ryukyu Islands, from July to October 2023. First, the population densities of grazing green turtles in the seagrass meadows were investigated using an aerial drone survey on both islands. Second, the distribution and coverage of seagrass species were examined through underwater observation. In the Fukido estuary of Ishigaki Island, the drone-based line transect survey revealed that the population density of grazing green turtles ranged from 0.08 to 1.98 individuals/ha. The dominant seagrass species were *Enhalus acoroides*, Pacific turtlegrass (*Thalassia hemprichii*), *Cymodocea rotundata*, and *C. serrulata*. The distribution range of seagrass meadows did not exhibit significant change compared to the data from the seagrass census conducted between 2018 and 2020 by the Biodiversity Center of Japan, Ministry of the Environment. However, the coverage of *E. acoroides* had notably decreased. Additionally, the leaf lengths of most *E. acoroides*, which are typically over 100 cm, were only 3–5 cm due to grazing by green turtles. In the Maja and Ou coastal areas of Kume Island, the population density of green turtles ranged from 3.95 to 5.18 individuals/ha. Seagrass meadows that previously consisted of large seagrass species (*T. hemprichii*, *C. rotundata*, and *C. serrulata*), as recorded between 2018 and 2020 by the Biodiversity Center of Japan, were currently no longer present. Instead, only several patches of small species (*Halophila* spp. and *Halodule* spp.) were observed. Our findings suggest that the seagrass meadows in the Maja and Ou coastal areas of Kume Island were largely consumed due to overgrazing by green turtles. Meanwhile, the seagrass meadows in the Fukido estuary of Ishigaki Island are currently experiencing heavy grazing pressure, which may lead to the collapse of the seagrass meadows in the near future. Our results highlight the need for wildlife management that acknowledges the coexistence of green turtles and seagrass meadows.

ASSESSING THE CURRENT STATE OF SEAGRASS MEADOWS AND THEIR INTERACTIONS WITH GREEN TURTLES IN ST. JOHN, USVI*

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Caribbean green turtles (*Chelonia mydas*) spend most of their lives foraging in seagrass meadows. The impact of green turtle grazing in St. John, US Virgin Islands, was well-documented in 1986 by Susan Williams (1988). Williams' study estimated the abundance of green turtles, measured seagrass productivity, and documented the impacts of anchor scarring on seagrass meadows in Maho Bay and Francis Bay. At the time, *Thalassia testudinum* was the dominant species in both bays. Williams found very low productivity of *T. testudinum* in Maho and Francis Bays due to the combined effects of intensive grazing by green turtles and extensive anchor damage. The green turtle aggregation was found to be at carrying capacity for the available seagrass meadows in both bays, and turtles were observed foraging consistently for nine hours per day in these degraded environments. Our study evaluates the current interactions between seagrasses and the green turtle foraging aggregation in Maho Bay and Francis Bay. Building on Williams' study, we re-evaluate the same seagrass study sites and assess how the ecosystem has changed over the past three decades. Our team observed the green turtle aggregation in Maho and Francis Bays using methods adapted from Gulick (et al. 2021) for a comprehensive analysis of *T. testudinum* in the same sites Williams (1988) used. *Thalassia testudinum* productivity and morphology, grazing intensity, and anchor scars were evaluated at each of Williams' sites. This data has allowed for a direct comparison between the seagrass meadows in 1986 to 2023. Furthermore, the number of hours per day spent foraging and seagrass species being consumed by the green turtle aggregation was documented to estimate the current grazing pressure. Meadows of *T. testudinum* are still present in Maho and Francis Bays and support the local green turtle foraging aggregation. Grazing patterns have shifted from consistently foraging for nine hours per day to a traditional bimodal pattern, foraging at peak times in the morning and afternoon. However, *T. testudinum* parameters measured in 2023 did not behave as predicted for fully grazed or ungrazed sites, suggesting that meadows are now in various stages of transition due to changes in grazing patterns by green turtles. As hypothesized, most sites throughout the bays have higher productivity in 2023 than 1986, likely due to reduced grazing pressure and reduction in anchor damage to the meadows. The National Park Service banned anchoring throughout the Virgin Islands National Park in 2013, protecting the seagrass meadows. In 2023, there were no observed anchor scars throughout Maho and Francis Bays and *T. testudinum* meadows have rebounded, demonstrating the importance of effective management strategies. This is a rare opportunity to gauge how seagrass meadows have sustained consistent grazing pressure over 35 years. This study will provide a framework to collectively assess how the seagrass meadows have responded to anchor scarring and continuous grazing pressure.

USING SATELLITE TELEMETRY TO IDENTIFY MIGRATION ROUTES AND FORAGING GROUNDS OF OLIVE RIDLEY SEA TURTLES (LEPIDOCHELYS OLIVCEA) FROM THE WEST PHILIPPINES SEA, PHILIPPINES*

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One of the most significant olive ridley turtle (*Lepidochelys olivacea*) nesting aggregations in Southeast Asia is located on the beaches of Palawan, Philippines, the country's westernmost province. The Municipality of San Vicente municipality along the island's northwest coast hosts some of the longest and most pristine beaches with hundreds of olive ridley nests per season, which are monitored by the San Vicente Marine Turtle Conservation Network composed of communities, NGOs, and government agencies. Olive ridley nesting biology, migrations, and inter-nesting patterns are particularly understudied in this region. Satellite telemetry studies have been previously conducted in neighboring countries with animals traveling in the Pacific and Indian Ocean, but no information is currently available for individuals moving through the West Philippines Sea and South China Sea. In response to this lack of information, a study using satellite telemetry to examine olive ridley inter nesting movements, post nesting migratory and foraging movements was initiated in 2023. Currently, this study has outfitted two individuals with platform transmitter terminals (PTTs), with plans to deploy six additional tags in December 2023. Both individuals tracked were deployed with Wildlife Computer's Spot tag, which utilizes the Argos satellite network. To date, the platform transmitter terminals (PTTs) transmitted across a range of 94 (22/1 - 4/26) to 104 (27/1 - 5/6) days respectively. Preliminary data suggest that tracked individuals traveled 888 and 1128 km to possible foraging grounds. One individual's telemetry data implies that an inter-nesting area located approximately 10 km offshore from its capture site was frequented throughout the nesting season until the migratory period began approximately 27 days after the tag was deployed. Our data suggest that the turtles migrated to areas located near Northeast Borneo, Malaysia. One individual ceased transmitting off the coast of Brunei, and the other went further west, potentially establishing residency in the coastal waters of Sarawak, Malaysia, before its final transmission. Data further suggests that individuals used a possible migratory corridor, with both females moving southwest along Palawan's nearshore waters and crossing the Balabac Strait that separates the Philippines from Malaysia and Borneo's north coast. Migrations to potential foraging grounds took approximately 51 to 66 days. The potential inter-nesting habitat identified, lies in an area of intense fishing activity and is a bycatch hotspot. An in-depth understanding of a species temporal and spatial distributions, migrations, and habitat utilization is crucial to its long-term management and protection. There is currently little to no information on at-sea distribution and foraging grounds around Palawan and the Philippines in general and this data together with bycatch and fishery data, nesting data and population genetic data currently under analysis, will set the bases for local and international cooperation for the conservation of the species in the region.

EVALUATING RESOURCE USE PATTERNS AND PARTITIONING IN RELATION TO CHANGING PREY ABUNDANCE IN CO-OCCURRING SEA TURTLE SPECIES USING MOLECULAR ISOTOPE GEOCHEMISTRY

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Understanding how resource use patterns vary among sympatric species and in response to human activities (e.g., fisheries) is critical to predicting ecological responses to future ecosystem change. Sympatric Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtles are ideal species to study resource partitioning under environmental change scenarios because the abundance of blue crab (*Callinectus sapidus*), a key prey species and one of high economic importance for regional fisheries, has fluctuated dramatically in recent decades. Using compound specific stable isotope analysis of individual amino acids applied to stranded sea turtle bone tissue, we compared multi-decadal Kemp's ridley and loggerhead sea turtle resource use patterns—trophic position and basal production source—and partitioning and evaluated relationships with blue crab (*Callinectes sapidus*) abundance. Bones were obtained from turtles that stranded dead in North Carolina and Virginia (Kemp's ridley n = 48; loggerhead n = 26) from 1992 to 2016. Bone and skin samples were also obtained from the North Carolina Museum of Natural Sciences for turtles stranded in North Carolina from 1952 to 1981 (Kemp's ridley n = 8; loggerhead n = 4) for comparison of modern (1992–2016) to historical (1952–1981) turtle samples. For modern bone samples, we identified a similar overall mean trophic position (MTP), internally indexed to the baseline nitrogen isotope value, for both Kemp's ridleys (MTP = 3.3 ± 0.3) and loggerheads (MTP = 3.3 ± 0.4). For loggerheads, historical MTP (3.4 ± 0.2) was similar to modern MTP. For Kemp's ridleys, historical MTP (2.9 ± 0.6) was lower but within the range of modern MTP. Loggerhead MTP increased by ~0.5 trophic levels from 1990 to 2012, suggesting a shift in foraging strategies through time to higher trophic level prey. This timeline corresponds with the decrease in blue crab abundance and aligns with the results of diet content studies that observed an increase in loggerhead sea turtle fish consumption from the 1990s to early 2000s, likely sourced from fisheries bycatch. Modern Kemp's ridley MTP did not change during the study period. Additionally, stable carbon isotope fingerprinting revealed that eukaryotic microalgae were the primary basal resources supporting both species' food webs throughout the time series. However, distinct clustering of each species within the linear discriminant analysis indicated possible microhabitat

partitioning. These patterns may align with recent research in the Chesapeake Bay that suggests there is fine-scale spatial partitioning between the two species, with Kemp's ridleys using more shallow, nearshore estuarine habitats and loggerheads using deeper, offshore habitats. The fluctuation in blue crab abundance and potential for fisheries bycatch subsidies adds to impacts of climate change stress and fishing predation on sea turtle food web dynamics. Increased sampling and gut content studies are needed to further understand variation in this species' resource utilization patterns across space and time to better inform conservation and management efforts.

TRACKING MALE TURTLES FROM KYPARISSIA BAY, WESTERN GREECE, THE LARGEST LOGGERHEAD ROOKERY IN THE MEDITERRANEAN

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Most sea turtle telemetry studies focus on the more readily accessible adult females that come ashore to breed at predictable times in predictable locations. Adult males are believed to undertake similar breeding migrations, but as they remain at sea the entire time, acquiring them for telemetry is more logistically challenging. The Mediterranean's largest breeding aggregation of loggerhead turtles use Kyparissia Bay in western Greece to mate and nest. Following a successful project tracking several adult females we wanted to examine the movements of adult males from the same population, but to additionally investigate their use of the water column during migrations and residency periods. During May 2023 we deployed three SPLASH10-385 Argos transmitters (Wildlife Computers, USA). Male turtles mounted on females were selected. They were captured using the rodeo technique where the researcher launches from a vessel onto the turtle which is then landed to be processed for the project. Turtle locations were gained from the standard Argos positioning system. Location accuracy is predicted to a few hundred metres but may be more accurate. Depth data were sampled and stored every 5 seconds. These were transmitted as raw data points subsampled at 75s intervals, in 1hr-long blocks. The turtles departed from the breeding site between 1 and 11 days after transmitter deployment. Tracking lasted a minimum of 98 days. Two turtles established residence in relatively shallow coastal waters and the third turtle, until the time of writing (Nov 1, 2023) did not settle. Turtle A was not recorded as diving deeper than 48.5m, during its 42-day migration, despite swimming through waters that were more than 200m deep for over 14 days. During his residency in a coastal foraging area, he remained predominantly in the top 10m of the water column, despite remote sensed bathymetry data suggesting the sea depth was often nearer 20m. Turtle B undertook a shorter 21-day migration incorporating coastal and open water sites. His diving was generally restricted to less than 10m with occasional dives no deeper than 30m. There was one exception to this, near the end of his migration he dived to 56.5m. From then on, during the restricted-area foraging period, the turtle increasingly dove deeper making regular dives to 75m or more with the greatest depth recorded as 119.5m. Turtle C has not settled into any one restricted area foraging site but instead has roamed the northern Ionian, with periods in both coastal and open waters. Despite often traversing waters over 1km deep the turtle was recorded as making only five dives deeper than 100m, with two of those dives occurring consecutively on 27 August. However, the turtle regularly dove between 50 to 100m deep. This turtle's deepest dive (the second on 27 August) reached 202m. Our results indicate that loggerhead turtles in the Mediterranean habitually use only a few tens of metres depth of water, making them most susceptible to threats at or near the surface. These data will further improve our knowledge for the species distribution and ecology in the study area.

ON BATTERED REEFS - INSIGHTS INTO FORAGING OF HAWKSBILL TURTLES AT KNOWN HOTSPOTS IN THE MALDIVES

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The Maldives hosts the seventh largest coral reef system in the world which covers an area approximately 8,900 km^2 in size. Coral reefs are among the most threatened ecosystems in the country and have been impacted by severe bleaching events in 1998 and in 2016. Degraded reefs dominated by zoanthid cover have been linked to hawksbill sea turtles in the Maldives. However, little is understood about the dietary composition of hawksbill sea turtles in Maldives, which hosts a recorded population of at least 4686 individuals. There are reports of hawksbill predation on the anemone-like zoanthids, *Zoanthus sociatus* and *Palythoa caribaeorum* made in the US Virgin Islands and Southern Brazil respectively. During a sea turtle expedition carried out in August 2023 in Maldives, several known hawksbills hotspots were surveyed for benthic cover association with foraging ecology. The hotspots surveyed across three atolls (North Malé, Baa Atoll and Lhaviyani Atoll) supported hawksbill populations of 85 to 227 individuals and were found to be degraded reefs with low live coral cover, where the substrates were heavily colonized by *Zoanthus* sp. which appear to be favored by hawksbill sea turtles. A similar pattern was also observed in several other hotspots where the predominant substrate cover was of the carpet corallimorph, *Rhodactis* sp. During the surveys, predation on *Zoanthus* sp. by hawksbills were observed on multiple occasions, with clear signs of undigested *Zoanthus* sp. also observed from a collected hawksbill fecal sample. The association is further supported by the number of identified individual hawksbills at these 'patches of reef' dominated by *Zoanthus* sp., with Makunudhoo reef in Malé atoll supporting a recorded 227 individuals, and Thanburaanu reef in Baa Atoll supporting a recorded 145 individuals. Although there were no observations made for hawksbill predation on *Rhodactis* sp. during the surveys, it has been suggested that this species may also be part of the diet of hawksbills in these reefs, as predation on corallimorphs have been observed in other parts of the world. Similar to the case with zoanthids, Muthaafushi reef in Baa Atoll consists of high Rhodactis sp. cover and is recorded to support at least 85 individual hawksbills. Although both zoanthids and corallimorphs are known to compete with corals for space, the distribution of *Zoanthus* sp. is generally known to be patchy with high abundances restricted to a few sites, while the corallimorph *Rhodactis* sp. is a reported invasive species that damage certain reef building coral families such as Poritidae, Acroporidae and Pocilloporidae in the Maldives. Our observations indicate that hawksbill sea turtles might play an important role in regulating the abundance of certain zoanthids and corallimorphs, and thus allowing more space for coral growth. The long-term implications of the hawksbill predation on these benthic communities could have an impact on the recovery of coral reefs, reinforcing the importance of hawksbill conservation in the Maldives.

SPATIAL ECOLOGY AND CONSERVATION OF FORAGING GREEN TURTLES IN THE NORTHERN TERRITORY, AUSTRALIA

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Identifying the foraging grounds and migratory corridors of threatened marine turtles is crucial for their conservation management. The complex logistical and safety challenges involved in investigating the at-sea behaviour of marine turtles in the Northern Territory create a considerable gap in the knowledge. Green turtles (*Chelonia mydas*) are an important food resource for indigenous Australians and a species of cultural importance across many areas of the Northern Territory. These turtles are considered conservation-dependent due to anthropogenic threats such as marine debris, climate change, chemical and terrestrial discharge, international take (turtles taken outside Australian waters), and indigenous take (DoEE, 2017). A general lack of ecological knowledge in the North Marine Region makes conducting effective conservation in this area difficult. This study compiles existing nesting green turtle satellite tracking data from across Australia, collected over multiple decades, and new data from foraging turtles in the Northern Territory. Spatial analysis of this turtle movement data with anthropogenic threats, marine parks and new habitat data will help identify priority areas and inform conservation management plans.

SPATIAL ECOLOGY OF THE EASTERN PACIFIC GREEN TURTLE (CHELONIA MYDAS): INSIGHTS FROM SATELLITE TRACKING AND STABLE ISOTOPE ANALYSIS*

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Sea turtles present complex life cycles ranging in entire ocean basins and requiring equivalent complex management and conservation measures. All seven species show feeding reproductive and nesting site fidelity to some extent, although this does not mean that all population individuals use the same non-breeding areas. Different habitat use and use of foraging areas in a population will impact demographic variables and implicate focus prioritization of conservation efforts. Five of the planet's seven species of sea turtles are distributed in the Eastern Pacific (EP) Ocean. *Chelonia mydas*, known in this region as the black turtle, is defined as a Distinct Population Segment (DPS) of the *Chelonia mydas* species and, according to the Endangered Species Act: ESA, is listed as threatened. Likewise, in Mexico is considered under the category of danger of extinction by the official Mexican standard NOM-059 - SEMARNAT- 2010. Four important nesting areas are known for this DPS: Revillagigedo Islands, Galapagos Islands, Costa Rica, and Colola Beach, Michoacán on the Mexican Pacific coast, while their distribution ranges from Southern California in the US UU to Chile and the Galapagos Islands. The Colola nesting population represents this DPS's most significant, registering more than 15,000 females annually. Colola Beach also provides a contingency habitat for this DPS and the *Chelonia mydas* species globally, taking climate change and sea level rise into account. The present study aims to understand the spatial ecology of the eastern Pacific DPS nesting population in Colola, Michoacán, Mexico. Furthermore, it was designed to reach the following objectives:

1. Identify migration routes, strategies, and feeding areas of the Colola nesting population using satellite tracking of 23 nesting females during 2018-2021 nesting seasons.
2. Identify potential areas of overlap of 23 tracked nesting females with fisheries in the EPO during 2018-2021 nesting seasons.
3. Assign pre-nesting habitat to 130 Colola nesting females through stable isotope analysis (δ13C y δ15N) calibrated from the satellite telemetry of a subset of individuals.

Twenty-three turtles were tagged with PTTs (Platform Transponder Transmitters) [Wildlife Computers SPOT6, n = 3 (Redmond, WA, USA); Lotek 376D, n = 20 (Havelock North, Hawkes Bay, New Zealand)] after nesting, at Colola Beach, Michoacán, (n=10) during the 2018-2019 season; (n=13) and the 2020-2021 season. Turtles were tracked using the Argos satellite system. Skin samples were taken from 130 nesting females and analyzed for δ13C and δ15N. Turtles' transmission averaged 58 ± 27.29 days (range: 24-160 days); distance traveled: average 914.8 ± 433 km (range: 1 a 2121 km). Statistical analysis indicates a significant correlation between size, Migration straightness index, nitrogen isotope ratio, and latitude.

Isotopic values of the skin simples ranged between -22.97 a -14.40‰ y de 13.22 a 21.97‰ para δ13C y δ15N respectively. The data provided by this study will contribute to the effective conservation of the eastern Pacific green turtle DPS, the preservation of its habitat, and other associated species.

DECODING THE INTERNESTING MOVEMENTS OF MARINE TURTLES USING A FINE-SCALE BEHAVIORAL STATE APPROACH*

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An understanding of animals' behavior is critical to determine their ecological roles and to inform conservation efforts. However, observing hidden behaviors is challenging, especially for animals that spend most of their time underwater. Using animal-borne devices, we investigated the fine-scale behavior of internesting hawksbill turtles nesting on the northeastern coast of Brazil. Our study analyzed data from ten turtles, including two that were tracked for two nesting seasons for a total sample size of 12 deployed FastGPS satellite transmitters equipped with time-depth recorders. We estimated latent behavioral states employing the mixed-membership method for movement (M4) and integrating dive variables (i.e. dive depth, dive duration and surface duration) with spatial components (i.e. on-land vs in-water, step lengths, utilization distribution). We identified five latent behavioral states: 1) pre-nesting, 2) transit, 3) quiescence, 4) area restricted search (ARS) within the residence, and 5) ARS near the residence of turtles. The last three states combined were categorized as "residency period". Pre-nesting behavior (5.5% of internesting), characterized by shallower and remarkably long dives (up to 292 minutes), highlighted the turtles' preparation for egg-laying and lasted 22.7 hours on average. Transit behavior (13% of internesting), distinguished by the longest average step length, indicated active movement to the residence, and after a residence period, movement back to the nesting beach, and lasted 2.3 days on average. Quiescence (56.1% of internesting), the most predominant behavior, showed the lowest activity level and lasted 11.3 days on average. ARS within the residence (18% of internesting) showed relatively larger step lengths than quiescence, but was still considered a low activity level and lasted 5.8 days on average. ARS near the residence (7.4% of internesting) showed step lengths and dive duration proportions similar to quiescence and ARS within residence combined, but outside of the residence core area and lasted 3.6 days on average. We noted high fidelity to residence core areas and nesting beaches, within and between nesting seasons. Initial residence areas tended to be larger than subsequent ones within a season, likely reflecting more exploratory behavior at first, which then decrease over time as turtles adopt more quiescent behavior, conserving energy for reproduction. These behaviors offer detailed insights into turtle ecology and behavior during internesting periods, which is critical for marine turtle conservation and management. Quantifying these individual behavioral states improves estimates of turtles' spatially explicit susceptibility to various threats, such as vessel strikes and entanglement in fishing gears. For example, our analysis suggests that implementing a proposed Marine Protected Area (MPA) to safeguard a reef formation, currently under review, would significantly increase the protected area from the existing 0.4% to 30% of the turtles' internesting habitats in our study region. This study provides valuable guidance for the conservation and management of internesting marine turtles at a fine spatiotemporal resolution, enhancing

national action plans for endangered species and the success of Marine Protected Areas. By incorporating biologically informative parameters, this approach can be applied broadly to study behavior beyond the hawksbill breeding season and other species.

RECALCULATING: DO INHERITED NAVIGATIONAL INSTRUCTIONS IN LOGGERHEAD SEA TURTLES ACCOUNT FOR CHANGING GEOMAGNETIC CUES?*

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When hatchling loggerhead turtles (*Caretta caretta*) from Melbourne Beach, FL, U.S.A. leave their nesting beaches, they embark on a multi-year pelagic migration, exploiting a series of regional geomagnetic fields as navigational markers to help them remain within the North Atlantic Subtropical Gyre (NASG). While the geomagnetic field provides ubiquitous spatial cues across earth's surface, it is not fixed in time; as molten iron in earth's core moves, geomagnetic signatures gradually drift. Thus, to use inherited regional geomagnetic cues in navigation, the loggerhead population presumably must update responses to regional geomagnetic fields that exist along their migratory route. Here, we investigate the timescale of these updates in orientation responses. To test innate responses to geomagnetic fields, hatchling turtles were allowed to swim in a magnetic coil system on the beach in Melbourne FL, where they are magnetically displaced to a location that exists off the coast of Puerto Rico. In a previous orientation experiment conducted in 2007, hatchlings from the 2007 cohort responded to a magnetic field that existed near Puerto Rico by swimming in a northeasterly direction (n=22), a response that aligns with their migratory route around the NASG. In this experiment, we test how the 2023 cohort of hatchlings respond to the magnetic field that 1) currently exists near Puerto Rico in 2023 (n=49), 2) previously existed near Puerto Rico in 2007 (n=23), and 3) previously existed near Puerto Rico in 1983 (n=20). Hatchlings from the 2023 cohort responded to the 2023 magnetic field in Puerto Rico by swimming in a northeasterly direction. By contrast, the 2023 cohort of hatchlings responded to the 2007 magnetic field by orienting strongly in the northwesterly direction, a response that is significantly different from both the 2023 response and the original 2007 response. This finding suggests that hatchling loggerheads can update their orientation responses to geomagnetic fields and can do so in under one generation time. The 2023 cohort responded to the 1983 magnetic field by orienting Northeast, which is also congruent with the present location of the drifted 1983 magnetic field. Because the population updates their response within the 16 years between the 2007 and 2023 experiments, it appears that hatchling loggerheads must rely at least in part on environmental influences to set or alter their geomagnetic instructions. Future behavioral work will continue to investigate the evolutionary mechanisms that underlie the ability to quickly update magnetic instructions.

A DEEPER DIVE INTO THE LIFE HISTORY AND HABITAT USE PATTERNS OF GREEN SEA TURTLES IN SOUTHERN CALIFORNIA, USA*

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In the eastern Pacific, along the coast of the United States and Mexico, green sea turtles (*Chelonia mydas*) are now commonly found foraging in bays, lagoons, and other interesting inlets as the population continues its impressive recovery. Once at extremely low numbers in the 1980s, the green turtles from this East Pacific population found in northern foraging grounds are reflecting a shift in demographics. There appears to be an increasing presence of smaller and younger turtles in both known, established foraging habitats – such as San Diego Bay and Seal Beach National Wildlife Refuge – and also in new and sometimes unexpected habitats - such as Mission Bay and the San Gabriel River. As a part of ongoing research, we have continued quantifying demographic parameters and variable vital rates, such as somatic growth rates, time to maturity, and reproductive longevity, to inform effective management of this population. Building on this work, we have now characterized size- and age-distributions in distinct habitats – oceanic vs. neritic – by using a combination of methods including skeletochronology, sequential stable isotope analysis, in-water mark-recapture, and community scientist sightings. Previous age analysis (by skeletochronology) of 65 green turtles recovered along the U.S. west coast showed that, based on observed minimum sizes of turtles in nearshore foraging grounds of ca. 50 cm curved carapace length (CCL), green turtles in the eastern Pacific spend approximately 5 years in the oceanic zone (a.k.a. the 'lost years') before recruiting to nearshore habitats. Here, we extended upon this study by applying stable isotope analysis (SIA) of bone growth layers to estimate age- and size-at-settlement to neritic habitats based on a change in chemistry (distinct stable nitrogen isotope values) in growth layers of humerus bones. A subset of the 65 aged humeri were sampled for SIA, and of the 33 turtle bones that recorded an ontogenetic shift (21 shifted + 12 recent recruits), the mean ± SD age-at-settlement was 7.4 ± 6.1 yrs (range: 1-33 yrs) and size-at-settlement was 52.6 ± 12.8 cm CCL (range: 28-98 cm CCL). We also evaluated long-term habitat use and foraging patterns based on the SIA results (stable nitrogen and carbon isotope values), and confirmed that once settled to nearshore foraging habitats, turtles remained largely consistent in what and where they ate. Most turtles showed specialization in their diet, yet some exhibited variability over time. Finally, we present a few detailed case studies of several individual turtles by combining lab, field, and community science data to better understand the life history and behavior of green turtles in Southern California. Collectively, the results present a more in-depth look at the life history and habitat use patterns of green turtles that are now more commonly encountered in Southern California waterways.

INSIGHTS INTO MOVEMENT OF GREEN TURTLES AT NINGALOO FROM SATELLITE TAGGING*

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CSIRO

Information yielded by satellite-tagged sea turtles is useful to generate understanding about multiple aspects of turtle ecology, like where they feed, the routes they follow during their nesting migrations, and how often they nest. This information can in turn be applied to answer many questions, like the type and severity of risks they face at feeding and nesting areas and on migration routes, and converting counts of tracks on beaches into estimates of turtle abundance. Data from green turtles *Chelonia mydas* at Ningaloo has shown that they move relatively little, other than for nesting or mating. The median displacement (distance between locations of capture and final transmission, transmitted over 72-416 days) of 19 "resident" turtles captured in the water (74-108 cm CCL) was 2.3 km, while the median displacement of 13 females tagged on the beach following nesting (94-104 cm CCL) was 179 km. Acoustic tagging provided further details about the locations and movement patterns of resident turtles. After nesting, females migrated either north or south, between the Kimberley and Shark Bay (a span of 10 degrees of latitude and ~1,500 km). Multiple turtles with vitellogenic (yolk-bearing) follicles identified with ultrasound were followed for their entire nesting migration. Each migrated >200 km from Ningaloo to nesting beaches on islands off the Pilbara coast, and then returned to Ningaloo (in one case the final transmission was 400 m from the location she was captured). Examination of GPS locations transmitted during the nesting period provided information on the likely number of successful nesting attempts (~4-7 clutches per individual).

INSIGHTS ON SEA TURTLE BEHAVIOR AND HABITAT USE IN NEW YORK'S COASTAL WATERS FROM MOVEMENT TAGS DEPLOYED ON REHABILITATED ANIMALS

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Instrumented tags (Customized Animal Tracking Solutions) were deployed on rehabilitated sea turtles released back into the ocean to provide short-term, fine-scale data on how sea turtles are using the estuarine and oceanic waters of New York. The tags are equipped with a variety of sensors including: high definition video, audio, inertial motion parameters (acceleration, orientation, magnetic field), temperature, and pressure (depth) which can be used to quantify the movement and behavior of the animal in the wild. Tags are attached to the carapace using suction cups, set to detach from the animal after 12 – 48 hrs depending on deployment configuration, and then float at the surface for tag retrieval and data download. Test deployments were conducted on rescued and rehabilitated turtles at the New York Marine Rescue Center (NYMRC) during the summer of 2023 to determine best suction cup attachment procedures and document behavioral reactions of individual turtles to the tags. Two field deployments on rehabilitated sea turtles (one juvenile green, one juvenile Kemp's ridley) released into the ocean were conducted in late summer / early fall 2023. Both individuals were documented feeding on aquatic vegetation within 30-60 min of entry

into the ocean. Inertial movement data were different for the two animal's movement characteristics (e.g., turtle pitch, roll, yaw, and accelerations) as they swam and dove. The juvenile green turtle had consistent behaviors (in terms of dive timing and profiles) throughout the tag attachment period. The Kemp's ridley turtle did not dive as often or as frequently during the first 4-6 hrs of release, but then dives became more frequent and deeper. Camera footage shows a variety of interspecific encounters (juvenile skate, sharks) occurring during the turtle's movements.

THE FLORIDA HAWKSBILL PROJECT: A TWENTY-YEAR REVIEW

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In 2004, the Comprehensive Florida Research and Conservation Program, a.k.a. the Florida Hawksbill Project, was initiated with the goal of establishing baseline data concerning the abundance, distribution, and population dynamics of hawksbills in Florida waters. Because hawksbills do not reproduce with any regularity in Florida, the Project has focused on in-water populations primarily along the southeast coast from Palm Beach County south through Monroe County. Depending on the depth of the habitat, all hawksbills were hand-captured while using either scuba or snorkel gear and returned to a waiting vessel. Once aboard, standard morphometrics were recorded, internal and external tags were applied, samples were collected, photographs were taken and, when appropriate, external tracking devices were attached. The turtles were then released at the surface near the capture site. As of November 2023, 302 individual hawksbills have been identified, and 76 of those have been re-captured at least once over 472 surveys encompassing 48,670 minutes (811.2 hrs) of in-water surveys. The turtles ranged in size from 19.3 - 83.9 cm SCL (median 54.5). Sub-adults captured in Palm Beach County revealed a female-biased population of 2.5:1 female:male ratio representing 17 Caribbean haplotypes, with a strong bias toward Mexican stocks. From satellite tracking data, subadults captured in Palm Beach County all confined themselves to relatively small home ranges (0.01 - 1.2km^2) at or near coral reef structures, and showed very consistent use of specific overnight refuges. Ethograms of in-situ foraging behavior revealed a highly discriminating process of prey identification, followed by the consumption of a narrow range of poriferan species. Reference intervals were established for haematological and plasma biochemical analytes, and differential colonization of barnacle epibiota between hawksbill and green turtles was noted. While the sampling effort continues throughout SE Florida, ongoing studies include stable isotope analysis and further investigations into gender ratios, movements, population dynamics, blood analytes, and environmental DNA. Though comparatively rare in Florida, hawksbill turtles are deserving of continued research and conservation efforts in Florida waters. This project has shed new light on the value of Florida's coastal reef habitats to this species, contributed significantly to our understanding of hawksbill behavior and physiology, and helped bring attention to Florida's hawksbill aggregation as a relatively small but valuable member of the overall Caribbean population.

HABITAT USE OF PACIFIC JUVENILE GREEN TURTLES ALONG THE COAST OF NORTH COSTA RICA*

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Understanding the coastal habits of endangered species and the extent of connectivity across various spatial and temporal scales is important in identifying critical habitats that can enhance conservation efforts in other regions of their distribution. In this study, we documented daily and seasonal locations of 15 juvenile yellow morphotype green turtles (*Chelonia mydas*) (49 – 83 cm curved carapace length; CCL) in Santa Elena Bay and Matapalito Bay in North Costa Rica for 19 – 629 days, determined their site fidelity and assessed their habitat use. We collected location data by employing 11 acoustic receivers placed within 5 main habitat types: muddy areas, reef patches, macroalgae, rocky reefs, and mangroves. Large juveniles (≥ 65 CCL) had their most detections in the macroalgae area during the upwelling season (43.9%) from December – April, and in the reef patch area during the non-upwelling season (36.0%) from May to November. Small juveniles (< 65 cm CCL) had the most detections in the reef patch area during both seasons (dry: 35.4%, rainy: 45.4%). Significantly, 10 out of the 15 juvenile yellow turtles displayed remarkable site fidelity ranging from 68.9% to 100%. Our findings indicated that juvenile yellow morphotype green turtles preferred reef patches, rocky reefs, and macroalgae habitats, with turtles demonstrating a shifting preference towards expected adult habitats (reef patches and microalgae areas) as they grew. Our finding suggested that by protecting similar habitat areas along the Central American coast we can help rebuild the Eastern Pacific Ocean green turtle population.

USING AN UNOCCUPIED AERIAL VEHICLE (UAV) TO ASSESS SEASONAL ABUNDANCES OF MEGAFAUNA IN FRONT OF AN IMPORTANT SEA TURTLE NESTING BEACH IN COSTA RICA

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Nearshore environments play a crucial role as habitats for marine megafauna, yet these dynamic ecosystems face intense human activity. To effectively monitor these habitats, frequent sampling is essential. Recent studies have demonstrated the efficacy of Unoccupied Aerial Vehicles (UAVs or drones) for surveys of nearshore marine megafauna. In this study, we focused on Cabuyal Bay, located in northwest Costa Rica, near an important sea turtle nesting beach. Utilizing a small, commercially-available UAV, we conducted video surveys from September to March in both 2017-2018 and 2018-2019. The survey transects followed a sawtooth pattern, transitioning between 0 – 100 meters and 100 – 200 meters from the shore. Post-hoc analysis of the footage revealed a total of 1,891 organisms, predominantly mesopredatory fishes and rays. Over 60% of species identified were listed as threatened by the IUCN Red List. Interestingly, most taxa were observed more frequently during the dry season (Dec – Mar) than the wet season (Sep – Nov), with the exception of *Mobulid* rays and green (*Chelonia mydas*) and olive ridley (*Lepidochelys olivacea*) sea turtles. Moreover, higher abundances were recorded within the 0 – 100m transects compared to the 100m – 200m transects. Our findings underscore the effectiveness of UAVs for rapid and cost-effective monitoring of marine megafauna in nearshore environments. The observed higher abundances during the dry season correlated with upwelling patterns and local productivity, although these patterns exhibited variation among taxa. Sea turtle detections in the wet season may have coincided with the arrival of females at the beginning of the nesting period, but more surveys are needed. Given the region's high biodiversity and the presence of an important sea turtle nesting beach, we propose that Cabuyal Bay warrants consideration for future protection measures.

NESTING BIOLOGY

SPANISH MEDITERRANEAN COAST: A CLIMATE CHANGE NESTING REFUGE FOR LOGGERHEAD TURTLES?*

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The loggerhead sea turtle *(Caretta caretta)* exhibits temperature-dependent sex determination, and current nesting populations are compromised by the combination of highly female-skewed sex ratios among nesting beaches and a decrease in the viability of embryo development due to elevated thermal incubation conditions in a warming world. Then, the future of the species depends on whether it can adapt to quick temperature changes or colonize new areas to reproduce with more suitable temperatures for clutch incubation. Loggerhead turtle colonization is occurring in the western Mediterranean, including the Spanish coast. Records of nesting events are increasing every year. Considering forecasts of the loss of viability of current nesting rookeries in the eastern Mediterranean and the Atlantic, the establishment of new populations can help to ensure the long-term survival of the species. Nest incubation temperature studies allow us to study ecology of the nests, vital demographic parameters such as hatchling sex ratio, and thermal conditions affecting hatching and emergence success. Here we evaluate natural incubation temperature regimes of 24 nests laid between 2018 and 2023 on Spanish coast beaches (Andalusia, Balearic Islands, Catalonia, Murcia and Valencia Community). Hatchling sex ratio (estimated as average temperature during the middle third of incubation period) and mean metabolic heating data of these nests are also analyzed. Dataloggers (HOBO® TidbiT® MX Temp 400, MX2203, ±0.2°C accuracy) were deployed in the center of the clutch to record incubation temperature every 30 minutes. In 17 of the nests, control datalogger was deployed in the sand at 70-100 cm apart from the nest at the same depth of the

clutch to evaluate embryo metabolic heating. The incubation period ranged 45-61 days. Average nest temperature ranged from 27,67°C to 31,54°C and average temperature in the middle third of the incubation ranged from 27,35°C to 31,62°C. The maximum temperature during this period increased between 1,25°C and 3,53°C, while the mean temperature also increased during the middle third of the incubation period (metabolic heating: 0,47±0,35°C) compared with sand temperature records and continued to increase during the last third (metabolic heating: 1,30±0,34°C). Results suggest a high variability on nest incubation temperatures among Spanish beaches. The results showed a variable estimated sex ratio among nests, indicating that male-female proportions in Spain's beaches can be more balanced eastern Mediterranean nesting areas. These results imply that Spanish beaches have a great potential to produce both males and females to guarantee a female recruitment and the establishment of regular nesting areas, but also to become both a spatial and temporal thermal refuge for the species according to male hatchling production. Further studies are needed to determinate areas and periods within the season where females and males are produced, to ensure an adequate management for the conservation of the emergent nesting population of the species in the western Mediterranean under a climate change scenario.

EFFICACY OF SEAWATER IRRIGATION TO MITIGATE THE IMPACT OF CLIMATE CHANGE ON HATCHLING SURVIVAL AND SEX DETERMINATION IN GREEN TURTLES*

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Sea turtles exhibit environmental sex determination and face concerns of over-feminization and increased heat-induced embryonic failure and hatchling mortality due to rising global temperatures. Mitigating the impact of climate change may necessitate interventions to reduce sand temperature. One proposed strategy is irrigation with seawater, but uncertainties persist regarding turtle egg tolerance to saline nest sand. To test the hypothesis that sea turtle embryos can tolerate a regimen of irrigation with seawater at a management-relevant scale, I investigated the impact of two levels of large-scale irrigation with cooled seawater on green turtle nests and embryos, assessing the effects on important nest environmental factors and developmental success. Irrigation reduced the temperature in clutches by up to 5.6 °C (1.34 ± 0.10 °C, mean ± SD) at the high level of irrigation without adversely affecting clutch oxygen levels, sand water (matric) potential, or sand moisture content. While hatching success of irrigated clutches was notably low (1.5%) compared with unirrigated clutches (82%), late-stage embryonic mortality predominated, suggesting an unexpected tolerance of early embryos to saline sand and increasing our understanding of sea turtle resilience to irrigation with seawater. The observation that younger clutches may be less susceptible to seawater-associated mortality than mature clutches near hatching further informs the limitations and potential applications of irrigation with seawater as a management strategy.

LAST STRONGHOLDS OF IRAN'S LARGEST HAWKSBILL ROOKERY: MICE INVASION ON THE NAKHILOO ISLAND, PERSIAN GULF

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With an average of over 210 nests per year, Nakhiloo Island (~0.3 km^2) in the northern Persian Gulf hosts Iran's largest rookery of Critically Endangered hawksbill turtles, which dominantly nest along almost all Iranian islands and some parts of the country's mainland beaches. Conservation efforts have successfully protected the Nakhiloo's nesting site for over a decade. However, in 2019, mice (*Mus musculus* L.) were introduced to the island, probably by the boats of recreational fishers camped there. In 2021, when conservationists returned to the island after the COVID-19 pandemic lockdown, the mice population had rocketed, feasting on migratory seabirds' eggs and chickens and hawksbill hatchlings. Here, we presented some information to define the dimensions of the crisis and discussed the best possible solution to tackle it. The information on hawksbill nesting on the island presented here comes from long-term annual monitoring surveys by the authors (2014-2022). During the 2022 nesting season, we patrolled the island's beaches daily from April to July. Data on nesting activities and mice density were collected. We used bucket traps to catch mice and estimated their density using the catch-per-unit effort method. Some nests were monitored while hatchlings were emerging to calculate the percentage of mice predation mortality. The nesting season on the island is from April to July, and the hatchling season is from May to August. During the 2022 nesting season, 188 nesting hawksbills (Mean CCL = 71.12±5 cm) and 310 nests were counted on the island. Nest density was 1.2±0.31 nest/10m^2 of the beach. A total of 40 nests were randomly monitored to estimate the mortality rate of hatchlings caused by the mice predation. Mice preyed on at least 50% of hatchlings before they reached the sea. The estimated mean number of hawksbill hatchlings for the site is 8000 per season. Therefore, mice predation probably causes mortality of about 4000 hatchlings per season. Mice density was estimated as one to two individuals/50m^2. Without an immediate and effective eradication project, which in the first-place needs funds, the hawksbill reproduction success will have been reducing for years until a complete collapse occurs. A literature review showed that the best solution would be broadcasting brodifacoum baits, starting immediately after the last birds and turtle hatchlings leave the island by the end of summer.

EXPLORERS AND RESIDENTS: DICHOTOMIC NESTING AND INTERNESTING BEHAVIOUR OF LOGGERHEAD SEA TURTLES COLONISING THE WESTERN MEDITERRANEAN

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In the present century, we are witnessing an increase in the number of loggerhead sea turtle nesting events in the western Mediterranean, an area supposedly out of the nesting range for the species. This increase has been hypothesised to be mediated by global warming. The increase in air and seawater temperature may have facilitated the possibility for loggerhead turtles to nest in previously unsuitable areas of the western Mediterranean. For a philopatric species, colonising distant beaches thousands of kilometres away from their natal beach is challenging. The western Mediterranean is known as a foraging developmental area for juvenile loggerhead turtles from Atlantic and Mediterranean regional management units. One of the hypotheses to explain this distant colonisation is that juveniles may reach sexual maturity in these developmental habitats and, under suitable conditions, nest in nearby beaches. In any case, the behaviour of these females in this new nesting area is unknown. In this study, we used satellite transmitters to track the movements of 13 adult female breeding loggerhead turtles (*Caretta caretta*) tagged on nesting beaches at the coast of Valencia (11) and Catalonia (2) from 2016 to 2023. Two of the females were tagged twice during this period, with an interval of four (2016-2020) and five years (2018-2023), respectively. The mean curve carapace length was 80 ± SD = 5.3 cm (range 73 – 90). Within the same season, four of the 13 females showed nest site fidelity, with successive nests found at the same beach or nearby beaches (< 10 km). Two of these four females made long-distance movements (> 100 km) between successive nesting events, while the other two remained near the nesting beach. Fidelity to nesting sites was also observed between seasons for two remigrant females. The other nine females used distant beaches, with successive nests up to 500 km apart within a season. These results suggest that there are two types of female behaviour among the breeders in Spain. We classified them as explorers, the ones wandering throughout the coast, and residents as the ones using only one beach for consecutive nesting activity. These two alternative behaviours have been previously observed in well-established nesting rookeries, but distances between consecutive nesting events recorded in the present study almost double previous recorded distances elsewhere. We hypothesise that this dichotomic behaviour could be explained as follows: explorer females would be those coming from distant nesting populations that may remain in the western Mediterranean

foraging grounds after reaching sexual maturity and, under suitable conditions, explore beaches nearby to nest. Alternatively, resident females may proceed from undetected nests laid in western Mediterranean countries years ago that returned to reproduce to the natal beach due to philopatry. Nonetheless, we cannot discard that the so-called residents may be explorers from distant populations who find a suitable nesting beach and use it for consecutive nesting events. Further research is needed since this information is crucial for managing and conservation in what seems to be a new-growing loggerhead turtle nesting population in the western Mediterranean.

IS THERE A FUTURE FOR LOGGERHEAD SEA TURTLE (CARETTA CARETTA, LINNEUS 1758) NESTING IN THE AEOLIAN ARCHIPELAGO (SOUTHERN ITALY)?

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Loggerhead turtles have started to expand their nesting range into the Western Mediterranean, which was known to hosted only sporadic nests until recently. The Aeolian Archipelago, located in the Southern Tyrrhenian Sea (Sicily, Italy), provides optimal foraging grounds for loggerhead turtles (*Caretta caretta*). Based on local people's report, sporadic nesting occurred along the beaches of Stromboli and Lipari, but in 2019 two nesting events were documented for the first time. Moreover, recently, several nesting attempts (2 in 2020, 21 in 2021, 8 in 2022 and 28 in 2023) were also recorded in the area. This may indicate suitability of these potential nesting areas as climate refuge for some individual. Indeed, from photo-identification analysis of scales around the face at least 2 individuals were identified to be involved in these attempts. In this study we analysed the characteristics and quality of these habitats, such as the composition of sand and beach location/morphology, as well as the related anthropogenic threats that may affect nesting success. Analysis results indicated that only Stromboli and Vulcano islands could host potential nesting beaches. Nevertheless, all nesting attempts were performed in the south-eastern coast of Lipari, Salina and Stromboli, which are probably more protected by the dominant winds. In those areas only few sandy (artisanal or volcanic) beaches are present, however, in the proximity of the cost, sand lays underwater and the morphology of the sea bottom decreases were slowly compared to other areas. The chosen habitats are characterized mostly by gravel or large rocks, although in the past the sand was present before disappearing due to coastal erosion. We suggest that the complete absence of nesting attempts on Vulcano island could be related to massive tourism and/or underwater hydrothermal activity. Based on our results, the Aeolian Archipelago may become an important nesting area if appropriate protection strategies are applied. Moreover, higher monitoring effort is recommended, especially in those coastal tracts identified as potential nesting habitats.

LOGGERHEADS NESTING IN FRANCE MAINLAND AND CORSICA IN 2023: AN EXCEPTIONAL YEAR OR THE BEGINNING OF A NEW STORY?

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Although France is a major country for the presence of sea turtles thanks to its overseas territories (French Guiana, Guadeloupe, Martinique, Mayotte, New Caledonia, Polynesia, Saint-Pierre et Miquelon, for example), sea turtle nesting activity in mainland France was either non-existent or anecdotal in the past. Since 2002, between zero and two loggerhead nests per year have been observed on the French Mediterranean coast. The year 2023 has proved exceptional, with 14 loggerhead clutches observed on the Mediterranean coast of southern France, including Corsica (2 at the mainland West, 7 at the mainland East and 5 in Corsica). In a single year, we can estimate that we have seen more nests in the south of France than in the previous 500 years. The nests were monitored by an exceptional large team of around 800 people involved in protecting them day and night. (probably the highest ratio persons/nest in the world!). Nest temperatures were recorded, and incubation success was characterized. The sex ratio of these nests will be estimated using a methodology developed for this species (Monsinjon et al. 2022, doi 10.1016/j.ecolmodel.2022.110119). This situation is one of the few times that colonization of a new habitat has been monitored in real time. Colonization of new habitats could be a strategy that has been underestimated until now. Indeed, in a more or less stable environment, the strategy of returning to lay eggs where females were born and where they have already laid is favored. With this in mind, work on sea turtle resilience has focused on changes in phenology (Fuentes et al. 2023, doi 10.1111/gcb.16991). However, in a changing world, the strategy enabling sea turtles to be resilient in the face of climate change is more likely to involve colonizing new nesting sites at higher latitudes than changing their phenology.

ASSESSING THE IMPACT OF CLIMATE CHANGE ON GREEN TURTLE HATCHLINGS AT TURTLE ISLANDS PARK, MALAYSIA: A MORPHOMETRIC, HATCHING SUCCESS AND SEX RATIO ANALYSIS*

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Global warming as a consequence of climate change, affects various characteristics of sea turtle hatchlings. In this study, we analyze how temperature influences sex ratio, hatching success, incubation period, and size of green sea turtle hatchlings (*Chelonia mydas*) from nests incubated at Turtle Islands Park (TIP), Sabah, Malaysia. Additionally, we predicted the sex ratio of green sea turtle hatchlings in 2050 and 2100, considering both conservative (Ssp2-4.5) and extreme (Ssp5-8.5) climate change scenarios in TIP's hatcheries. All sea turtle nests at TIP are relocated to hatcheries on the island, which include shaded and unshaded hatcheries. Data were collected from 69 nests in unshaded hatchery and 44 nests in shaded hatchery between August 2023 and January 2024, comprising 71 nests during the dry season and 42 nests during the wet season. To determine whether significant differences exist, Student's t-test was used with p-value=0.05. Results indicate that the mean hatching success is similar between hatcheries (57%, $p>0.05$) but it is slightly higher during wet season (60%) compared to dry season (52%). Hatchlings incubated under shading conditions exhibit larger body sizes, but no significant differences are recorded in hatchling sizes between seasons. The incubation period is significantly longer during the wet season (58 ± 2.36 days) compared to the dry season (53 ± 2.79 days) for nests incubated in unshaded conditions. Furthermore, sand temperature was collected using temperature data loggers placed in both hatcheries (from December 2019 to August 2023) at a depth of 70cm within the sand, to which 0.5°C was added to replicate metabolic heating and thus nest temperature. The obtained nest temperature was fitted into the Hill equation thermal reaction norm for sex ratio, best suited for this population with parameters obtained from *embryogrowth*, a package in R. Results showed that the mean percentage of females produced at TIP hatcheries during the dry season in shaded and unshaded hatcheries was 44.3% and 91.3%, respectively, while during the wet season, it was 41.6% and 68.5%, respectively. Statistical projections obtained using KNMI Climate Explorer of air temperature and subsequently nest temperature via linear regression show that by 2050, the percentage of females will be 96.8% and 98.7% according to scenarios Ssp2-4.5 and Ssp5-8.5, respectively. By 2100, it will be 99.3% and 100%, respectively. Furthermore, the nest temperatures throughout all months of the year 2100, according to the most extreme scenario, exceed the upper threshold limit for hatching success (35°C). Our results revealed a higher percentage of females being produced in the TIP hatcheries. Further investigation into the structure and design of hatcheries is recommended, particularly due to the anticipated increase in female hatchlings resulting from rising temperatures.

LOGGERHEAD SEA TURTLE HATCHLING SIZE: THEN AND NOW

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Sea turtles, recognized for their longevity and extensive migrations, reach sexual maturity between 25 to 35 years of age. Throughout their lives, these creatures traverse a variety of habitats, from nesting on coastal beaches to inhabiting coastal waters and venturing into the open ocean. Monitoring sea turtles across these different life stages is a complex challenge due to their intricate life histories. Notably, young sea turtles, the cornerstone of the population, have remained enigmatic and underexplored. Recent research identified a reduction in the size of nesting loggerhead (*Caretta caretta*) sea turtles at maturity over time within the Archie Carr National Wildlife Refuge (ACNWR). The ACNWR, located on the east coast of Florida, USA was established to protect the most significant loggerhead rookery in the Western Hemisphere and hosts 12% of annual loggerhead nests in Florida, with more than 10,000 loggerhead sea turtle nests recorded annually within the northern 21 km of nesting beach. While nesting and reproductive output (clutch size, hatching and emergent success) have been continuously collected in the refuge by UCF MTRG since 1982, hatchling size has been intermittently collected since the 1970's. We examined the size of hatchlings over four decades, with a primary objective to assess whether shifts in hatchling size have occurred over time, similar to the shift observed in adult females. We tested whether there has been a shift in hatchling size over time by using historical hatchling morphometric data (straight carapace length, straight carapace width, depth, and weight) from 1977-1979 coupled with recent hatchling data (2021-2023). Measurements were collected for 3,897 hatchlings from 125 nests (1,760 hatchlings from the 1970's and 2,137 hatchlings from the 2020's). Using Bayesian ANOVA analysis, we compared the variance among the two groups in our morphometric data. Results suggest that hatchlings from the 1970's were larger in every morphological measurement when compared to hatchlings from the 2020's, following the trend seen within the adult females. Our results, while subtle, aid in understanding the nuanced dynamics of the loggerhead population within the ACNWR. The size of hatchlings is a critical parameter to monitor as it can provide insight into the viability of the sea turtle population. If smaller hatchlings are produced over time, this may reflect in the overall fitness and reproductive success of the species in the future. Understanding the implications of these size variations is vital for the conservation and long-term survival of sea turtles in the region.

DETECTION THRESHOLDS FOR VISUAL LIGHT IN ERETMOCHELYS IMBRICATA HATCHLINGS*

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Hatchling sea turtles are highly phototactic, a trait that is instrumental in the process of seafinding after emergence from a nest. However, anthropogenic lights can cause hatchlings to misorient towards human developments rather than towards the ocean. To combat this misorientation while still providing adequate lighting for human properties, turtle-safe lights are employed. These lights cause minimal misorientation in hatchlings by employing wavelengths least attractive to hatchlings; however, what "turtle-safe" is, may be species specific. Greens, loggerheads, and leatherbacks have been investigated for threshold of detection, or the lowest intensity light to still illicit a phototactic response, showing higher thresholds for longer wavelengths of light (such as orange or yellow) and lower thresholds for shorter wavelengths (blue or indigo). Hawksbill turtles are underrepresented in the literature of phototactic studies, having never been investigated for thresholds of detection. They may prove more sensitive to light due to their preference for nesting in dense vegetation where light levels are low. Hatchlings for our experiment were collected from fourteen nests over two field seasons (with multiple clutches generally being necessary to determine a threshold intensity) and were kept in ambient climatic conditions for no longer than one hour before testing. To determine the hawksbill hatchling detection threshold for visual light, we used a Y-maze choice experiment where hatchlings were presented with a single-wavelength LED source at one end of the maze and no light source at the other end of the maze. Wavelengths tested were 415 (violet), 470 (blue), 535 (green), 555 (green), 590 (yellow), 601 (orange), and 660 nm (red). The intensity of light was controlled using a series of neutral density filters. Light intensity was measured pre-experimentation using a S400 Optical Meter and S247 Flat-Response Sensor Head situated at the decision point of the maze. Each hatchling was chosen randomly for experimentation and tested only once. To determine threshold intensities, hatchlings were tested using the up-down staircase statistical method, using 1.0 log steps down and 0.3 and 0.7 log steps up. A one-tailed binomial test was used to determine if a significant number of hatchlings were attracted to a specific intensity of light. Hawksbill hatchlings displayed detection thresholds intermediary to those studied in other species at most wavelengths (i.e., they had less or equal sensitivity as greens or loggerheads, and equal or more sensitivity as leatherbacks). The exceptions to this were at 555 nm and 470 nm. Hawksbills were more sensitive to green light of 555 nm than any previously tested species. They were also less sensitive to blue light (470 nm) than any previously tested species. Hawksbill sensitivity to blue light was on the same order of magnitude as that of red light. Red light required the highest intensity to illicit a phototactic response, while green light of 555 nm could illicit a response at the lowest intensity. Our results may be critical for informing standards for beachfront lighting, as we illustrate that even at very low intensities, light across the visual spectrum may still attract hawksbill hatchlings.

17-YEAR GREEN SEA TURTLE MONITORING ON TETIAROA ATOLL, FRENCH POLYNESIA

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TE MANA O TE MOANA, NGO, French Polynesia

Tetiaroa atoll holds a unique place in French Polynesia islands. Its cultural heritage is of the outmost importance but it has also become a very unique laboratory since 2014 through the innovative set up of the Tetiaroa Society Foundation in synergy with The Brando Eco-Resort. However, Te mana o te moana biologists and veterinarians have started under Dr. Cécile Gaspar guidance in 2007, a long-term green sea turtle monitoring on 3 islets of this atoll, including female identification measures and tracking, nesting and hatchling success, nest temperatures and parameters collection, hatchling predation and beach erosion monitoring. This presentation will highlight the key data collected and share long term vision for this monitoring that is expected to be exported in other key green sea turtle nesting Polynesian Islands.

CHANGE IN CLUTCH DEPTH AND REPRODUCTIVE SUCCESS OF LATE-SEASON GREEN TURTLE (CHELONIA MYDAS) NESTS ON THE EAST-CENTRAL FLORIDA COAST, USA

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The depth at which sea turtle nests are laid in sand affects key factors such as moisture levels, temperature, and gas exchange, which impact sex ratios, and hatching and emergence success. Florida's late-season nests, defined as those laid after 31 August and that may still be incubating past 31 October, are exposed to extreme weather events such as hurricanes, tropical storms, and exceptionally high autumn "king" tides. Extreme weather is known to heavily affect sand accretion and erosion on the beach. The change in sand depth and reproductive success of late-season nests on the Archie Carr National Wildlife Refuge (ACNWR) is unstudied. To better understand hatching success and challenges facing late-season nests, we measured change in clutch depth in 40 green turtle (*Chelonia mydas*) nests laid June through October. During nest marking (shortly after deposition), a HOBO MX2201 temperature datalogger was placed on the top of the clutch ("nest datalogger"), and depth of the nest datalogger from the surface was recorded. A second datalogger ("sand datalogger") was placed south of the clutch at the same depth as the nest datalogger. During inventory of the nest, we recorded the final depth of both dataloggers. We calculated the difference in depth measurements recorded for the nest and sand dataloggers to determine if the clutch had experienced any accretion or erosion. Inventory data collected from these nests were used to describe hatching and emergence success, as well as incubation duration. Changes in depth and reproductive success of these late-season nests were further compared to those of nests laid during the main nesting season (June-August). Data collection is ongoing and is expected to continue into early 2024; early results indicate nests laid in August and September experienced higher rates of sand accretion, whereas nests incubating as of 8 November experienced higher rates of erosion and wash outs due to high tides. As the nesting of green sea turtles increases in Florida, the number of late-season nests can be expected to increase. Results from this study can help determine the best way to protect these understudied late-season nests and help inform future nourishment and dune restoration projects, as well as understand the role late-season nests

play in overall population dynamics and recovery efforts. Sampling and data logger deployment is part of a larger ongoing late-season project by the University of Central Florida's Marine Turtle Research Group and is funded by the Sea Turtle License Plate Grant.

FIRST YEARS OF MONITORING THREE POTENTIAL KEY BEACHES FOR SEA TURTLES ON THE OSA PENINSULA, COSTA RICA

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The Osa Peninsula has been recognised for its terrestrial and marine importance globally, supporting 2.5% of global terrestrial diversity and 50% of all marine species found in Costa Rican waters. The surrounding coastal environment provides nesting beaches for eastern Pacific green (*Chelonia mydas*), and olive ridley (*Lepidochelys olivacea*) sea turtles. COPROT (Comunidad Protectora de Tortugas de Osa) is a non-profit organization dedicated to the conservation of sea turtles through environmental education of the local community and monitoring of three key nesting beaches on the Osa Peninsula namely: Pejeperro, Rio Oro and Carate. These very remote beaches are adjacent and are located on the south Pacific coast of Costa Rica. Prior to COPROT there was no consistent long-term data collected on these beaches and therefore little is known about the nesting population here with its potential importance overlooked. COPROT has been carrying out continuous monitoring of these beaches since 2020 to determine ecological population trends for this region. Results from the last three nesting seasons suggest these are critical beaches and could become index beaches for solitary nesting eastern Pacific green and olive ridley turtles in Costa Rica. Almost 700 nests were recorded annually, made up over 400 eastern pacific green turtles where 75% were placed in vegetated areas, and 6000 olive ridley nests where more than 93% were placed in intertidal zones. It is worth highlighting for green turtles that more than 50% of the activities were false crawls or abandoned nest attempts. Clutch fertility, hatching success and emergence success was found to be 93%, 84% and 82% respectively for green turtles and 83%, 64% and 62% respectively for olive ridley clutches. Green turtles had an average of 70 eggs per nest and a mean CCL of 87.5 cm whilst olive ridley clutches had an average of 96 eggs and a mean of 67 cm CCL. Clutch size for green turtles were similar to other nesting populations in the north pacific but smaller compared to the Atlantic ones. These populations, although still not fully understood, would suggest that these beaches with further monitoring could be well suited to serve as index beaches for both green and olive ridley turtles in Costa Rica because of the high number of nests and success of turtles here. Continued monitoring and further research of the ecology of the population could show that indeed these beaches have been overlooked. With further recognition, better systems and funding could be in place to gain spatiotemporal data of the nesting population during inter-laying periods. This could include turtle interactions with fisheries, regions of coastal development and habitat destruction so that appropriate attention can be implemented efficiently. It would also boost socioeconomic standards in the local community through more funding for financing qualifications and infrastructure as well as increase ecotourism which would also increase local job opportunities. Together these factors will ultimately support the conservation of the nesting turtles on the Osa Peninsula.

THE SIGNIFICANCE AND CHALLENGES FACED BY THE INCREASING NUMBER OF NESTING HONU (HAWAIIAN GREEN SEA TURTLES) ON OAHU

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The honu or Hawaiian Green Sea Turtle once nested in large numbers on all the main Hawaiian Islands. Starting in 1800s and continuing until the 1970s, widespread, unsustainable harvest, primarily for consumption of adults and eggs by humans, constrained and eventually eliminated all significant nesting areas with one exception; Lalo or French Frigate Shoals. Hard-wired life history traits like late maturation and natal site fidelity work synergistically to impede recovery which will require expansion into previously used nesting areas. Although honu numbers have increased at ~5%/year, there is little evidence of any significant nesting outside of the low-lying atoll of Lalo. Expansion in nesting to high-elevation islands that will persist as sea-level rises is necessary for survival and recovery. A collaborative, community-based project using citizen scientists to find, monitor and protect honu nests on Oahu started in 2016 and revealed a dramatic increase in sea turtle nesting starting in 2020 and continuing through the present. Nest numbers increased from 0 – 2 nests found in 2016 – 2018 to a high of 58, 67 and 31 nests found in 2020, 2021 and 2022 respectively. Hatching success and emergence success were generally high (>85% & >75% respectively). However, many nests and hatchlings require protection from artificial lights, vehicles driving on the beach, invasive predators and discarded fishing line. Public education focused on these threats, especially on how to use artificial light responsibly, and management is needed to protect honu as they once again begin to nest on Oahu.

LAYANG LAYANG, SPRATLY ISLANDS: NESTING AND FORAGING GROUNDS FOR MARINE TURTLES IN SOUTH CHINA SEA*

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Marine turtles are highly migratory species that utilize various habitats for development, reproduction, and foraging. Protecting these vital habitats is crucial for conserving marine turtle populations. Layang Layang (Swallow Reef), an oceanic atoll within the Spratly Islands under the Malaysian administration, about 300 km northwest of Kota Kinabalu, Sabah, Malaysia, has been previously identified as a foraging area for the green turtles (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*). In 2022, comprehensive surveys, on the beach and in water, were carried out to update our knowledge of the marine turtles in Layang Layang. During these surveys, a total of 25 turtles were sighted over four days of diving across all dive sites, with an occurrence of 0 to 4 individuals observed per dive. The central lagoon seemed to be a favored foraging spot for immature green turtles with an observed surfacing rate of 7 to 10 turtles per hour. These smaller turtles (<60 cm) likely recently completed their oceanic phase, but further investigations are needed to confirm this. Interestingly, we discovered evidence of marine turtles nesting on the reclaimed beach, marking the first documented instance of nesting within the Spratly Islands. The presence of marine

turtle body pits provides strong evidence of nesting activity in the area. In-water surveys also revealed an outbreak of crown-of-thorns starfish and a significant decrease in coral cover. Recognizing the importance of Layang Layang as a foraging and nesting site for marine turtles, we emphasize the need to protect these habitats and consider designating Spratly Islands as an international marine park, despite political disputes over its affiliation. The results of this survey are important as they establish a significant baseline dataset for developing effective conservation strategies and management plans, vital for safeguarding these migratory species and their habitats.

RUNNING OUT OF SAND: SEA TURTLE NESTING ACTIVITY ON FÉLICITÉ ISLAND, SEYCHELLES

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The Seychelles are home to one of five regional populations of hawksbill turtles with more than 1000 females nesting annually (Mortimer 2000). Cousin Island has observed an estimated emergence of up to 256 individual nesting hawksbills per season and has been identified as the most important nesting spot in the region (Allen et al. 2010). In Seychelles hawksbill turtles exhibit a distinct nesting period from October until March (Mortimer 2000). Félicité Island, located in the inner islands of the Seychelles, harbors five sandy beaches, of which four are easily accessible. Six Senses Zil Pasyon resort was established on this privately owned island in October 2016, occupying one third of the island. In December 2021 the Olive Ridley Project partnered with Six Senses Zil Pasyon to establish a monitoring and conservation program to ensure long-term data collection and protection for nesting turtles on the island. In this study, we present the results from the first completely monitored nesting season in 2022/2023. During the reporting period 87 false crawls and 51 true nests were recorded on all five beaches on Félicité Island. The majority of nesting activity was recorded on Grand Anse, the longest beach on the island. 43 clutches were laid by hawksbill turtles, and an additional eight green turtle clutches could be recorded. Hatching success, the percentage of eggs within a nest that hatched, was 80.1% for green turtles (SD = 35.5, N = 7) and 76.2% for hawksbill turtles on average (SD = 30.1, N = 36). Limited availability of suitable nesting space, highly dynamic beaches due to monsoon related erosion, as well as predation by ghost crabs (Ocypode spp.) were identified as the main challenges to nesting success on the island. 12 out of 30 hawksbill turtle clutches on the main nesting beach Grand Anse had to be relocated due to erosion or inundation. No previous data are available to comment on a trend in clutch numbers for either turtle species on Félicité, therefore we recommend continuation of monitoring reproductive females at Félicité to compare with population levels and trends observed at other islands in Seychelles.

EX-SITU CONSERVATION OF OLIVE RIDLEY TURTLES (LEPIDOCHELYS OLIVACEA) IN PANADURA BEACH, SRI LANKA*

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The beach in Panadura provides nesting habitat mainly for *Lepidochelys olivacea* (Olive Ridley). In addition, *Chelonia mydas* (Green turtles) and the *Dermochelys coriacea* (Leatherback turtles) have been recorded previously. Panadura is a coastal town located in the Kalutara District of the Western Province, Sri Lanka. The nesting season in Panadura beach begins in late November and continues until the end of April every year. Local poachers used to harvest turtle eggs if they are not relocated in a safe place. The Coast Guard officers has been recruited as lifesaving guards who involved in collecting turtle eggs and incubating them. The project intends to evaluate the efficacy of exsitu conservation of turtles in recently created hatchery enclosure at Panadura beach. The square-shaped hatchery enclosure encircled by a wire mesh made to protect the incubating nests and hatchlings from predators like stray dogs and land monitors was used as the sampling site. The potential issues impacted to turtle nesting in the beach were identified. The eggs laid by *Lepidochelys olivacea were* recorded monthly basis. The beach is patrolled at night by volunteers, TCP employees, and Coast Guard officials, to gather eggs and to keep for incubation. Consequently, all resulting hatchlings were released to the sea and counted the hatchlings. During the 2022 nesting season, all together 5638 eggs of *Lepidochelys olivacea* have been collected and incubated. Out of the 5638 eggs, 4366 eggs were successfully hatched giving a 77.4% of hatching success. The highest average number of eggs (326/day) recorded in month of March while the lowest average number of eggs (125/day) recorded in January. Average number of eggs laid was 115/turtle. Vehicle use on the beach has the potential to harm emerging hatchlings, and light can disorient the hatchlings and disturb the nesting turtles. As a public beach, a lot of residents spent there for leisure time day and night with at beach. The beach features a kids' park, and the municipality allows individuals to rent it out for various events. Littering on the beach by visitors is also a considerable environmental issue. Noises of all these activities can potentially disturb the arriving of nesting females. In contrary cleaning events conduct by TCP at regular basis at the beach is supportive for the turtle nesting habitat improvement and the established education center is well functioning to inform visitors about the value of protecting sea turtles and their ecosystems. Regardless of the disturbance, the beach stretch is a highly promising site for turtle nesting, particularly for the *Lepidochelys olivacea* species. Eliminating obstacles will undoubtedly increase the number of species and turtle nesting sites in beach area. It recommended to implement a beach usage policy based on the findings, for the implementation by the Panadura Urban Council regards to protect the nesting beach. Findings of the study will be helpful for further strengthen the ex-situ sea turtle conservation.

VARIABILITY IN THERMAL TOLERANCE OF CLUTCHES FROM DIFFERENT MOTHERS INDICATES ADAPTION POTENTIAL TO CLIMATE WARMING IN SEA TURTLES*

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The current climate warming is a challenge to biodiversity that could surpass the adaptation capacity of some species. Hence, understanding the means by which populations undergo an increase in their thermal tolerance is critical to assess how they could adapt to climate warming. Specifically, sea turtle populations could respond to increasing temperatures by (1) colonizing new nesting areas, (2) nesting during cooler times of the year and/or (3) by increasing their thermal tolerance. Differences in thermal tolerance of clutches laid by different females would indicate that populations have the potential to adapt by natural selection. Here we used exhaustive information on nest temperatures and hatching success of leatherback turtle (*Dermochelys coriacea*) clutches over 14 years to assess the occurrence of individual variability in thermal tolerance among females. We found an effect of temperature, year and the interaction between female identity and nest temperature on hatching success, indicating that clutches laid by different females exhibited different levels of vulnerability to high temperatures. If thermal tolerance is a heritable trait, individuals with higher thermal tolerances could have greater chances of passing their genes to following generations, increasing their frequency in the population. However, the high rate of failure of clutches at temperatures above 32 °C suggests that leatherback turtles are already experiencing extreme heat stress. A proper understanding of mechanisms of adaptation in populations to counteract changes in climate could greatly contribute to future conservation of endangered populations in a rapidly changing world. Our results can guide management actions to mitigate short-term effects of climate warming on sea turtles, while allowing adaptation in the long-run.

UNVEILING A RECENTLY DISCOVERED LOGGERHEAD SEA TURTLE NESTING SITE IN GREECE PRODUCING A PREDOMINANCE OF MALE HATCHLINGS

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Greece hosts the largest reproductive aggregations of loggerhead sea turtles (*Caretta caretta*) in the Mediterranean, with temperature-dependent sex determination (TSD) being a critical factor in their population dynamics. This study focuses on Preveza beach, located in northwestern Greece, surveyed as part of the LIFE EUROTURTLES project initiated in 2017. The project involved beach monitoring, nest protection against predation, and post-hatch excavations and, additionally, an effort to understand the male-to-female ratio of sea turtle hatchlings. From 2017 to 2019, daily surveys were conducted to monitor sea turtle nesting activities, while from 2018 to 2021, temperature loggers were deployed to record beach temperatures, used as a proxy for incubation temperatures which play a crucial role in determining the sex of hatchlings. A total of 15 loggers were placed in strategic locations along the beach, with temperature

data collected at regular intervals. Nesting activity on Preveza beach was regular but relatively low. The number of nests recorded increased over the years, with 3 nests in 2017, 8 in 2018, and 13 in 2019. In 2020, 16 tracks indicating nesting attempts were identified, but the exact number of nests remained undetermined due to limited surveying. Beach temperatures consistently remained below the pivotal temperature of 29.7°C, a threshold for balanced sex ratios in sea turtle hatchlings. This suggests a predominant production of male hatchlings. Peak sand temperatures are typically observed in July and August, and the data indicated that temperatures during June and early July were consistently below the pivotal temperature, contributing to a male-skewed hatchling sex ratio. The male hatchling bias, due to its cooler sand conditions, make the area significant for sea turtle conservation efforts. This is particularly important in the context of ongoing global warming trends, which are expected to lead to increasingly female-biased hatchling outputs on other beaches. The potentially increasing nesting activity and the extensive, relatively undeveloped beach suggest that Preveza beach may become a significant nesting site in the future, provided that loggerheads will consistently expand their nesting range towards cooler zones in the face of global warming. In the Mediterranean, this expansion is already observed in two directions: a northward expansion into Albania and a westward expansion into the western Mediterranean. These findings have implications for understanding and preserving the endangered loggerhead sea turtle populations and their emerging habitats in the region.

EMERGENCE PATTERNS OF HATCHLINGS OF CHELONIA MYDAS, LEPIDOCHELYS OLIVACEA AND DERMOCHELYS CORIACEA AND PREDATORS BEHAVIOR IN PLAYA CABUYAL, COSTA RICA*

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Generally known that ecological patterns and other environmental elements influence the behavior of neonates as well as their success in hatching and rate of emergence. Also, there are other threats such as predators, is an important source of mortality for the eggs and hatchlings of sea turtles. Turtle nesting areas typically contain a mixture of vegetated and non-vegetated habitats, and habitat selection by both nesting turtles and nest predators can lead to uneven patterns of predation risk across the landscape. These makes extremely important to study how these processes work and relate to the nesting of sea turtle populations, as this knowledge can be used in nest translocation and protection programs. It is worth mentioning the lack of published work comparing species emergence patterns. Our goal in this study is to identify and compare emerging patterns between the three species hatchlings. Additionally, determine whether the emergence process and predation are related. In northwest Costa Rica, on the Gulf of Papagayo (10° 400N, 85° 390W), is Cabuyal Beach, an energetic beach that regularly changes throughout each season. Different habitats can be found along the shore; at the southern end is an open estuary linked to a mangrove, and the forest stretches behind it. In contrast, the northern end is more suited for turtle nesting since it is rocky with areas of sand. During the sea turtle reproductive season of 2018–2019, the sampling was done between January and March. The cameras were positioned close to the nests (behind or laterally) close to their emergence or that had emergency indicators (sand depression or hatchlings). This allowed for the recording of the process without the need for direct human presence. A total of 18 nests of different species (11 green turtle, 6 olive ridley and 1 leatherback) were analyzed in the different emergence phases (time spent on videos = 78.41 minutes). The emergency process occurs mostly at night, this pattern is confirmed in our data, with the exception of some neonates that emerged during the day, and this could be justified by being nests of green turtles that predominate in shaded areas. With the recordings of the photo trap cameras, was possible to obtain the real time of emergencies and also identified 4 types of predators (raccoons, ants, birds and dogs), in the initial phase of process of emergence. This behavioral study employing trap cameras is innovative, taken in count the previous research. Contributes to improving our comprehension of the behavior of these species at an important phase in their life. It provides the capacity to gather more information concurrently from several nests, eliminating human interference, and capture real-time images of the emergence process and threats. For future studies the use of cameras can be useful for management the efforts in the conservation of sea turtles. These highlight the advantages of trap cameras in future studies, understanding the predator behavior in the different phases of the emergence process. Developing management strategies to achieve conservation goals, especially when the species of concern are threatened.

OLIVE RIDLEY NESTING MONITORING IN THE OSA PENINSULA; THREATS AND CONSERVATION MEASURES

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The study area covered by COPROT, Comunidad Protectora de Tortugas de Osa, extends along 3 sea turtle nesting beaches: Playa Pejeperro, Playa Río Oro and Playa Carate. These beaches are contiguous, with a total length of 8.3 km and are located in the south of the Osa Peninsula. The peninsula, which is in the southwest of Costa Rica along the Pacific coast, is renowned as one of the most biodiverse places in the world. The beaches are located within protected areas and have special relevance for olive ridley sea turtle solitary nesting. The aim of this study is to describe relevant nesting aspects such as the number of nests per season, the predation percentage and compare the success rate for nests left in situ to the relocated nests in the hatchery. The data collection method of this study is based on patrols, nest exhumations and hatchery data. Rio Oro and Pejeperro beaches have been monitored continuously since 2020 by COPROT, whereas Carate beach has been monitored by different organizations intermittently since 2005. The most evident threats in the study area are predation by domestic dogs and/or wild animals, illegal egg collection, and effects of climate change. To combat these threats, a hatchery has been constructed in Carate beach, providing a safe environment for the relocated nests and giving us the opportunity to monitor temperature, hatchling biometrics and hatching success. Data, such as hatching success, from a sample of nests marked on the beach will be compared to nests in the hatchery to assess the effectiveness of this initiative. Hatching success is expected to be greater in nests within the hatchery than those left wild on the beaches, which is 64%. The number of olive ridley (*Lepidochelys olivacea*) nests for these 3 beaches exceeds 6000 nests per year. The minimum number of nests per season is 2300 for Pejeperro, 2700 for Río Oro and 800 for Carate. So far 2023, the percentage of predation is 7.24% in Pejeperro, 20.7% in Rio Oro and over 50% in Carate. Predation increases with proximity to the community of Carate, where there is a higher concentration of people and pets. The community of Carate is small and isolated with low resources and numerous environmental problems. Work in previous years suggests predation by domestic dogs to be an issue facing Olive Ridley nests in this area. Another protection measure has been to put up bamboo nets to protect some nests in situ. The effectiveness of this measure is being studied and the results are expected to be similar to previous studies for this same beach which suggested the nets have a positive impact. In addition, COPROT carries out annual pet castration clinics and environmental education campaigns. This study, and

future research, will be essential in determining adequate protection and management measures for the species in the peninsula.

AN INCREASED RISK OF PREDATION FOR CARETTA CARETTA NESTS IN CALABRIA (SOUTHERN ITALY)

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Sea turtles' nests are threatened by various anthropogenic and natural factors, including the predation of eggs and hatchlings by opportunistic species that frequently patrol the beaches in search of food. The Calabrian Ionian coastline (Southern Italy) ranks among the primary national nesting grounds for *Caretta caretta*. In this area, loggerhead nests are located through systematic shoreline patrols covering approximately 30-50 km daily, carried out by Caretta Calabria Conservation Onlus. This search is aided using drones and fat bikes, and it is conducted by skilled operators with expertise in identifying and interpreting the tracks of the species. The main predator of eggs and hatchlings is the fox (*Vulpes vulpes*) to which has recently been added the ghost crab (*Ocypode cursor*) found for the first time in the summer of 2020. The protection of the nest involves security to prevent predation by natural threats. It consists of placing a fox exclusion device (FED) (size 1x1 m, mesh 10x10 cm) on the egg chamber, under about 10 cm of sand. In cases of repeated excavation attempts by predators, additional dissuasion measures are opportunely employed. Annually, in the study area, we observe fox predation attempts on loggerhead nests. In the 2023 season, predation attempts increased, affecting 31% of nests. However, even with the utilization of the mentioned anti-predation methods, only 4 nests were entirely predated. Regarding the ghost crab, there have been n = 3 instances of predation detected since 2020. However, in only one of these cases, which occurred in the summer of 2023, it was possible to confirm the entire destruction of a clutch. The Ionian coastline features pristine beaches where both foxes and crabs thrive, thanks to the favorable ecological conditions that support their survival and, notably, their food search. The measures taken to prevent fox digging have shown only partial effectiveness thus far. In specific environmental conditions, such as after rainfall or when dealing with a compacted substrate, the predator can still dig and reach the most superficial eggs despite the presence of the FED. In more exceptional cases, it can even access the clutch through side tunnels. The impact of this threat is greatest in more natural stretches of coastline and generally seems to increase towards the end of the bathing season (late August) when human presence drops considerably. As regards the ghost crab, its presence represents a further concern for the safety of the nests of *C. caretta* in the studied geographical region. While the crab's distribution is currently confined to a small coastal area, the significant rise in its population density indicates the likelihood of its rapid expansion across the entire area in the future.

EFFECTS OF RISING TEMPERATURE ON SEA TURTLE NESTING OUTCOMES - HOW TREE FOUNDATION MAINTAINS THE TEMPERATURE ALONG THE ANDHRA PRADESH COAST, INDIA

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A warmer ocean and coastal environment poses challenges for sea turtles whose sex determination is temperature-dependent. Warmer incubation temperatures produce more female hatchlings and a reduction in the natural number of males one would expect. Warmer beaches will put sea turtle embryos at risk. During development, the sex of an embryo is determined by the nest temperature during incubation, with warmer nests producing more females and cooler nests producing more males. It should be noted that temperatures above 33°c will cause a nest to fail completely. The olive ridley turtles nest along the Andhra Pradesh coast, East Coast of India and the green and hawksbill sea turtles forage offshore, using various habitats during their nesting, migration and feeding, including beaches, sea grass beds, coral reefs, near-shore bottom areas, and the waters of the open ocean. However, a rise in temperatures is altering their nesting habitats. The density of nests protected over the past 15 years show that more nests these days are being laid later in the season and it is becoming warmer earlier than in previous years. Adhering to protocols for protecting nests from rising temperatures through hatchery- based conservation has helped in protecting incubating eggs and safely releasing the emerging hatchlings that they may make their way down the beach to the sea despite rising temperatures. The poster illustrates the meticulous conservation protocols followed by the Sea Turtle Protection Force members of TREE Foundation in maintaining temperatures to ensure nest viability and the protection of todays hatchlings so they may produce further generations in the future when they too mature. The poster also illustrates the awareness programs conducted to reduce the existing threats, such as incidental capture in commercial fisheries and artisanal fisheries and need for protection of the nesting habitats along the Andhra Pradesh coast.

A SUMMARY OF TWENTY-EIGHT YEARS OF SEA TURTLE NESTING DATA ON TOPSAIL ISLAND, NORTH CAROLINA

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The Karen Beasley Sea Turtle Rescue and Rehabilitation Center (KBSTRRC) is a non-profit sea turtle conservation organization in North Carolina, USA. KBSTRRC's Topsail Turtle Project (TTP) is permitted to monitor the beaches of Topsail Island for nesting sea turtles, protect the nests and hatchlings, and gather conservation data. Nesting data has been collected consistently for 28 years. May 1 through August 31 is sea turtle nesting season in North Carolina. Each day during nesting season, TTP volunteers survey the 41.8 km (26 miles) of Topsail Island looking for turtle tracks. When tracks are found, an experienced volunteer is dispatched to determine whether the tracks lead to a clutch of eggs or represent a false crawl. If eggs are found, it is designated a nest and protected with tape and signs, and a wire grid is placed over the top to exclude predators. If eggs are deposited in an unsuitable location, volunteers will carefully

relocate the nest. At this time, and for relocated nests only, data on the number of eggs are collected. Approximately 60 days after eggs were laid, TTP volunteers monitor the nest until hatchlings emerge. Three days after hatchling emergence, the nest contents are inventoried, and additional data are collected. Over the past 28 years, the TTP has responded to 5,042 sea turtle crawls. Of these, 2,832 have been determined to be egg clutches while 2,210 have been determined to be false crawls. The highest number of clutches laid was 187 in 1999, while the lowest number was 53 in 2014. The average number of clutches per year is 98. There is an increasing trend in the number of false crawls. The average number of false crawls during the first five years is 58, and the average for the last five years is 109.2. The majority of clutches (98.48%) are loggerhead turtles. Green turtles comprise 1.48% of the total clutches. There has been one documented Kemp's ridley clutch (0.035%) and one unknown nest (0.035%). The mean clutch count on Topsail Island during this time frame was 119.9 eggs. Annual mean clutch count ranged from 109.2 to 127.7 eggs. The mean incubation period was 59.5 days (range 52.9 to 66.8 days). An inventory was conducted on 86.9% of the clutches after the end of incubation, or after 80 days if no emergence was detected. The mean emergence success was 73.7% (range 0% to 83.7%.) Years of lowest emergence success were attributed to hurricanes. These data are comparable with other sea turtle nesting beaches in North Carolina. This preliminary summary presents our first comprehensive review of the data. We hope continued data examination will offer additional insight into sea turtle nesting, emergence, and conservation.

HATCHING SUCCESS AND SEX RATIOS OF CHELONIA MYDAS NESTS IN LANG TENGAH ISLAND, MALAYSIA

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Climate change poses a threat to species with temperature-dependent sex determination, like sea turtles, potentially resulting in skewed female offspring. Among potential adaptions is their nesting behavior shifting towards cooler areas. This study aims to evaluate trends in incubation temperatures and incubation periods, estimate sex ratios, and determine the hatching success of *Chelonia mydas* nests on Lang Tengah Island from 2021 to 2023. Lang Tengah Island is vital for green and hawksbill turtles, serving as nesting and feeding grounds in Terengganu. Two nesting beaches, Turtle Bay and Lang Sari are patrolled nightly from March to October each year. Nests laid on Lang Sari were relocated to Turtle Bay to prevent poaching while nests laid on Turtle Bay were relocated only if below the high tide line. A data logger was deployed in 43 nests (13 *in-situ* nests and 30 *ex-situ* nests) to measure the incubation temperature for estimating hatchling sex ratios. All the nests were excavated at least 3 days after mass hatchling emergence to determine the hatching success. In total, 135 nests were protected, of which 85 nests were relocated and 31.9% had data loggers. The average hatching success rate of all the nests over the three-year observation period was 75.5% (SD = 24.01), while the nests equipped with a data logger had an average hatching success of 80% (SD = 12.83) (79.5% and 80.2% for *in-situ* and *ex-situ* nests, respectively). Logistical equations were used to estimate the hatchling sex ratio in each nest with a proposed pivotal temperature of 29.1°C for the Malaysian green turtle populations. Analysis of sex ratio of these 43 nests revealed an average of 7.5% female hatchlings (SD = 13.61), with an average incubation temperature during TSP of 28.3 °C (SD = 0.42) and incubation period of 55–65 days. Specifically, *in-situ* nests had an average of

7.8% female hatchlings (SD = 15.4), with an average incubation temperature during TSP of 28.3 °C (SD = 0.49) and incubation period of 57–62 days, while *ex-situ* nests had 7.4% female hatchlings (SD = 13.3) with an average incubation temperature during TSP of 28.3 °C (SD = 0.40) and incubation period of 55–65 days. This deviation towards more male hatchlings may be attributed to the triple-dip La Nina effect occurring over three consecutive years (2020-2022). Furthermore, all the *in-situ* nests were laid under vegetation which were fully shaded. Notably, nests were mainly moved to shaded or partially shaded areas due to the beach's 70 m length, as the open space below the high tide line. These findings contrast with the prevalent high female bias reported in offspring at many rookeries worldwide and underscore the significant role that local beach characteristics play in influencing incubation temperature. The findings, of this study, have significant implications for sea turtle conservation. To mitigate the impact of climate change on sea turtle population, conservation efforts may need to focus on protecting and maintaining nesting sites that provide cooler incubation conditions for the production of males, and where necessary, relocating nests to such sites.

DETERMINING INCUBATION DURATION AND REPRODUCTIVE SUCCESS OF LATE-SEASON LOGGERHEAD (CARETTA CARETTA) AND GREEN TURTLE (CHELONIA MYDAS) NESTS ON THE EAST-CENTRAL FLORIDA COAST, USA

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Though sea turtle nesting on Florida's east coast extends nearly year-round, nests laid in the last months of the loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*) nesting season, especially after the official "end" of the season (October 31), are historically understudied. Late-season nests (laid after August 31 with possibility of incubating past October 31) are the most likely to be impacted by beach nourishment projects typically occurring from November-March. These nests are also exposed to lower temperatures, which will slow egg incubation duration and may reduce nest viability and hatching success. With the recent increase in green turtle nesting, it is likely that late-season nests will become more common and may have an important contribution to population dynamics. The beaches monitored by the University of Central Florida's Marine Turtle Research Group (UCF MTRG) in south and central Brevard County are representative of nesting in the state, hosting about 1 in 6 loggerhead and 1 in 3 green turtle nests, making this an optimal study area. This study aims to describe incubation duration, viability, and reproductive success of late-season nests by species, compared to main-season nests (April-August), using nest emergence and inventory data. In 2021-2023, the UCF MTRG supplemented its reproductive sampling scheme to include more late-season nests. Nine loggerhead and 70 green turtle nests were marked during the 2021 late season (September-November), comprising 2% and 18% of total marked nests in 2021, respectively. During the 2022 late season, 9 loggerhead and 67 green turtle nests were marked, comprising 5% and 14% of total marked nests, respectively. As of 8 November, 13 loggerhead and 46 green turtle nests were marked in the 2023 late season, comprising 3% and 10% of total marked nests, respectively. Late-season 2021 nests incubated more slowly and were more susceptible to being washed out compared to those laid earlier in the season. In 2022, nests laid during August-September were heavily impacted by Hurricane Ian, with nearly all of the remaining nests and those laid in October, washed out by Hurricane Nicole. Only 33% of the hatched late-season green turtle nests in 2021 had an observed emergence date and therefore a known incubation duration. To better determine incubation duration of late-season nests, temperature of green turtle clutches and the adjacent sand were measured throughout the 2023 nesting

season using HOBO MX2201 temperature data loggers. The drop in clutch temperature post-emergence due to loss of metabolic heat allowed us to estimate emergence date and calculate incubation duration for nests where emergence was not observed. Many late-season nests in 2023 experienced high levels of sand accretion, lowering hatching and emergence success, with data collection still ongoing. Results from this research will be useful for determining the contributions of late-season nests to reproductive output, as well as informing nest inventory protocols during cooler months and aiding managers overseeing beach construction and seasonal beach restrictions.

EMERGENCE SUCCESS OF LEATHERBACK SEA TURTLES IN A CHANGING CLIMATE ON THE ARCHIE CARR NATIONAL WILDLIFE REFUGE, FLORIDA, USA

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Sea turtles face a variety of challenges across their life stages, with their nest environment being particularly susceptible to diverse environmental conditions like storm surges, erosion, washouts, and nest temperature conditions. Historically, reproductive success of the endangered leatherback (*Dermochelys coriacea*) is known to be low compared to green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) sea turtles. Florida's (USA) east coastline provides important habitat for leatherback nesting, embryonic incubation, and hatching. We used a long-term leatherback reproductive output dataset from the Brevard County section of the Archie Carr National Wildlife Refuge (ACNWR) to examine whether leatherback emergence success has varied over time in a changing climate. The ACNWR is a 21-km section of the Atlantic coastline in Melbourne Beach, Florida, USA where the UCF Marine Turtle Research Group (UCF MTRG) has consistently monitored since 1982. During this period, the UCF MTRG observed an increase in leatherback nesting, from 0 to 5 nests annually in the 1980s to about 30-60 nests annually in the 2020s. We assessed leatherback emergence success relative to air temperature overtime on the ACNWR. Our objective was to understand whether temperature has impacted leatherback emergence success on this nesting beach, thereby contributing valuable insights into leatherback hatchling output trends over time. To determine if emergence success has shifted over time due to changes in temperature, we calculated emergence success for each leatherback nest from 1996-2023 and obtained historical local air temperature data from NOAA's National Center for Environmental Information (NCEI). Using iterative model selection, we conducted analyses in Rstudio to test if changes in temperature are associated with a change in emergence success over time. Elevated temperatures may push nest environments to their thermal limits, potentially resulting in decreases in emergence success, hatching success, and increased hatchling mortality. Understanding how climate change impacts leatherback emergence success is imperative for gaining insight on the future population dynamics of the species as their nests continue to face rapidly changing environmental conditions.

NESTING ECOLOGY OF LEATHERBACK TURTLES AT BURU ISLAND, INDONESIA

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Leatherback turtles (*Dermochelys coriacea*) are one of six species of sea turtle that nest in Indonesia. The leatherback turtle population in the West Pacific is critically endangered and fully protected in Indonesia. To support sea turtle protection efforts, in 2022 the Ministry of Marine Affairs and Fisheries of Indonesia created and ratified the National Plan of Action (NPoA) for sea turtle conservation. The NPoA has identified seven priority areas and seven national turtle conservation goals, with Buru Island (Maluku Province) as one of the priority areas due to its recent identification as a regionally important leatherback nesting beach. The NPoA also identified the generation of data through research as one of its main goals. In 2017 we began daily monitoring of leatherback nesting along the 13.7 km of Fena Leisela coast on Buru Island. Trained local patrollers collected data on leatherback turtle nesting activity including # of nests, # eggs, location of nests, # of crawls, as well as female turtle morphometrics. After the incubation period, hatching success was determined. We documented a significant decrease of illegal take of turtle eggs over the project timeframe. These nesting ecology data are currently being analyzed and the results will be shared during the symposium. The results of this work will also be shared with local community members, government agencies (provincial, national, and international), non-profit organizations, policy makers, and other stakeholders to support management decision making. Given the critically endangered status of West Pacific leatherbacks, this research will have major implications for recovery efforts on behalf of the population.

WHICH THREATS AFFECT HATCHING SUCCESS OF THE HAWKSBILL TURTLE (ERETMOCHELYS IMBRICATA) IN FIJI?

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Sea turtles face multiple threats and challenges during their life stages. The lack of comprehensive data, particularly in the South Pacific, often hinders the ability to implement effective conservation measures to minimize these threats. This study examines hawksbill turtle nests to determine hatching success and identify the threats faced by the small nesting population of Fiji. Annual surveys were conducted from 2014 to 2017 during the peak nesting season, which extends from November to April and coincides with the cyclone season. A total of 110 nests were documented at 19 sites over three consecutive seasons. Of this, 21.8% of the nests failed to hatch, resulting in no hatchling emergence, and 63.6% successfully hatched. Logistical constraints prevented follow-up examinations for the remaining 14.6% of nests, leaving their fate unknown. The mean hatching success was 56.5 ± 44.4 % (range = 0% - 100%). The Kruskal Wallis analysis revealed that there was no significant difference in the hatching success between nesting seasons ($p = 0.372$). A number of threats affecting nest success were identified; including predation by sand crabs and dogs (15.5%), illegal harvest (10.9%), and coastal inundation (13.6%). At the time of the survey, the remaining 60% of the threat to nests could not be determined. Findings from this study can enable local stakeholders to direct conservation efforts toward mitigating at least some of these threats.

LONG-TERM TRENDS IN REPRODUCTIVE OUTPUT OF MARINE TURTLES ON THE ARCHIE CARR NATIONAL WILDLIFE REFUGE, FLORIDA, USA

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Temperature plays a major role in phenology, the seasonality of life history events, by disrupting natural reproductive patterns. The consequences of these disruptions on population dynamics are not well understood. It is crucial to assess the climate effects on phenological shifts in ectothermic organisms, given their substantial contribution to global biodiversity. Oviparous reptiles are particularly susceptible to these disruptions as many of their life history traits are vulnerable to climate change due to their high physiological sensitivity to temperature, absence of parental care, and temperature-sensitive embryonic development. Sea turtles are particularly at risk from global changes, as populations are facing multiple threats such as coastal development, marine pollution, over-exploitation, and entanglement, in addition to global warming. For this study, we focused on the Brevard County section of the Archie Carr National Wildlife Refuge (ACNWR), 21-km of the Atlantic coastline in Melbourne Beach, Florida, USA. This area is of great significance to sea turtle nesting, hosting one-eighth of all loggerhead sea turtle (*Caretta caretta*) nesting and one-third of all green sea turtle (*Chelonia mydas*) nesting in Florida. Assessing the reproductive

ecology of sea turtles nesting on this beach is important for providing demographic information to measure conservation success and population recovery efforts. The UCF Marine Turtle Research Group (UCF MTRG) has monitored the ACNWR for sea turtle nesting activities for over four decades, resulting in an extensive dataset that has yet to be analyzed for long-term changes in reproductive success and output. Our two primary objectives were: 1) to assess changes over time in hatchling emergence success in relation to temperature for each species, and 2) estimate yearly hatchling output for both species and test for changes over time. To determine if emergence success has shifted over time, nest data from 1988-2023 were analyzed with historical air temperature data to predict if changes in these air temperatures influenced emergence success. Using historical nest count and inventory data, the average number of eggs per year were calculated, and this value was used to estimate hatchling output per year. Fluctuations in emergence success occurred over time, which could be attributed to various factors like turtle species, storm activity, nest placement, and predation rates, in addition to temperature effects. We show a significant increase in the number of hatchlings produced per year for green sea turtles while hatchling output for loggerheads throughout the years remains consistent and shows no clear trend. To make sure this trend is not exclusively due to the increase in green nests and stable loggerhead nesting trends, multiple models were created to assess other variable impacts. Nest numbers alone did not predict emerged hatchling estimates. The interaction of both nest numbers and emergence success rates significantly predicted hatchling output ($p<0.05$). The survival of early-stage sea turtles is a powerful driver of sea turtle population numbers. Understanding how the threat of climate change impacts their early life stages is essential for the implementation of conservation strategies to protect sea turtle species on this important refuge.

HATCHING AND EMERGENCE SUCCESS OF LEATHERBACK SEA TURTLES (DERMOCHELYS CORIACEA) ON BIOKO ISLAND, EQUATORIAL GUINEA*

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Bioko Island, Equatorial Guinea, is a major nesting beach within the southeast Atlantic regional management unit, a region whose population is considered data deficient. Despite Bioko's importance, research pertaining to the island's leatherback nest ecology and reproductive success remains limited. Here, we report on nest parameters and describe the long-term hatching and emergence success rates of marked in situ leatherback nests that made it to full incubation, on Bioko Island. Data was collected over nine nesting seasons on two beaches, identified as Beach E (2008–2014) and Beach D (2016–2019). We calculated seasonal and total average hatching success (H), emergence success of all nests (E_A; $H \geq 0$), and emergence success of hatched nests (E_H; $H > 0$) for both beaches. The average H on Beach E was 0.21 ± 0.03 ($n = 126$), E_A was 0.15 ± 0.02 ($n = 126$), and E_H was 0.31 ± 0.04 ($n = 63$). On Beach D, the average H was 0.64 ± 0.07 ($n = 21$), E_A was 0.56 ± 0.08 ($n = 21$), and E_H was 0.69 ± 0.06 ($n = 17$). H and E_A varied by season on Beach E but E_H did not, none of these varied by season on Beach D. The major outliers on Beach E were the 2011-2012 and 2012-2013 seasons, which were significantly lower than the other seasons but not each other, indicating a likely shift in weather/ocean patterns. On average, nest temperature was lower on Beach E (27°C) than on Beach D (33°C), which could relate to the dynamics of the beach, or the multi-annual variation in weather patterns. We found that hatching success was higher in nests with more total shelled albumin gob (SAGs) mass (Beach E). The mass of SAGs in a nest increased as the total egg

mass increased; on average, SAG mass made up between 6.2% (Beach E) and 9.9% (Beach D) of total clutch mass. Further, emergence success (E_A) was also higher in nests with heavier eggs (both average and total mass). Finally, for all nests, larger females (curved carapace length) laid heavier eggs, and therefore had generally higher hatchling and emergence success. Larger turtles did not, however, lay more eggs. These findings provide insight into the reproductive success of leatherback nests on one of the most productive nesting beaches. The spatial and temporal variations, and relatively low hatching success on Beach E reported here, may provide information to stakeholders who aim to implement management strategies to boost the reproductive success of leatherbacks nesting on Bioko Island.

MONITORIZATION AND CHARACTERIZATION BY PHOTO-TRAPPING OF THE ACTIVATION TIME OF CARETTA CARETTA HATCHLINGS IN A HATCHERY IN BOA VISTA, CAPE VERDE*

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Before the emergence of sea turtle hatchlings is completed, there is a period of inactivity on the surface, defined in this work as activation time. In order to characterize and understand the factors involved in this activation time, 85 *Caretta caretta* nests were monitored by photo-trapping and 25 thermometers were placed in the sand of a hatchery on Ervatão beach (Boa Vista Island, Cape Verde). The camera traps were useful in the study of the activation time, defined as the time from when a first movement or hatchling was detected from the surface until at least one hatchling fully emerged from the nest. The activation time proved to be highly variable and had a mean of 39 minutes and 24 seconds. Of the variables analyzed, hatching and emergence successes, the number of hatchlings, and incubation time were the only variables with a statistically significant effect on the activation time. Nests with larger groups of hatchlings and higher hatching and emergence successes had longer activation times. This may be due to a higher volume of hatchlings in the nest chamber, which enables their detection from the surface to be earlier. These longer activation times may also be due to higher rates of O^2 consumption and CO^2 production and/or early excavation due to group effect, whereby turtles would arrive more tired at the surface requiring longer resting times. In addition, temperature fluctuations within the nests could also be also responsible for the longer activation times. However, hatchlings from nests with longer incubation times had shorter activation times, probably due to increased body and locomotor development. The activation time is an understudied stage of the emergence process, but of great conservation interest because of its high vulnerability to predation.

NESTING TRENDS OF LEATHERBACK, GREEN, AND OLIVE RIDLEY SEA TURTLES AT PARQUE NACIONAL MARINO LAS BAULAS, COSTA RICA

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Parque Nacional Marino Las Baulas (PNMB) in Costa Rica was established in 1991 and is well known as a nesting beach for leatherback turtles (*Dermochelys coriacea*) in the eastern Pacific Ocean, where green turtles (*Chelonia mydas*), and olive ridley (*Lepidochelys olivacea*) also nest. Here, we report the nesting trends of the three sea turtle species nesting at Playa Grande and Ventanas, PNMB from 2012 to 2023. These beaches were considered the fourth largest leatherback nesting area in the world, with 1,367 leatherback turtles estimated to have nested in the 1988-1989 season. Today the Eastern Pacific leatherback sea turtle population is critically endangered due to declines over the last 35 years. In the 2012-2013 season, 29 nesting leatherbacks were observed, but in the 2022-2023 season only three nesting leatherbacks were observed. This 90% decrease in 10 years is likely caused by high adult mortality rates from interactions with fishing gear, rather than terrestrial threats due to implementation of nest protection. The olive ridley sea turtle is listed as vulnerable, and their nesting numbers decreased by 48% over study time period from 85 nesting olive ridleys in the 2012-2013 season to 44 nesting olive ridleys in the 2022-2023 season. This decrease in nesting females might be caused by olive ridley turtles' low fidelity to nesting beaches as indicated by inter-annual fluctuation, however ridley turtles are also at risk for mortality associated with fishing activity. The green turtle is listed as an endangered species, with populations in the eastern Pacific struggling relative to other populations. Green turtle nesting numbers increased by 36%, from 14 nesting turtles in the 2012-2013 season to 19 nesting turtles during the 2022-2023 season. Trends indicate that PNMB is no longer among the most important leatherback colonies, but continues to be an important nesting site for the three sea turtle species. As such, the continued protection of these beaches is crucial. We will continue to monitor the changes in population dynamics of the three species.

HOW SAND GRAIN SIZE DICTATES SEA TURTLE HATCHLINGS’ DESTINY IN THE NEST ESCAPING?

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Sea turtles are oviparous reptiles that deposit eggs in underground nests and provide no post-ovulatory parental care to their offspring. Upon hatched, hatchlings use the egg’s finite energy reserve to sustain embryonic development and the first few days of their post-hatch live, which includes nest escape, beach crossing, and swimming offshore. This study investigated whether the grain size of nest substrate can affect hatchling energy usage during nest escape. About-to-hatch eggs (incubated *in-situ* for 42 to 51 days) were collected from a natural nesting beach and further incubated in two separate laboratory chambers filled with either coarse-grain sand or fine-grain sand at 28°C. Open-flow respirometry was used to measure hatchlings’ oxygen consumption rate during the nest escape process, which was then converted to energy

consumption. We found that hatchlings digging through the coarse sand took significantly shorter time (168 ± 13.9 h) to emerge from their nest chambers than those digging through the fine sand (233.21 ± 12.6 h) and consumed significantly less energy. Identifying the effects of nest substrate on hatchling energy consumption during nest escape can provide improvements in hatchery management practices by choosing to relocate "doomed" clutches into protected hatcheries located in coarse sand, which should maximise the energy reserves of hatchlings when they emerge from their nests. Additionally, we are investigating the influence of environmental noise on hatchling activities. Preliminary observations suggest that natural and anthropogenic noise may significantly impact hatchling orientation and energy use. This aspect of the study highlights the need for a broader environmental consideration in hatchery management.

ENSO DYNAMICS AND THE RESILIENCE OF CHELONIA MYDAS AT CHAGAR HUTANG TURTLE SANCTUARY, MALAYSIA*

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Peninsular Malaysia is bordered by the South China Sea and climatically influenced by the El Niño Southern Oscillation (ENSO) which is often drier than usual during El Niño and wetter than usual during La Niña. Malaysia has been very much affected by climate change leading to a worsen ENSO events. Notably, ENSO's impact extends beyond climate, potentially influencing the recovery of the green turtle (*Chelonia mydas*) populations through variations in hatching success rates which is very sensitive with the changes of temperature. This research examines the correlation between ENSO phases and hatching success at Chagar Hutang Turtle Sanctuary (CHTS), a critical nesting ground for green turtles, which could indicate broader implications for population recovery trends. Leveraging two decades of data (2003-2022) from the Sea Turtle Research Unit (SEATRU) at Universiti Malaysia Terengganu, we employed statistical analyses to explore this relationship. Nest monitoring and beach patrol records from the CHTS provide a robust dataset for analysis via SPSS software. We specifically focus on the average nesting site air temperatures and corresponding hatching success rates, utilizing multiple regression analysis to understand (i) temporal temperature trends in Terengganu state, (ii) annual mean green turtle hatch rates per clutch, and (iii) the interplay between these temperature trends and hatch rates. Preliminary results suggest a negative correlation between warmer temperatures and hatching success, with an anticipated decrease in hatchlings emergence under these conditions. The findings could signal a significant ENSO-mediated environmental influence on the reproductive viability of *Chelonia mydas*, shedding light on adaptive strategies crucial for the conservation of this species.

THE MAKING OF MALES IN A FEMINIZING ENVIRONMENT: AN ASSESSMENT ON THE ARABIAN PENINSULA*

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The Arabian Peninsula is characterised by high levels of solar radiation and low levels of rainfall, with many species inhabiting the region at the edge of their thermal tolerance. None more so than species that display temperature-dependent sex determination such as sea turtles where population demographics are sensitive to environmental temperature. Previous studies in the region show sand temperature profiles at many nesting sites above the supposed pivotal temperature and in some cases above the thermal maximum. This suggests that populations persisting in the region are either highly feminized, suffer high mortality or, alternatively, adapted to elevated incubation temperatures. During the 2023 green turtle nesting season 20 nests were equipped with HOBO temperature and movement G-loggers to monitor profiles during incubation. After 63 days, loggers were retrieved and the nests were excavated to determine hatching success. Movement loggers allow us to define incubation duration and establish the thermal reaction norm of embryo growth. Based on this model, the embryonic stages for any nest with a time series of temperature can be predicted and the thermosensitive period of development for sex determination can be inferred. The predicted sex ratio is then determined using a constant temperature equivalent (CTE) model taking into the growth rate of the embryo, the time at each temperature, the force of the effect of temperature during the thermosensitive period and the thermal reaction norm of sexualization for each temperature. Unsurprisingly, high incubation temperatures between 30-35°C were recorded for nests monitored. For embryo growth our models predicted a decline in growth rate at temperatures greater than 30°C, suggesting a negative effect on green turtle embryos at high temperatures, likely producing hatchlings which are smaller and less fit. Furthermore, the pivotal temperature was estimated at 30.06°C suggesting a highly feminized sex ratio, yet, the primary sex ratio was projected at 86% female, starkly less than other estimates for other green turtle populations. We attribute this to a wide range in transitional temperature (4.67°C), where both males and females are produced within a single clutch. Here, we observe a differential response in embryo growth and sexualisation to temperature as temperatures higher than 30°C have a lower influence on CTE because of the lowered growth rate. It seems that turtles in this region are well-adapted to elevated temperatures in some aspects of their biology (sex ratio) but not others (embryo development rate declines for temperatures above 30°C). Monitoring sea turtle populations persisting at higher incubation temperatures in extreme environments like the Arabian Peninsula can be used as a proxy to estimate how other populations worldwide may respond to global warming and shed light on the plasticity of these organisms under thermal stress.

COLLABORATIVE CONSERVATION INITIATIVES: PRELIMINARY ASSESSMENT OFTHE GREEN TURTLE (CHELONIA MYDAS) NESTING ECOLOGY IN CHAKAR HUTAN, TERENGGANU, MALAYSIA

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Four species of sea turtles are known to nest in Terengganu, located on the east coast of Peninsular Malaysia, with the green turtle being the only species showing a recovery nesting trend. Majority of the high-density nesting beaches are protected as turtle sanctuaries or reserves. One of the beaches is Chakar Hutan in the south of Terengganu. Two Terengganu State Department of Fisheries (DoF) rangers patrol this 1.4 kilometer stretch of turtle reserve between April and September, relocating nests to a nearby hatchery in Ma'Daerah for incubation. Apart from the number of nests and number of turtle individuals tagged, little was known about the nesting ecology of the green turtle population on this beach. Since July 2022, Lang Tengah Turtle Watch (LTTW) and DoF formed a collaborative partnership, in which LTTW sets up and manages a hatchery at Chakar Hutan. The nests are relocated to the hatchery on the same beach to reduce the relocation distance, travel time and egg movement. The nests were not left *in-situ* to prevent poaching, predation, inundation during high tide, and beach erosion. The primary objectives of this project were to (1) increase monitoring efforts, (2) understand the nesting ecology, and (3) implement conservation strategies. In 2023, monitoring effort was undertaken by LTTW staff, interns alongside the DoF rangers throughout the nesting season from March to early November. Nightly patrols were conducted to identify nesting and non-nesting emergences. Encountered individual nesting females were identified using the photo identification and/or tagging method. Retrieved clutches were incubated *ex-situ* and monitored throughout the incubation period, except for nests that were missed during night patrols. The nest content was excavated at least 3 days after mass emergence of hatchlings to determine the hatching and emergence success rates. The nest temperatures were monitored throughout the incubation period. These monitoring efforts in 2023 documented a total of 1,193 turtle landings, resulting in 504 nests and the protection of 46,598 eggs, with an average clutch size of 93 eggs (SD=20.55). A total of 40,206 hatchlings were released, with an average incubation period of 61 days (SD=3.45). Overall, the hatching and emergence success rates were 87.59% (SD=14.62) and 83.53% (SD=15.64), respectively. Nest predation incidents, which accounted for 9.89% of nests, involved fungal infections, ants, and maggots. Of the 27 nests monitored, the average nest temperature during TSP was 28.86°C (SD=0.97), estimated to produce an average of 63% male hatchlings. Throughout this nesting season, 129 nesting individuals were identified. On average, each female laid 2 – 7 nests, with a nesting interval between 9 and 11 days. Notably, two females nested up to seven times. This is the preliminary data for 2023 green turtle nesting monitoring in Chakar Hutan, the first year following the establishment of this project. The findings provide crucial insights into the nesting ecology of green turtles at Chakar Hutan beach, emphasizing the positive impact of collaborative initiatives on the conservation of this endangered species.

IRRESPONSIBLE TOURISM IS A THREAT TO THE HABITAT OF THE GREEN SEA TURTLE ON THE NORTHERN COASTS OF THE SEA OF OMAN SEA

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With an average of 50 nests per year and a hatching rate between 35 and 40%, the northern coasts of the Sea of Oman host Iran's endangered green turtle species (*Chelonia mydas*). So far, about 30 beaches have been identified as green turtle nesting habitats on these beaches. 15 years of conservation efforts have protected the species' alleged habitats. During the COVID-19 pandemic, we saw a decrease in habitat destruction and more presence of turtles on these coasts. But with the end of the COVID-19 epidemic, the large number of tourists on different coasts, especially during the egg-laying season, increased several times, which greatly affected the desirability of the green turtle egg-laying habitat on the northern coasts of the Sea of Oman. Here we provide information to define the crisis that has occurred and discuss the best possible solution to deal with it. The information on green turtles nesting on these coasts presented here comes from long-term annual monitoring surveys by the authors (2010-2022). During the 2022 nesting season, we patrolled the beaches daily from June to November. Turtle egg-laying information was collected on different beaches. Also, protective measures were taken to prevent nests from falling. In some cases, it was necessary to build a hatchery site to do this. Nests were monitored while the hatchlings were emerging to calculate the hatching percentage. The nesting season on the northern coasts of the Sea of Oman is from June to November. During the 2022 nesting season, 10 egg-laying green turtles were counted on the coasts. The average CCL = 106.12 ± 4 cm was counted. The average weight of green turtle eggs on the coasts was 40.5±5.2 gr and the average diameter was 34.6-±3.1 mm. The results show that the average incubation period of eggs in different beaches is 63-55 days, the lowest of which was 51 days and the highest was 70 days. One turtle has been found for every 2160 meters. The coasts of Poshat, Kacho, Lipar, Ramin, Pozm, Tang, Abkohi, Kohe Mobarak were monitored. The average number of hatchlings of the green species for these coasts was 600 in this season. coasts such as Lipar, which show the highest number of visitors, do not have nesting and egg-laying due to the large presence of tourists after the COVID-19 epidemic. Installation of signboards and production of educational content such as production of motion graphics and brochures have been done. However, without implementing a strong project that requires the participation of all stakeholders and funding in the first place. Industrial development on the northern coasts of the Sea of Oman (Makoran coast) is on the agenda of the government of the Islamic Republic of Iran, and if the necessary measures are not implemented, industrial development and irresponsible tourism will cause the extinction of this species on the northern coasts of the Sea of Oman. Introducing marine coastal protected areas and intensive and strong management programs are recommended on coasts like Lipar where nesting has stopped.

HAWKSBILL (ERETMOCHELYS IMBRICATA) HATCH SUCCESS AND PREDICTED SEX RATIOS AT SANDY POINT NATIONAL WILDLIFE REFUGE*

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Nesting sites within the Caribbean region are home to approximately half of the global hawksbill turtle (*Eretmochelys imbricata*) nesting population. Given the Critically Endangered status of hawksbill turtles by the IUCN and the changing climate, it is crucial to assess hatchling production and investigate the effects of sand temperature and water content on index nesting beaches. Recent research has identified Sandy Point National Wildlife Refuge (SPNWR) in St. Croix, US Virgin Islands, as a nesting beach with a high density of hawksbill nesting activity, with nest numbers increasing 4.5% yearly since 2003. Our study analyzed hawksbill hatch success from 2021 to 2023, nest incubation temperatures from 2021 to 2023, and nest water content for the 2023 peak season. We used nest incubation temperatures to predict hatchling sex ratios and investigate the relationship between sand temperature and hatch success. Elevated sand temperatures during development have multiple consequences for hatchling production and survival. Nest incubation temperatures of 35°C or higher have lower hatch success rates. In this study, nest incubation temperatures from the peak season in 2021 to 2023 indicate that SPNWR is a mainly female hatchling-producing beach. However, hawksbill nests incubating outside the peak season are exposed to sand temperatures 2°C lower than the pivotal temperature for hawksbills. Also, the average hatch success of clutches laid outside peak season months was 10% higher than within peak season, suggesting seasonal differences in the survival of eggs and the sex ratios of hatchlings. Several clutches laid in the 2021 and 2023 peak seasons experienced incubation temperatures above 35°C. Measurement of nest water content of nests showed that nests were exposed to a wide range of sand water contents, ranging from 0.037 to 0.67 m^3/m^3. Clutches laid on the southern shore of Sandy Point had higher sand water content and lower incubation temperatures compared to the western and northern shores. Additionally, linear modeling identified a negative relationship between hatch success, the average daily moisture range, and the average daily maximum temperature in nests. These findings suggest that as climate change progresses, provided nesting seasons do not shift, hawksbill hatchling production in the Caribbean may decrease and should continue to be monitored.

PREDATION OF SEA TURTLE EGGS*

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Offspring survival is a vital demographic factor that drives population success. To put it simply, there is a trade-off between parental investment in individual offspring and their survival. In the case of sea turtles, where there is no parental care, egg predation by invasive and native species can have severe impacts, and negatively affect species recovery. On the island of Diego Garcia, Chagos Archipelago (Indian Ocean), we assessed the levels of egg predation within green turtle (*Chelonia mydas*) clutches between 2021-2022. We found that native coconut crabs (*Birgus latro*) and ghost crabs (*Ocypode spp*.) as well as introduced black rats (*Rattus rattus*) predated on eggs, entering nests by digging tunnels in the sand. Whole eggs were often removed from clutches, made apparent through observations and differences between initial clutch and final excavation counts. Clutch size at oviposition (mean = 127.8 eggs, range = 74-176, n = 23) was significantly larger than at excavation (mean = 110.9 hatched and unhatched eggs, range = 9-147, n = 16), i.e., a 13.2% decrease. Where both measurements at oviposition and excavation were available for the same clutch there was a similar decrease of 13.9%. On other occasions, egg predation was recorded where egg contents were eaten within the nest. Ultimately, hatching success was 64.9%, while 3.1% of eggs were predated in the nest, 18.1% did not survive incubation and 13.9% of eggs were removed from the nest. To place our results in the context of sea turtle egg predation around the world, we reviewed evidence from 34 sites and identified 36 predators that were either native (e.g., crabs and goannas, n = 30) or invasive (e.g., rats and pigs, n = 8). A predator could also be identified and reported as both native and invasive (e.g., dogs) depending on site. Globally, the most important predators were medium sized mammals (e.g., pigs, red foxes), crabs (e.g., *Ocypode spp.*) and goannas (*Varanus spp.*). To the best of our knowledge, we report the first cases of coconut crab and rat predation on sea turtle eggs. In conclusion, we highlight the need to consider whether predation intervention is necessary and whether nest protection and/or invasive predator eradication may be used to increase egg survival and in turn population recovery.

HOW IMPORTANT IS SEA TURTLE NEST SITE SELECTION IN THE CONTEXT OF CLIMATE CHANGE?

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The ability of animals to mitigate climate change impacts could be key to their future survival, such as altering breeding and migration timings. Climate change and sea level rise pose a serious risk to sea turtles by influencing nest temperatures that can increase sex ratio skews and embryo death. In theory, we could assume that sea turtles may be able to mitigate threats from climate change by shifting to cooler nest sites along the beach. For this study, we evaluated 48 green turtle (*Chelonia mydas*) laid nest location on Diego Garcia, Chagos Archipelago, in the Indian Ocean. Nest locations were generally (90%) at the back of the beach in vegetation, where the risk of over-wash and inundation was lowest and the 10% of nests on the

open beach were still close (within 1.5m) to the vegetation. All nests were above the mean high-water line (range = 0.14-2.44 m; mode = 1.35 m). When crawl distance increased, nests tended to be further into the vegetation, although, some crawls were long and circuitous (up to 76 m) when vegetation was impenetrable. Further, we compared our results to nest positions recorded from all seven sea turtle species around the world. We reviewed 53 sites (including this study) from 51 studies and found that turtles generally crawl far enough inland to reduce the risk of nest over-wash, ultimately reducing embryo mortality. We suggest that increasing embryo survival is the main consideration over hatchling sex ratios when it comes to nest site selection and so sea turtles are unlikely to switch to cooler beach locations to mitigate the impacts of climate warming.

IDENTIFICATION OF SEA TURTLE SPECIES USING MALDI-TOF/MS

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Sea turtles are reptiles belonging to the order Testudines and are among the most threatened groups of marine vertebrates. Sea turtles significantly contributions to the maintenance of both aquatic and terrestrial ecosystems by performing vital functions, such as facilitating nutrient cycling within and between ecosystems, and aiding the restoration of degraded environments. Populations of sea turtles continue to decline due to declines in prey, habitat loss, direct take of eggs and individuals for human consumption, traditional medicine, international pet trade, and illegal wildlife trafficking. Female sea turtles lay eggs that are in early embryo development. After incubation, young hatch from the eggs to the external environment. The eggshell serves a physicochemical function to protect the developing embryo from physical damage, defending against microbial invasion, facilitating gas exchange, and acting as a source of calcium for the embryo. Although the eggshell membrane provides a generalized foundation for calcification, differences in eggshell structure among sea turtle species may be based on compositional differences in membrane peptidome. Research on eggshell proteome and peptidome has focused mainly on avian eggshells, due to the poultry's commercial priority and the availability of large numbers of samples. Since the methods used to identify animal species are mainly based on DNA analysis, DNA barcoding methods play a crucial role in species identification because of the advantages of specificity and sensitivity. However, this method is not always expedient for routine species identification due to the high costs and many steps involved in the working procedure. Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF/MS) is a potential tool for species identification based on protein composition by generating peptide barcode signatures (spectra) from protein extracts of organisms. MALDI-TOF/MS is a reliable, efficient, and high-throughput technique useful for species identification in other taxa. Since studies using peptidome analyses of chelonians are extremely limited, we aimed to validate species differentiation and identification, and to present a spectra of peptide barcodes for sea turtle eggshell membranes. A total of 105 post-hatching samples were obtained during the nesting season, consisting of 75 hawksbills (*Eretmochelys imbricata*), 15 green (*Chelonia mydas*), and 15 leatherback (*Dermochelys coriacea*) eggshells. MS spectra and peptide patterns were analyzed by using the Metaboanalyst software, respectively. Results differed in sea turtle eggshell membrane and peptide spectra demonstrating unique MS spectral peaks for hawksbill, green, and leatherback turtles. The use of the MALDI-TOF/MS approach demonstrated effectiveness as a tool for developing nongenetic identification methods by using turtle eggshell membranes. This method can provide rapid, sensitive results for minimal costs, while increasing the ease of sample collection by utilizing eggshell membranes. However, the limitation of this study is that the current spectral database requires improvement in terms of both species coverage and intra-specific variation, thus enhancing analysis performance. Future studies may be focused on identifying peptide biomarkers from selected peaks for target species, and detecting the functionalities of identified peptides.

LEATHERBACK HAVEN IN THE INDIAN OCEAN

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The Northeast Indian Ocean leatherback subpopulation mainly consists of nesting populations in India, Sri Lanka, and to a lesser extent, Thailand and Indonesia. In India, leatherback turtles only nest in the Andaman and Nicobar Islands; this population has been studied over the past four decades through surveys, tagging and nest monitoring programmes at various index beaches. Here, we present findings from two studies, one conducted on Great Nicobar Island with annual monitoring before and periodic surveys after the 2004 Indian Ocean tsunami, and the second a long-term monitoring programme on Little Andaman Island (2008-2023). Despite previous concerns regarding the viability of this subpopulation, recent surveys of the Nicobar Islands indicate that the beaches have reformed after 2004, leading to an increase in leatherback nesting with numbers comparable to the pre-tsunami period. Our long-term data from Little Andaman Island indicate a stable nesting population with some inter-annual fluctuations, ranging from ~80-173 nests per year. The average nesting female size observed in the region was CCL 156 cm (±SD 8.3; n=450) with an average clutch size of 85 eggs (±SD 23.0; n=592). Satellite telemetry studies conducted between 2011-2014 on leatherbacks nesting in Little Andaman Island indicate that all the turtles started their post-nesting migrations by heading south of the Andaman and Nicobar Islands and dispersed in varied paths in the southeast and southwest Indian Ocean. Five turtles travelled southeast, some along the coastal waters of Indonesia, towards Timor-Leste and north-western Australia and four turtles travelled southwest with some reaching the eastern coast of Africa. With over 1000 nests a season, the nesting beaches of the Andaman and Nicobar Islands host important nesting grounds for a significant population in the northeast Indian Ocean thus highlighting the critical need for conservation of these habitats.

SEX RATIO ESTIMATION OF GREEN TURTLES AT CHAGAR HUTANG, AN IMPORTANT SANCTUARY SITE IN PENINSULA MALAYSIA*

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Increasing mean global temperatures due to climate change may potentially threaten organisms with temperature-dependent sex determination (TSD), such as sea turtles, resulting in skewed sex ratios and subsequent population declines. This study expands upon prior work, such as Tolen et al. (2021), which found that the relocation of Green Turtle (*Chelonia mydas*) egg clutches from their natural nest site into artificially constructed nests significantly alter incubation temperatures and sex ratios, raising the incubation temperature by 1.8°C and increasing the proportion of female hatchlings by 45% at Chagar Hutang and Perhentian Islands, Malaysia. Continuing this line of research, our current study focuses on the sex ratio estimation of Green Turtle hatchlings in 2023 at Chagar Hutang, one of Peninsula Malaysia's most important nesting sites, located on Redang Island. We employed a dual approach: (i) a direct method involving gonad histology on 74 deceased hatchlings to examine their sex, and (ii) an indirect method using 22 unit temperature data loggers in 11 incubating nests to monitor nest incubation temperatures during the thermosensitive period (TSP). Satellite-derived weather and sea surface temperature (SST) data for the entire year were also obtained from the Malaysian Meteorology Department to estimate the 2023 sex ratio. Preliminary results indicate a continuation of the trend toward a highly female-biased sex ratio for the Chagar Hutang green turtle hatchlings, which aligns with earlier findings. These results underscore the need for immediate conservation measures to mitigate the potential long-term implications of climate change and management practices on the sex ratio and viability of sea turtle populations.

ROLE OF SEA TURTLE EGGS AS A MARINE ORIGINATED ORGANIC MATTER IN THE DIET OF TERRESTRIAL INVERTEBRATE GHOST CRABS

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Sandy beaches have low primary productivity because large plants are unlikely to grow naturally. Therefore, marine originated organic matter, such as seaweed and fish carcasses, supports the basis of the beach food web. Sea turtle nesting plays a role in the movement of organic matter from the ocean to the sandy beaches. Sea turtle eggs are known to be predated by a wide variety of taxonomic groups that use the beaches. Although they are a pulsed resource supplied over a limited period, sea turtle eggs are likely to support the food web of the sandy beach. However, few studies have been conducted on the effects of sea turtle eggs on beach food webs in comparison with seaweed and other drift materials. This study aimed to verify the role of sea turtle eggs in the food web of sandy beaches by estimating the contribution rate of sea turtle eggs to the food of ghost crabs (*Ocypode* spp.), which are predators of sea turtle eggs around the world. Sample collection site was Ishigaki Island, Ryukyu Archipelago, one of the main nesting sites for green sea turtles (*Chelonia mydas*) in Japan. Samples were collected in summer (July, October 2022 and July 2023) during the sea turtle nesting season and in winter (March and April 2023) when no sea turtle eggs are present on sandy beaches. Ghost crabs (*O. ceratophthalma* : n=24 in summer and n=14 in winter, and *O. sinensis* : n=38 in summer and n = 4 in winter) and prey candidates including sea turtle eggs were collected at three beaches in the Ibaruma area with different numbers of green turtle nests. Samples were analyzed for carbon and nitrogen stable isotope ratios. The contribution of each prey candidate to the diet of ghost crabs was estimated from the stable isotope ratios with a Bayesian statistical isotope mixing model. Differences in the contribution among beaches and between species of ghost crabs were investigated. Carbon isotope ratios were higher in *O. ceratophthalma* than in *O. sinensis*. In summer, ants and terrestrial plants contributed more to the diet of *O. sinensis*, while brown algae contributed more to the diet of *O. ceratophthalma*. The contribution of seaweed in the diet of *O. ceratophthalma* and the contribution of ants in the diet of *O. sinensis* tended to be lower on a beach with sea turtle nests than on a beach with no sea turtles nest. In addition, green turtle eggs contributed approximately 10% of diets of *O. ceratophthalma* in summer, whereas the contribution was replaced by ants in winter when there were no green turtle eggs. These findings suggest that *O. sinensis* utilize mainly terrestrial-derived food, while *O. ceratophthalma* utilize marine-derived food. Green turtle eggs are considered to be a significant food resource for *O. ceratophthalma* in summer, but their contribution to the diet of *O. sinensis* was almost negligible.

UTILISATION OF THE SPATIAL MONITORING AND REPORTING TOOL TO MONITOR NESTING SEA TURTLE ACTIVITY AND VOLUNTEER PATROL EFFORT AT CAMBODIA'S ONLY KNOWN NESTING SITE

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In March 2022 the first sea turtle nest in over ten years was discovered in Cambodia by the Fauna & Flora team during an expedition to the remote island group of Polou Wai. This ended a decade-long search for the last remaining sea turtle nesting sites in Cambodia by the Fauna & Flora team and counterparts from the Fisheries Administration. Following the discovery of this nest, a plan was formulated to concentrate conservation efforts at this site and other remote island locations. A relationship was established with the Royal Cambodian Navy Personnel based on the island. In close coordination with the navy base commander, a volunteer network was established on the island with eligible personnel selected to support sea turtle conservation efforts. These volunteers have now been trained in how to spot key signs of sea turtle nesting activity, how to confirm nests, nest relocation and tagging techniques. Importantly, they have received training from Fisheries Administration counterparts in how to utilise the Spatial Monitoring and Reporting Tool (SMART) to monitor their survey efforts and submit data on sea turtle nesting activity. Key metrics captured by the SMART tool include distance, hours and number of days patrolled. The Fauna & Flora team would like to share our experience using this tool to engage with sea turtle patrol volunteers, track their patrol effort and monitor nesting sites during the first two years of its implementation.

INCREASING LONG TERM TREND OF LOGGERHEAD SEA TURTLE (CARETTA CARETTA) NESTING ACTIVITY IN SPAIN*

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Sea turtles are responding to climate change by colonizing new nesting areas. The recent increase in loggerhead sea turtle (*Caretta caretta*) nesting activity in the western Mediterranean seem to reflect a process of colonization that may be mediated by global warming. Since 2001, sporadic nesting has been recorded on Spanish Mediterranean beaches. However, since 2014, nesting activities have been recorded every year. Out of the 150 nesting activities recorded until summer 2023, 70 were egg-laying activities, with an average of 5.38±7.65 nests per year (2001-2023). In 2023, a total of 29 confirmed nests and 17 other activities were recorded, which suggests the establishment of a nesting population on the Spanish Mediterranean beaches. The numbers in 2023 nearly tripled the previous maximum number of nesting activities per year recorded in Spain (11 in 2020). Additionally, nesting occurred in all Spain's Mediterranean regions, with more intensive activity observed in the northern half of the Spanish Mediterranean coast (Balearic Islands, Catalonia, and the Valencia Community). Although a few areas have multiple nests recorded, nesting is still scattered throughout the coastline, and no beaches with regular nesting have been identified yet. Records from 2023 confirmed that the nesting season lasts from early June to the end of August, but this year, the earliest and latest nesting date records were broken. The finding of a clutch hatched in October 2023 confirms previous observations that hatchling emergences can occur until this month. At least 8 of the 70 nests recorded since 2001 were discovered either after observing hatchlings emerging from the nest or crawling by the beaches attracted by promenade/urban lights (five), discovered when uncovered by waves after storm surges (two), or depredated (one); without knowing neither the time of nesting nor the nesting female. This suggests that several clutches laid on our beaches

go undetected every year, which means that nesting numbers could be even higher than reported. Despite increased monitoring efforts and awareness campaigns made by Spanish and regional administrations and institutions in all regions, regular monitoring is not in place along most of the Spanish coast due to scattered nesting activity. Tourist activity in Spain is massive in summer months. The Spanish Mediterranean receives millions of tourists from other parts of Spain and other European countries every summer, and the night-time activity on beaches results in a considerable source of acoustic and light pollution that hampers sea turtle nesting activity. Beach cleaning with machinery or urban development near beaches also pose further threats to nesting and hatching success. Therefore, beach monitoring efforts should be increased to protect nest, and if necessary, clutches should be relocated for successful incubation. Moreover, working with local authorities is crucial to ensure the coexistence of tourism, an economically significant activity in the area, with the increasing sea turtle nesting activity on Spanish Mediterranean coasts. Considering the increasing trend observed in Spain and in other countries of the western Mediterranean, this nesting activity should no longer be considered sporadic but indicative of new nesting populations.

A NOVEL APPROACH TO ASSESSING FERTILITY RATES OF LEATHERBACK SEA TURTLE (DERMOCHELYS CORIACEA) EGGS*

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Leatherback sea turtle (*Dermochelys coriacea*) nests have highly variable hatching success that trends lower than that of other sea turtle species. Many eggs fail and show no signs of embryonic development when necropsied. To understand this egg failure, it is fundamental to identify whether eggs with no signs of development are infertile or have very early-stage embryos that die before signs of development become apparent during necropsy. To investigate the rates of infertility versus early-stage death, 300 freshly oviposited leatherback eggs were collected from 10 nests and incubated *ex situ* in the lab. These eggs were closely monitored throughout incubation, and if egg chalking (a sign of development resuming after diapause) did not occur, eggs were necropsied. Perivitelline membranes of necropsied eggs (n=8) were collected and analyzed for the presence of sperm or embryonic cells using fluorescent microscopy protocols that have been used successfully in avian and other reptile fertility studies. These techniques previously were not confirmed to work in sea turtles. This study positively identified the presence of embryonic cells in the perivitelline membranes of 3 out of the 8 unchalked eggs, with the other 292 eggs either resulting in successful hatching or in dead embryos. This resulted in a fertility rate of 98%. Additionally, this study successfully utilized fluorescent microscopy in degraded eggs from *in situ* nests. Our results are the first to demonstrate high fertility in leatherback sea turtle nests of southeastern Florida and validate the use of fluorescent microscopy protocols to detect fertility in sea turtles.

THERMAL INCUBATION ENVIRONMENT OF GREEN TURTLES (CHELONIA MYDAS) AT TORTUGUERO BEACH, COSTA RICA*

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Understanding the effect of increasing temperatures on organisms at the population level, and their resilience to these changes, is of paramount importance to promote their conservation in a warming planet. Climate change poses a particular threat to oviparous vertebrates that exhibit temperature-dependant sex determination (TSD) through suboptimal sex allocation, making the relationship between sex ratio and incubation temperature an important life history parameter for conservation. For sea turtles, warmer temperatures reduce the proportion of males being produced, which may reduce population viability if extreme feminisation occurs. At Tortuguero beach, Costa Rica the largest green turtle rookery in the Atlantic Ocean, the sex ratio has remained unstudied since the 1980s. Here we characterised the thermal incubation environment at this site using an embryo growth model and *in-situ* empirical data (2017-2021) to define the pivotal temperature (PT) (ratio 1:1) and transitional temperature range (TRT) without the need for lethal sampling of hatchlings and thus estimate primary sex rations of hatchlings produced. A PT of 29.09°C and TRT of 26.85 – 31.34°C (4.49°C range) resulted in estimated primary hatchling sex ratio of 76% female (range = 71% -88% female between 2017-2021). Microhabitat had a significant influence on sex ratio ($\chi^2_{(4,\ 248)} = 35.50$, $P < 0.001$). The highest proportion of males were seen to be produced during the months of June, and within the shaded vegetation zone. These results will be useful for the future monitoring of climate change impact on sex ratios in green turtles within the Atlantic basin.

LONGER LOGGERHEAD TURTLE INCUBATION DURATIONS DESPITE A WARMING CLIMATE*

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Increasing atmospheric and nearshore sea surface temperatures pose a significant threat to many sea turtle populations through feminization of hatchling sex ratios, diminished hatchling fitness, and reduced hatchling production. The intrinsic ability (or lack thereof) of nesting females to counteract such climate change effects through changes in nesting phenology, latitudinal distribution, or microclimate selection has significant implications for conservation management. Temperate nesting beaches are of particular interest as these may provide significant male contributions to the operational sex ratios at in-water breeding sites and could serve as refugia for more tropical nesting populations to move into. Bald Head Island, North Carolina, USA is a regionally important temperate beach which lies toward the northern limit of the loggerhead sea turtle (*Caretta caretta*) nesting range in the western North Atlantic. Previous work demonstrated declining incubation durations coincident with increasing seasonal air temperatures and

decreasing precipitation from 1991 to 2015. Mean incubation durations of *in situ* undisturbed nests fell from 59.2 days to 52.5 days during this period, corresponding to an increase in estimated female sex ratios from 55% to 88%. However, despite a sustained increasing trend in air temperature, mean incubation durations from 2019 to 2023 have increased to 57.4 days – durations not seen since the mid-2000s – with an estimated female sex ratio of 69%. Preliminary analyses suggest recent increases in precipitation were partly responsible for this observed lengthening, meaning biological or behavioral factors are likely responsible for the remainder. Nests laid earlier in the season or on the eastern aspect of the island have longer incubation durations, but there was no observed trend in phenology or alongshore distribution through time to suggest shifts toward these conditions. Additional trends such as maternal identity, clutch size, and cross-shore nest placement are still under investigation to determine their respective contributions to the recent increase in male hatchling production. Understanding the extent and limits of this intrinsic capacity of sea turtles to adjust their reproductive efforts to changing climatic conditions will help us to determine if, when, and which management interventions may become necessary to preserve this threatened species throughout their range.

REPRODUCTIVE TRENDS OF LOGGERHEAD AND GREEN SEA TURTLE POPULATIONS OVER TIME: AN ANALYSIS OF A LONG-TERM NEST MONITORING DATASET FROM SANIBEL, FLORIDA, USA

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Analyses of long-term nest monitoring datasets can reveal trends that can be used to evaluate how marine turtle populations respond to increasing environmental and anthropogenic pressures. These trends can also provide metrics to assess the success of conservation efforts. The nesting beaches of Sanibel Island, Florida, USA, have been monitored since 1959 to protect the local loggerhead (*Caretta caretta)* nesting population, as well as a growing population of nesting green (*Chelonia mydas*) turtles in more recent years. In this analysis, nest-monitoring and night-tagging datasets from Sanibel were analyzed to identify trends in reproductive metrics. These included nest counts and dates of first and last nesting emergences from 1980 to 2023, as well as incubation duration and hatch success from 1998 to 2023. The differences in years represented are due to discrepancies in data collection during early years of nest-monitoring. Our results indicate that nest counts for both species significantly increased over time, which we attribute to early conservation efforts. Our results also showed that the date of first nesting emergence for loggerhead turtles and green turtles shifted significantly earlier in the season, while the date of last nesting emergence for both species did not significantly change. Additionally, there was a significant decrease in loggerhead incubation duration over time. However, there was no significant change in green incubation duration over time, though this is likely due to the comparatively small sample size of green turtle nests. There was also no significant change found in either species' hatch success over time. Finally, a standardized tagging dataset was used to compare the average size of encountered loggerhead nesting females from 1972 to 1976 to those from 2016 to 2023. The results suggest that the local population has exhibited a significant decrease in size over time, as has been observed in previous studies conducted on other nesting beaches. We explore how these trends may be a result of changes in population demographics and large-scale threats, such as the increasing severity of storms, rising temperatures, and predation. By bridging the gap between the past and present trends of demographics and reproductive activity, our investigation 1) provides insights into how these species have been impacted by environmental changes and human-induced impacts, 2) highlights the importance of the continuation of long-term studies, as well as the need for consistent and standardized methodology, and 3) demonstrates evidence of the effectiveness of conservation efforts, which can help promote the protection of endangered species for future generations.

CLOSING THE KNOWLEDGE GAP: CONTRIBUTING DATA FROM SUMATRA ABOUT THE NORTHEASTERN INDIAN OCEAN LEATHERBACK SEA TURTLE SUBPOPULATION

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There are seven subpopulations of leatherback turtles in the world, one of which is the northeastern Indian Ocean subpopulation. This subpopulation nests on the Andaman and Nicobar Islands, in India, Sri Lanka, Thailand and Sumatra (Indonesia), with the Andaman and Nicobar Islands being the centre of nesting activity in terms of nest numbers. Notably, the IUCN status for this subpopulation is currently listed as 'data deficient', but there is a significant threat of exploitation for meat and eggs, particularly in Indonesia. So far, nesting data from Indonesia for this subpopulation have only been published for Amandangan Beach, Bangkaru Island (Aceh). This informational void creates a pressing need for comprehensive research and monitoring. Since 2017, Yayasan Penyu Indonesia has conducted surveys on offshore islands of Sumatra and discovered eight previously unpublished nesting beaches for leatherback turtles. Together with the national conservation authority BPSPL Padang, we initiated a leatherback turtle conservation programme on Sipora, Mentawai District (West-Sumatra), in the same year. In addition, in partnership with the conservation NGO Ecosystem Impact, two more protection projects have been launched on the island of Salaut Besar, Simeulue District in 2021, and on Along beach, Simeulue Island (Aceh) in the beginning of 2023. At two of the monitored nesting sites, the nesting season runs from October to March, with peak nesting in December and January. As we've only just started monitoring Along beach, the season cannot yet be accurately determined, but preliminary observations suggest a similar range. On Sipora, during six monitored nesting seasons we calculated an average of 32 nests per season, but with a wide range from 0 to 65 nests per season. On Salaut Besar, two contiguous nesting seasons yielded an average of 18 nests per season; the first of the three seasons we covered was incomplete because we started monitoring in the middle of it. On Along beach, were we just started in the beginning of 2023, in this half season 52 nests were counted, which could be extrapolated very carefully to approx. 100 nests laid in that particular season. Taking all three nesting sites together, we estimate that between 100 and 200 leatherback clutches could be laid each year at these sites. Although the time frame is too short to estimate a population trend, the six seasons of observation on Sipora suggest a downward tendency. Compared to an average of around 1,000 nests found each year on the Andaman and Nicobar Islands, which are thought to make up the bulk of the northeast Indian Ocean leatherback subpopulation, and numerous unexplored Indonesian nesting sites, we believe the Indonesian part of this subpopulation is very important for the health of the population. However, exploitation of the leatherbacks for human consumption is still rampant at all unprotected nesting sites. We therefore recommend that similar protection and monitoring programmes be established for the Indonesian nesting beaches of Babah Ngom, Aceh Jaya District (Aceh), Lhok Dalam, Simeulue District (Aceh), Moale beach and Simuk Island, South Nias District (North-Sumatra) and Siberut Island, Mentawai District (West-Sumatra).

POPULATION BIOLOGY AND MONITORING

COMBINING UAV AND MULTI-SENSORS DATALOGGERS TO ESTIMATE SPATIO-TEMPORAL TRENDS IN FINE SCALE DENSITY*

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Determining the population density of sea turtles in their foraging habitats is crucial for developing effective conservation tactics as these regions serve both as growth environments for young turtles and convergence zones for adults from various nesting sites. However, the remote nature of these habitats and the unique characteristics of the oceanic environment make research challenging. Although the use of drones for aerial surveys in sea turtle studies has seen an uptick recently, there is a notable lack of focus on distant offshore areas. Furthermore, aerial density assessments are intricate, particularly for species like sea turtles that are not always visible at the ocean's surface, necessitating a correction factor to account for their surface time. While satellite tracking offers a general idea of surfacing patterns, bio-logging devices yield more accurate data on the turtles' diving behaviour. This research seeks to calculate the fine-scale density of loggerhead turtles in the Tunisian shelf, a key feeding zone within the Central Mediterranean Sea, and explore spatial and temporal variations in density, developing a method transferable to other regions. Drone surveys were performed by DJI Phantom Pro 4 flying at 74 m, covered two 1 km^2 zones offshore in 2017 - 2018 and one 1 km^2 area nearshore in 2020 - 2023 and provided surface density estimates as turtle counts. A correction factor for density estimates was derived from a prototype bio-logging device equipped with cameras and sensors, which was attached to 22 turtles for a maximum of 12 h. The device's recordings provided the turtle surface time percentage (TAS), which was then used to adjust the surface density estimates to estimate the actual density. Annual trends in surface density of nearshore area were investigated. Turtle surface density in the Tunisian shelf resulted among the highest globally for loggerheads foraging grounds. In nearshore area, counts showed a negative relationship with years close to significance (est = -0.468; p=0.052). By focusing on delimited areas, the study highlighted as the confluence of these two innovative technologies offers a fresh methodology for gauging the density of sea turtles at sea, with implications for enhancing the conservation efforts of these endangered marine creatures.

GENOME DRIVERS OF ADAPTATION IN THE MEDITERRANEAN LOGGERHEAD TURTLE (CARETTA CARETTA) NESTING POPULATIONS*

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We are facing the sixth mass extinction, and marine turtles are particularly vulnerable to global warming, especially in light of their temperature-dependent sex determination and sea-level rise. The loggerhead turtle (*Caretta caretta*) nesting sites in the Mediterranean Sea are predominantly concentrated in the eastern basin, where the temperature is expected to increase higher than the global average in the upcoming decades in this area. Consequently, evaluating the conservation status of the populations in the eastern Mediterranean, whether they are locally adapted and their structure, is crucial for the species' survival in this area. Genomics is a key tool allowing genome-wide knowledge of both population structure and local adaptation. The recent publication of the reference genome of the loggerhead turtle enables unprecedented fine-level resolution genomic studies in this species. Here, we provide a large-scale genomic analysis of loggerhead turtles inhabiting the Mediterranean. To do so, we sequenced 243 individuals from 11 nesting populations using 2b-RAD technology and genotyped them using the recently assembled reference genome. We assessed the population structure and local adaptation by combining genomic information with environmental (salinity and temperature), behavioural (hatchling dispersal patterns and adult foraging strategies) and reproductive (clutch sizes) population-specific published data. We found genetic differentiation among most Mediterranean rookeries clustered in three main groups: north-eastern (Greece), south-eastern (Libya) and east-eastern (Turkey, Syria, Lebanon, and Israel), which was supported by both DPAC and hierarchical discriminant analysis using all loci. To scan for local adaptation in the Mediterranean populations we used a combination of Outlier and Redundancy Analyses. We identified a highly differentiated set of 326 candidate loci for local adaptation and genomic signatures significantly associated with environmental, behavioural and reproductive population parameters. Of note, candidate loci were enriched in genes, as 56.43 % of the candidate SNPs were located either in exonic (3.46% of them) or intronic (96.54% of them) regions. Interestingly, more than 50% of the candidate genes were

specifically found in a single outlier or RDA analysis, suggesting that different gene networks are driving the adaptation to the different phenotypic and environmental variables tested. On the contrary, only three were shared among all analyses, indicating that testing multiple potential drivers is key for a comprehensive understanding of local adaptation. We functionally characterised the candidate loci for local adaptation using a Gene Ontology analysis and found that the candidate genes are involved in a myriad of basic biological cell functions, including immunity, cytokinesis or protein synthesis among others. Finally, we integrated genetic structure and connectivity in a conservation prioritisation analysis to identify high-priority areas for protection. We conclude that there is a need to protect most populations to maintain healthy levels of genetic diversity. Our study provides a baseline for future genomic studies and establishes conservation priorities of the main nesting sites of the loggerhead turtle in the Mediterranean while providing target genes for future research directed to the study of the genomic basis of adaptation.

INCREASE IN NESTING ACTIVITY OF SEA TURTLES AT THE REKAWA TURTLE ROOKERY, SRI LANKA DURING LAST 26 YEARS (1996-2022)*

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Rekawa rookery, located on the south coast, is the largest sea turtle rookery in Sri Lanka, visited by all five species that nest in Sri Lanka (Green turtle, Leatherbacks, Loggerheads, Hawksbills and Olive ridleys). The in-situ nest protection programme at Rekawa was initiated in September 1996, and nesting data was collected throughout the year along a 2km stretch of beach. Nine hundred seventy-three egg clutches were observed from September 1996 to August 1997, and only 375 egg clutches were observed from September 2009 to August 2010 (about 96% were green turtles), suggesting a >60% decline in the turtle population nesting at Rekawa. At least three decades before 1996, we suspect 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 population for at least 30 years before 1996. However, there were 1,730 egg clutches (Green - 1,690, Olive ridley - 40) recorded at the Rekawa beach in 2020, 1,538 egg clutches were recorded (Green - 1,511, Olive ridley – 26, Leatherback - 1) in 2021and 1,771 egg clutches in 2022 (Green - 1,698, Olive ridley – 72, Leatherback - 1). This is over 70% increase in egg clutches compared to 1996/1997 and over 400% increase compared to 2009/2010. So, it can be concluded that the Rekawa nesting turtle population remarkably increased compared to the population in the late nineties. If the turtle hatchlings released after 1996 represented a restart of turtle recruitment, we suspect they began returning to Rekawa as nesting adults.

SIZE MATTERS: NESTING FEMALE HAWKSBILLS TRENDING SMALLER OVER FIVE DECADES IN SEYCHELLES*

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Declines in the average body size of nesting sea turtles of various species have been documented around the world, with the cause attributed to a combination of ecological and demographic factors. Declines in ocean productivity may cause slower growth rates possibly resulting in smaller size at onset of sexual maturity. Conservation efforts may lead to larger nesting populations comprising higher proportions of smaller neophytes. More turtles might also increase competition for food. Our study examines long-term trends in body size of nesting hawksbills and the demographic factors that may be responsible for observed trends. Daily beach surveys incorporating near-saturation flipper tagging, curved carapace measurements (CCL), and egg counts have been conducted at Cousine Island since 1992. We calculated the proportion of neophyte versus remigrant turtles each year, the relationship between CCL and clutch size, adult growth rates, and temporal trends in both body size (CCL) and nesting activity. We included CCL data collected at adjacent Cousin Island prior to 1998 in our analyses. Mean annual CCL declined significantly at 0.05 cm^{-yr} between 1974 and 2022 when data from both Cousine and Cousin were considered. Considering Cousine data alone during 2002-2022, however, the downward trend in CCL of 0.02 cm^{-yr} in the general population was not statistically significant. When neophyte and remigrant turtles were considered separately, neophyte CCL declined significantly at 0.19 cm^{-yr}, while remigrant CCL increased significantly at 0.12 cm^{-yr}. Clutch size was positively correlated with CCL, and annual egg clutch numbers increased significantly during 1992-2002. The number of neophyte females in the population fluctuated over time, while that of remigrant turtles increased during the same period. The mean annual CCL growth rate of individual mature females breeding at Cousine was 0.18 cm^{-yr}. We conclude that at Cousine Island the declining trend in CCL over time was caused by a continuous decline in mean CCL of neophyte females over time, combined with increasing numbers of smaller neophytes. Declines in CCL of neophyte females are likely to produce smaller clutches in those individuals but this negative impact on reproductive output is appears to be offset by the benefits to the population that legal protection affords turtles at Cousine Island and the wider Seychelles. Strict conservation measures enable neophyte females not only to survive their first nesting season, but also to return to breed as remigrant females during multiple subsequent nesting seasons. As they age, the females get bigger and produce larger egg clutches. Over time, with reduced mortality, the numbers of remigrant females that nest each year tend to increase along with the contribution individual remigrant females make to reproductive output, even though neophyte body size is in decline.

GENETIC ANALYSIS OF HAWKSBILL SEA TURTLE (ERETMOCHELYS IMBRICATA) BY MTDNA SEQUENCES IN THE YUCATAN PENINSULA

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The biodiversity of sea turtles plays a significant role in Mexico, as it is home to 6 out of 7 existing species in the world. Hawksbill sea turtle (*Eretmochelys imbricata*) is endangered both in Mexico and globally. This study aims to increase the understanding of the genetic population for hawksbills obtained in females, hatchlings, and juveniles in the Mexican Caribbean and Pacific. The analysis of haplotypic and nucleotide diversity and genetic divergence in hawksbill populations in Mexico revealed 5 new Mexican haplotypes compared to those previously reported. The haplotype network confirmed the separation between Atlantic and Pacific populations. In the Atlantic, there was a higher overall diversity of haplotypes, with at least three groups of redundant haplotypes indicating better population conservation. In the Pacific and Mexican Caribbean, no redundant haplotypes were found, and an emerging haplotype diversity was observed, suggesting a potential population expansion. Genetic divergence in Pacific's nesting turtles showed moderate haplotypic diversity (h= 0.4891) and low nucleotide diversity (π = 0.00057), while in the Atlantic Caribbean, populations exhibited below-average haplotypic diversity (h= 0.2356) and low nucleotide diversity (π = 0.00038). This indicates a vulnerability of hawksbill turtle populations. High FST values between Mexican populations in the Atlantic and Pacific (FST = 0.69741) suggest limited genetic flow between populations, emphasizing the importance of conserving individual populations of the hawksbill turtle. A better knowledge of the diversity and distribution of sea turtles can lead, based on these results obtained, to the implementation of better conservation strategies, such as a study of protection of the migration and feeding areas of the Mexican Caribbean, as well as aspects interaction of this population with others from the Atlantic or the Caribbean itself.

THE MYSTERY OF BIMODAL NESTING SEASONS IN MARINE TURTLES

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The seasonality of egg-laying in marine turtles is a well-known phenomenon that has been exploited to determine population trends based on an integration of the number of female emergences or nests during a season. However, there are situations where several peaks in female emergence may have been detected during a season. We explore two such situations, one involving leatherback turtles laying eggs in French Guiana and another involving green turtles in the Indian Ocean. In both cases, we demonstrate the presence of bimodal nesting season with a new statistical model. Using this model, we show that estimates that do not take this bimodality into account can provide biased results both in terms of describing phenology and quantifying the number of nests. The origin of these different groups of females is discussed based on available information. This new model opens the door to a more rigorous analysis of egg-laying seasonality in sea turtles. Such rigor is essential in a context of climate change, where shifts in seasonality can have a major influence on these species, which have temperature-sensitive sex determination. Finally, the presence of bimodal nesting season is analyzed worldwide.

4-DECADES OF LOGGERHEAD NESTING TRENDS AND SURVEY ANALYSES AT MARINE CORPS BASE CAMP LEJEUNE

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Loggerhead sea turtles (*Caretta caretta*) have the broadest nesting range of any sea turtle species; however, very few long-term studies have been conducted at the geographic limits of the reproductive habitats. Climate change in coastal zones has impacted seasonality, storm frequency and intensity, high water events, and shifted the timing of weather conditions during the reproductive season. With these changes, it is unclear how nesting itself has changed throughout the range. Long-term loggerhead sea turtle nesting surveys at Marine Corps Base Camp Lejeune (MCBCLJN), located in southeastern North Carolina, USA, have been conducted continuously since the passing of the Endangered Species Act (ESA) in 1973. While military training operations occur on a portion of the beach, nests in active training locations are relocated; while other parts of the beach function effectively as a natural and undeveloped beach. MCBCLJN manages one of the longest running continuous surveys at the northernmost extent of the Northwest Atlantic loggerhead population. This study analyzed a 40-year dataset to determine change in nesting indicators and population trends over time while considering phenological shifts from longer summertime conditions due to climate change. To estimate population growth rate, the total nests observed each year were log-transformed and a linear regression was used over the time series. The loggerhead nesting season on MCBCLJN begins in May and typically ends in October, the number of nests over the past 40-years has ranged from a high of 92 nests to a low of only 7 nests in a single nesting season. To estimate the discrete rate of increase, λ, the slope of the linear regression was exponentiated. The loggerhead nesting population at MCBCLJN had a slight positive population growth rate from 1983 - 2023, with an estimated growth rate

of 1.0063 (95% confidence interval 1.00218 - 1.0282); this translates to a 0.63% increase annually. In addition, the number of unsuccessful nesting attempts (false crawls) have decreased. There was no statistical evidence to support that the nesting season has increased in total number of days or shifted earlier in the year for nesting loggerheads. There was also no statistical evidence that the mean clutch size has changed over time. The results of the study suggest that the nesting population at MCBCLJN is at least stable and is slowly increasing, despite impacts from nest relocations and military training activities. While MCBCLJN's nesting trend is estimated to be increasing about 0.6% a year. One possible explanation of an increasing population in North Carolina could be that nesting is very slowly becoming more successful and is slowly supporting the expanding nesting population on the northernmost extent of the loggerhead breeding range. The results from this study highlight the importance of monitoring loggerhead nesting throughout the nesting range, especially given concern about future impacts of climate change to this broadly distributed marine reptile.

LONG TERM MONITORING OF MALE SEA TURTLES IN SOUTHEAST FLORIDA, USA*

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Sea turtle research has focused primarily on adult females and hatchlings due to the relative ease of accessibility to these life stages on nesting beaches, whereas male sea turtles have been extensively understudied as they spend the majority of their lives in neritic and pelagic habitats. Although often expensive and logistically complex, in-water studies are critical to address the knowledge gaps accompanying the life stages of free-swimming sea turtles, particularly for adult males. Inwater Research Group (IRG) has several long-standing in-water research projects in Florida, USA, the largest of which has captured and collected data from more than 20,000 sea turtles. In addition to the routine collection of morphometric data, captured turtles were outfitted with Inconel #681 flipper tags and Biomark passive integrated transponder (PIT) tags (beginning in July 2001) before their release. These tags allow for the long-term monitoring of individual animals through recapture and tag return data. We analyzed data from 735 male turtles captured from four research sites in Florida, USA. Males from six species of sea turtles were documented, with the vast majority comprised of loggerhead (*Caretta caretta*; N=521) and green (*Chelonia mydas*; N=204) sea turtles. There were 86 recapture events at the original tagging sites from 35 individuals. The mean number of captures for individuals was four (range 2-53), with a mean time of 1,919 days (range 1-12,539) between first and last capture. There were ten tag returns from researchers at other study sites; mean time between initial capture and subsequent tag return data was 1,050 days (range 52-2,916). Seven turtles were captured bearing tags from researchers at other study sites. The mean time between initial tagging and subsequent captures by IRG biologists was 3,717 days (range 312-5,988). Strange tag and tag return data show male turtles captured in southeast FL and the Florida Keys are utilizing waters far from their initial capture locations, including the nearshore waters of both the East and West coasts of Florida, Georgia, Virginia, and North Carolina. In addition to historical tag return data, satellite tags were deployed on four adult male green turtles in St. Lucie County, Florida towards the latter half of the 2023 nesting season. All four turtles made quick and directed migrations to waters in the Florida Keys, and in concert with tag return data, demonstrate the connectivity between our research sites. As climate change threatens to skew sex ratios even further, it is important to utilize in-water research projects to fill gaps in our knowledge and understanding of migratory pathways, habitat utilization, and mortality threats

to male sea turtles over large temporal and geographic scales. These long-term study sites have provided continued access to male sea turtles and should be further utilized to collect additional data to help fill these identified knowledge gaps.

SURVIVING THE NORTHERNMOST WATERS: GENETIC INSIGHTS INTO GREEN TURTLES' ADAPTATION IN JAPAN

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Green turtles (*Chelonia mydas*) have a global distribution encompassing tropical and subtropical regions. Japan serves as the northernmost breeding site and foraging habitat for this species. Previous studies have delineated distinct foraging habitats in Japanese waters based on turtles' natal origins, revealing a crucial distribution boundary. Coastal seagrass beds south of Japan's Ryukyu Islands are vital for low-latitude populations, while the coastal waters surrounding Japan's main islands are predominantly used by turtles from the northernmost nesting sites. Since the coastal waters around Japan's main islands are temperate, the water temperature seasonally varies. Especially in winter, it substantially drops compared to the tropical and subtropical waters, probably making the adaptive traits of green turtles in these regions crucial. In addition, the types of food resources for green turtles also differ in these two waters due to the differences in environments. The ongoing rise in seawater temperatures along Japan's main islands, attributed to climate change, may pose a significant threat to the future distribution of green turtles and their food resources, which have achieved local environmental adaptation. This study analyzed whole-genome sequencing data from individuals from the northernmost nesting populations (Ogasawara, Japan) and the low-latitude nesting populations (Southeast Asia and the western Pacific islands) to understand the genetic signatures related to distribution boundary and local adaptation. Several genomic regions were differentiated between the Northernmost and low-latitude populations, and 88 genes were included in these regions. Some of those genes are known to have functions relating to the metabolisms of energy, glucose, galactose, and fatty acids, suggesting that the adaptation has been enabled through the evolution of metabolic functions. This study aims to uncover the genetic underpinnings of the local adaptations in northernmost green turtle populations acquired through evolutionary history, obtaining valuable insights into their tolerance to varying environmental conditions and contributing to future monitoring.

SMALL ONTOGENETIC CHANGES IN SEX RATIOS AT THE LARGEST LOGGERHEAD TURTLE ROOKERY IN THE NORTH PACIFIC*

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Sex ratios are one of the determinants of population size. If the operational sex ratio is extremely skewed to one sex, the population will not grow due to its small effective population size. In sea turtles whose sexes are determined by incubation temperatures, low temperatures produce males whereas high temperatures produce females. At rookeries exposed to high incubation temperatures, primary sex ratios are thus skewed to females. However, because high incubation temperatures also affect body size and activity levels of hatchlings negatively, female offspring are not considered to be able to survive better than

male offspring, leading to reversed (i.e., male biased) sex ratios in adults. Here, we examined (1) whether the operational sex ratio is balanced, and (2) whether sex ratios change with ontogeny, at Yakushima Island, Japan, the largest loggerhead turtle (*Caretta caretta*) rookery in the North Pacific, which is not exposed to high incubation temperatures. Incubation durations were recorded for 107 nests during five years (2014–2016, 2020, and 2021), and they were converted into mean sand temperatures during incubation. A regression equation between air temperature, rainfall, and sand temperature were constructed with a generalized linear model (R^2 = 0.940). Using this equation, mean sand temperatures experienced by clutches laid during six bins of the nesting season were estimated for 48 years (1975–2022). Primary sex ratios for the six bins were estimated from the mean sand temperatures, assuming a pivotal temperature of 29.7℃. By multiplying a primary sex ratio and nest frequency for each bin and summing them, an annual primary sex ratio was calculated. In 2020 and 2021, tissues for genetic analysis were collected from 28 females and their 548 offspring. Five microsatellite loci were analyzed, and the number of sires were calculated using two programs (GERUD and COLONY). The mean (±SD) primary sex ratio (%female) for 48 years was 27.8 ± 14.0. The operational sex ratio was 40.9 in GERUD and 25.2 in COLONY, with the mean being 33.1. The lack of an extreme bias in the operational sex ratio means that the effective population size of loggerhead turtles that breed at Yakushima Island is large. A small difference between primary and operational sex ratios suggests that the survival rate of female offspring produced at Yakushima Island is similar to that of male offspring. These suggest that the population size of sea turtles may be primarily determined by the incubation environment that affects hatchling characteristics.

IDENTIFYING GEOGRAPHIC LOCATIONS WHERE SEA TURTLE SPECIES ARE LIKELY TO INTER-BREED AND HYBRIDIZE

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Multiple sea turtle species are known to hybridize which occurs in particularly high frequency in Brazil. However, the ecological factors that promote sea turtle hybridization remain understudied, as is the possible prevalence of hybridization outside of Brazil. Current hypotheses suggest a combination of factors may lead to sea turtle hybridization including timing of reproduction, promiscuity, and population status. In this study, we aim to identify geographic locations where sea turtle species are likeliest to interbreed via a global literature review and data synthesis, using the ecological conditions in Brazil as a baseline for comparison. We specifically performed a systematic literature review of sea turtle nesting data—all 6 Cheloniidae species—to characterize the spatiotemporal overlap in sea turtle nesting seasons between species and evaluate ecological factors that may be linked to hybridization events (i.e., length of temporal overlap, order of species nesting seasons, population status). We initially identified 1,317 papers pertaining to sea turtle nesting, which were reduced to 383 that contained data on sea turtle nesting season length. From these papers we extracted data denoting the start and end of nesting seasons, sampling effort, nesting female and nest count, nesting trend through time (if available), and geographic locations used to assign studies to Regional Management Units (RMUs). Resulting nesting data was used to quantify the length of overlap in nesting seasons between co-occurring species at local scales (e.g., state within country) whenever possible or RMU when data were limited. Additionally, our literature review yielded 154 records of sea turtle hybridization globally. Ongoing work is using binomial regression to identify the ecological conditions—species order of reproduction, length of temporal overlap in reproduction, population status, population size—that best predict the presence/absence of sea turtle hybrids. We are also identifying geographic hotspots with ecological conditions qualitatively similar to known hotspots such as nesting sites found in Brazil that may be important areas for further study. Our project aims to inform and guide research efforts to identify potential hybridization hotspots globally, holding important implications for where future research and conservation efforts should be concentrated. This is all the more pressing given recent findings that sea turtle hybrids can produce successful offspring, raising important questions about the conservation and management of hybrids.

A NEW FRAMEWORK FOR SURVIVAL ESTIMATION OF SEA TURTLES*

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Sea turtles are categorized as endangered species, and effective conservation necessitates precise survival estimation. Confidence intervals or Highest Density intervals (HDIs) serve as indicators of this accuracy, emphasizing the need for the development of a new framework to enable narrower-interval survival estimations. In this study, we developed a novel survival estimation framework. Catch-curve analysis, commonly used for survival estimation, encounters limitations due to the existing framework's inability to account for growth curve errors or sea turtle immigration. However, compared to mark-recapture analysis, which relies on tag data, catch-curve analysis does not demand intensive research efforts. Consequently, our research team devised a new estimation framework that incorporates growth curve errors and turtle immigration using the Bayesian estimation method, allowing for adaptable model construction and the integration of prior information in the estimation process. Within this framework, we specify the parameters and their respective ranges as prior information and execute the program to fit the distribution of carapace lengths, subsequently estimating the posterior distribution or 95% Highest Density Intervals (HDIs) from the converging values of each parameter. Using the developed framework, the survival rate of loggerhead turtles in Muroto, Kochi Prefecture, Japan was estimated as 0.852/year (95% HDI: 0.799-0.903). For this estimation, the straight carapace length (SCL) data were used and obtained from incidentally captured individuals from July 2002 to November 2009, comprising 1391 individuals (mode:740–749 mm class; range:563–960 mm). Our research framework enables estimations even with limited sample sizes; for example, with data on carapace length from over 500 individuals, it becomes possible to estimate survival rates with less than 10% HDIs.

INSIGHTS INTO FORAGING AGGREGATIONS AND NESTING OF MARINE TURTLES IN TUN MUSTAPHA PARK, SABAH, MALAYSIA*

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Tun Mustapha Park (TMP) is a marine protected area (MPA) in northern Sabah, Malaysia. It is known as foraging and nesting grounds for marine turtles; however, available data are scarce and have not been thoroughly analysed. Comprehensive information on foraging and nesting marine turtle within TMP remain largely unexplored, yet it is crucial for effective marine turtle conservation. In-water study spanning 23 days from 5 April 2019 to 16 August 2020 was conducted. Foraging grounds at Kudat Mainland and Balambangan Island were identified. We recorded 94 individual green turtles (*Chelonia mydas*) and one juvenile hawksbill turtle (*Eretmochelys imbricata*). These green turtles have curved carapace length (CCL) ranging from 36.0 to 105.5 cm (n = 94; mean 57.2 ± 13.0 cm). The captured turtles were categorized as juveniles (80.85%), subadults (14.9%), and adults (4.25%). Genetic analysis revealed 12 haplotypes from the green turtle samples, with both foraging aggregations exhibiting similar genetic compositions. Mixed-stock analysis (MSA) indicated the primary natal origin as the Sarawak and Sabah Turtle Islands Park nesting populations, underscoring TMP's importance as foraging grounds, especially for nearby rookeries. In addition, we analysed 12 years of nesting marine turtle data obtained from community-based beach monitoring and hatchery operations, covering the period from 2009 to 2020. This initiative, led by WWF-Malaysia in collaboration with government agencies, encompassed 11 nesting beaches. The beach monitoring surveys documented a total of 85 green, 23 hawksbill, and three olive ridley turtle (*Lepidochelys olivacea*) nests. The 12-year data analysis revealed TMP hosts a smaller nesting population compared to other Malaysian sites, an increasing nesting trend, and highlighted distinct nesting seasonality and hatching success patterns between green and hawksbill turtles. The nesting data analysis also demonstrates that community-based monitoring is essential for the conservation of marine turtle populations Malaysia. Both in-water and nesting beach surveys emphasizes the significance of northern Sabah, Malaysia, and the establishment of MPAs for the conservation of marine turtles in the Southeast Asian region.

GENETIC DIVERSITY AND PHYLOGEOGRAPHIC PATTERNS OF MTDNA HAPLOTYPES OF HAWKSBILL TURTLE (ERETMOCHELYS IMBRICATA) IN THAILAND*

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The hawksbill turtle (*Eretmochelys imbricata*) is globally threatened and listed as Critically Endangered in the IUCN Red List, partly due to the loss of nesting and feeding habitats, and illegal wildlife trade. Establishing a regional reference of spatial genetic variation is crucial for monitoring changes in genetic diversity necessary for adaptive potential, and tracing geographic origins of unknown individuals, such as those from the wildlife trade. In Thailand, however, the genetic database of wild hawksbill turtle populations remains scant, hindering effective conservation strategies to promote population viability and species recovery. In this study, we aimed to (1) assess the number of mitochondrial DNA (mtDNA) haplotypes (*Nh*), haplotype diversity (*h*) and nucleotide diversity (*pi*) of hawksbill turtles from the head-starting facility at Koh Mannai, along the eastern coast of the Gulf of Thailand using partial 776bp Control Region sequences, and (2) infer phylogenetic relationships and phylogeographic partitioning between eastern Thailand populations and other range countries. Based on 22 blood samples of hatchlings collected from Koh Kram and raised at Koh Mannai, 19 samples (86.4%) were successfully sequenced based on the partial hypervariable portion (776bp) of the Control Region. Of the 19 samples and seven variable sites, a high level of mtDNA diversity was detected from the eastern Thailand populations ($Nh = 6$, $h = 0.789$ ($\pm$ 0.073), $pi = 0.00303$ ($\pm$ 0.00037)). Phylogenetic analyses strongly supported that all six haplotypes were clustered within the previously characterized Indo-Pacific III Clade, including haplotypes from Peninsular Malaysia and East Malaysia. Of the total six haplotypes, only the EiIP-151 haplotype is considered to be a newly characterized haplotype, while the remaining ones were shared with populations from Peninsular Malaysia and East Malaysia. Phylogenetic placement provides insight into the maintenance of dispersal and genetic connectivity between eastern Thailand populations with Malaysian populations. This genetic database will help guide management actions for hawksbill turtle conservation.

GENETIC STOCK STRUCTURE OF HAWKSBILL TURTLE (ERETMOCHELYS IMBRICATA) NESTING POPULATIONS IN FIJI

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Little is known about hawksbill turtle (*Eretmochelys imbricata*) nesting populations across the Fijian archipelago, which is made up of more than 800 predominantly uninhabited islands and islets in the South Pacific that are difficult to access and monitor. In 2014, the University of South Pacific Sea Turtle Team began a concerted effort to assess nest abundance, distribution and collect genetic samples to characterize the nesting populations of hawksbill turtles in Fiji, and fill a critical information gap for hawksbills in the Pacific. During the nesting season, beaches across four administrative divisions (northern, eastern, southern and western) of Fiji were monitored after initial reports of nesting activity. A total of 65 tissue samples were collected between 2014-2023 from adult females, hatchlings, or salvaged embryos for genetic analysis. DNA was extracted and ~800 base pairs of the mitochondrial (mtDNA) control region were sequenced using primers LCM15382 and H950g. Haplotypes were determined by comparing the sequences to known haplotypes (published and unpublished), resulting in the identification of five different mtDNA haplotypes (EiIP04, EiIP33, EiIP57, EiIP74, EiIP136) among the samples analyzed. EiIP33 is very common and widespread across the Pacific. To date, haplotypes EiIP04 and EiIP57 have only been identified in the North Queensland rookery while EiIP74 and EiIP136 have not been described at any nesting population, which illustrates the importance of this small nesting population as a potential source population to key foraging areas in the south Pacific. We present the results of stock structure analysis to characterize the Fijian hawksbill nesting populations and determine the level of differentiation from regional nesting populations across the Southwest Pacific. These results demonstrate the importance of continuing sampling efforts around Fiji in order to improve our understanding of the hawksbill population structure in the region and achieve a robust assessment of population status on a local and regional level for better management and conservation.

ENVIRONMENTAL INDICATORS PREDICTING LOGGERHEAD SEA TURTLE OCCURRENCE IN SOUTHERN CALIFORNIA DURING EL NIÑO CONDITIONS*

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Previous studies have found there is a high spatial correlation between Loggerhead presence offshore of Southern California and pelagic sea surface temperature (SST). Additionally, sea turtle bycatch records have found that the occasional presence of Loggerheads in southern California largely occurs during El Niño conditions. As the climate shifts warmer, scientists have suggested sea surface temperature (SST) alone may not be a good proxy for Loggerhead habitat. We integrated three datasets (2003-2023) to predict Loggerhead presence in the California Bight during El Niño conditions; aerial surveys, shipboard marine mammal surveys, and sighting reports from the public. In addition to sea surface temperature, primary productivity, surface elevation mean, and bathymetry coefficients from the GAM model were all statistically significant in predicting Loggerhead occurrence. Loggerhead presence was statistically higher in locations with sea surface temperatures of 17.5 to 22.5 °C. Loggerhead presence was statistically higher in areas of low primary productivity (1000 mg C m-2 day-1), waters with shorter wave heights, and closer to the shore. Additionally, the probability of Loggerhead presence was slightly higher, closer to the edge of frontal eddies. Stakeholders can use these findings to identify new environmental indicators linked with Loggerhead presence and key areas for longline fishing closure to reduce Loggerhead bycatch offshore of Southern California. Our study also provides evidence of the added benefits of public sightings reports and citizen engagement in monitoring endangered species.

SOMATIC GROWTH RATES OF JUVENILE GREEN SEA TURTLES (CHELONIA MYDAS) FORAGING IN THE FIJIAN ARCHIPELAGO

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Establishing key life history traits (i.e., somatic growth rates) for sea turtles produces insights into population demography and informs conservation efforts. Despite a plethora of studies on sea turtles over the past decades, there remain significant knowledge gaps for the demography of most populations. From 2015 – 2022, we measured size and somatic growth for 212 foraging green turtles (*Chelonia mydas*) captured at three foraging grounds in the Fijian Archipelago, tropical South Pacific. Mean size of all turtles was 57.3 ± 9.5 cm curved carapace length (CCL) with a size range of 41.1 – 104.0 cm ccl. We modeled a mean size-specific growth rate function for this foraging aggregation that was decreasing and non-monotonic. The mean growth rate for this foraging aggregation was 1.6 ± 0.1 cm/yr minimum CCL. We found variation in mean growth rates among the three foraging sites, perhaps owing to differences in habitat quality and/or the foraging ecology of growing turtles. Despite the observed differences, the range of Fijian juvenile green turtle growth rates align with those reported from foraging aggregations elsewhere in the tropical West and East Pacific. Establishing growth parameters for Fijian green turtles provides a baseline of information to inform ecological and health assessments vital to the development of future conservation plans.

UPDATING HAPLOTYPES FOR ANTIGUA & BARBUDA AND RE-ANALYZING ROOKERY STRUCTURE IN THE EASTERN CARIBBEAN

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Mitochondrial haplotypes have been used in marine turtle studies for decades to delineate rookeries and to link rookeries to foraging grounds, shedding light on population structure, natal homing, and habitat connectivity. These studies rely on robust sample sizes from many locations to accurately characterize haplotypes. New samples (n=74) were collected from hawksbills nesting in Antigua and Barbuda, including samples from the west coast of Barbuda and mainland beaches of Antigua that previously had low sample sizes. We sequenced the 740-bp segment of the mitochondrial control region, edited sequences with BioEdit, and matched our haplotypes with known haplotypes in BLAST. We then re-analyzed rookery structure (pairwise Fst) in the Eastern Caribbean using newly published data from the region. We found similar haplotype frequencies to those previously reported for Jumby Bay, mainland Antigua, and Barbuda. The Barbuda rookery contains only one haplotype (A20) that is rare in Antigua, even after increasing the sample size from 18 to 34. We also identified two new haplotypes for Antigua and Barbuda that are typically found in hawksbills nesting in Mexico (A23) and Brazil (A61). Lastly, we report on rookery structure in the Eastern Caribbean and discuss implications for natal homing behavior. These results, especially the Barbuda rookery with its regionally unique haplotype composition of 100% A20, could be helpful for updating mixed-stock analyses.

ASSESSING BREEDING SEX RATIOS AND RELATEDNESS AMONG MALE AND FEMALE BREEDERS IN A HAWKSBILL TURTLE ROOKERY

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Males are often missing from marine turtle demographic studies since they are absent from easily accessible nesting beaches. Genetic techniques provide a solution: male breeders can be identified indirectly by reconstructing paternal genotypes from the genotypes of hatchling cohorts and their known mothers. Breeding sex ratios can then be estimated by comparing the number of discrete paternal genotypes to the number of nesting females contributing to nests. This is especially important information for species with temperature-dependent sex determination to track potential shifts in sex ratios driven by climate change. These reconstructed genotypes can also be used to assess relatedness among male and female breeders. Here, we use microsatellites to reconstruct paternal genotypes from 12 nests sampled in 2014 from the Jumby Bay (JB) rookery in Antigua to strengthen a previous estimate of the JB breeding sex ratio,

and to assess whether the breeding sex ratio is consistent in consecutive years. We then include these paternal genotypes in a pedigree reconstruction analysis with JB nesting females to assess relatedness among breeders, e.g. to determine if male breeders are offspring of long-term JB nesters. We report our findings on the updated JB breeding sex ratio and relatedness among male and female breeders, and discuss the implications of our findings on hawksbill population resiliency and male natal homing.

GOING BEYOND THE REFERENCE GENOME IN LOGGERHEAD TURTLE CONSERVATION GENOMICS*

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The current biodiversity crisis demands urgent conservation actions to halt and reverse the situation. In this context, conservation genomics can assist biodiversity conservation and management with reference genomes being key centrepieces in such analyses. Consequently, many initiatives are in progress to provide reference genomes with the ultimate goal of sequencing all earth biodiversity, and marine turtles are no exception, as reference genomes of several species are already available. However, no single genome can represent the diversity of a species, as structural and sequence polymorphisms may differentially drive the future conservation actions of populations. We aimed to go beyond the reference genome of the loggerhead turtle by adding nuclear and mitochondrial genomes from individuals sampled worldwide. We performed whole genome sequencing (> 30 Gb output) on 12 individuals from four different Regional Management Units (RMU): Pacific (Mexico: 2), western Atlantic (Mexico: 2; Florida: 1), eastern Atlantic (Boavista: 2) and Mediterranean (Libya: 1; Greece: 2; Turkey: 2). We assembled the 12 mitogenomes (coverage > 900X) and combined our results with the full mitogenomes available from GeneBank to produce a final set of 20, covering the four RMUs. The structure of the mitogenomes was similar across all individuals. The phylogeographic analysis supported a scenario of an initial haplogroup split between the Atlantic and

Pacific after the closure of the Panama Isthmus and a secondary introduction to the Atlantic from the Pacific that reached the Mediterranean and western Atlantic. The genotyping against the reference genome (GCA_023653815.1) produced a set of more than 12.7 million nuclear SNPs across all individuals (coverage >11.5X), with the number of SNPs per chromosome highly correlated to chromosome size (R^2=0.99). All the individuals were clustered by RMU on multidimensional scaling, the Pacific being the most different to the remaining RMUs on the first axis. The second axis separated the Mediterranean from the Atlantic RMUs, the third axis separated the Mediterranean populations and the fourth axis separated the two Atlantic RMUs. The genetic distances, measured as Fst, showed the same pattern, with a high differentiation of the Pacific RMU and the two Atlantic RMUs being less differentiated. When performing pairwise Fst comparisons by chromosome, the most extreme values were always concentrated on the macrochromosomes, suggesting different evolutionary patterns across chromosomes. Thus, macrochromosomes would host highly conserved regions but also highly differentiated regions across RMUs that might drive local adaptation. An analysis of Runs of Homozygosity (ROHs) showed that the degree of inbreeding was uneven across RMUs. The individuals from the Mediterranean had genomes with longer ROHs and a higher portion of the genome in homozygosity, indicating higher inbreeding. Moreover, the ROHs distribution across the chromosomes was not uniform, as macrochromosomes had a higher proportion of their content in homozygosis than microchromosomes. In summary, combining the reference genome with whole genome sequencing data worldwide can provide novel insights into marine turtle conservation genomics. Future efforts to increase sample size and to incorporate more RMUs are advisable to expand our comprehension of marine turtle genomes for conservation.

NEW COLONISERS DRIVE THE INCREASE OF THE EMERGING LOGGERHEAD TURTLE NESTING IN WESTERN MEDITERRANEAN

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The loggerhead sea turtle (*Caretta caretta*) is particularly sensitive to global warming, due to its temperature-dependent sex determination, increasing hatchling mortality and the potential constraints to colonize new suitable areas due to philopatry. Despite these limitations, the species is colonizing the western Mediterranean, with a substantial increase in the number of nests year by year. To understand this rapid colonization in recent years in Spain, we sampled 45 hatchlings from 8 nests between 2016 and 2019. We build individual 2bRAD libraries from a variable number of hatchlings per nest (generating a dataset with 2,291 SNPs), sequenced the mtDNA D-loop region of one sample per nest and collected data on clutch size, hatching success, and incubation duration. Our results confirm that this ongoing colonisation has a Mediterranean and Atlantic mixed origin and we showed that nests were laid by different females, except for two nests laid 213 Km apart within the same season in 2019. There are no records of returning females in the two periods analysed: present study (years 2016-2019) and past study (years 2001-2015), suggesting that the recent increase in nesting seems to be due to an increase in the number of colonising individuals rather than females born in the same area returning to breed. We hypothesise that this increase in the number of colonisers results from successful conservation, feminisation of the populations and earlier sexual maturation in foraging areas related to an increase of sea temperature. However, given the high degree of philopatry in the species and the high rates of estimated female offspring in some Spanish nests, some of them could return in the future as breeding adults. Consequently, the detection of re-emigrant females nesting in subsequent years would confirm the successful consolidation of a new rookery. Interestingly, some nests along the Western Mediterranean coast have more males, making it a key area for producing male offspring in the Mediterranean basin. In addition, regarding the male genetic composition of the nests, the relatedness analysis shows higher values among individuals in the same nest, except in one case where its pair of individuals shows lower relatedness values than those of other nests, suggesting possible multipaternity within this clutch. All these evidences confirm that we are witnessing a shift of species distribution at evolutionary level induced by climate change. These results allow defining the colonization process of a long-lived species and sets the current status of this emerging population to understand the patterns towards the establishment of a resident population under a global warming scenario. Detecting and studying these new events through genomic monitoring, is crucial for the potential expansion and long-term survival of the species.

WHERE DO THEY COME FROM? A GENOMIC BASELINE FOR INDIVIDUAL ASSIGNMENTS IN THE LOGGERHEAD TURTLE (CARETTA CARETTA)

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Genomic techniques are becoming widely used in conservation, offering an unprecedented resolution to evaluate the behaviour, reproductive success, and impact of different threats on endangered species. In the case of sea turtles, there is an urgent need to identify the natal origin of individual juveniles in feeding areas or breeders colonising new nesting beaches to make scientifically-informed management decisions. In the case of species with large genome sizes, such as sea turtles, it is necessary to use genomic reduction techniques to optimise costs and it is fundamental to standardize protocols for reliable cross-comparisons. Additionally, it is crucial to build a genomic baseline with data from known regular nesting areas from where the individuals could have originated. To build a robust baseline for the loggerhead turtle, we analysed with 2bRAD a total of 278 samples, including individuals from nine regular nesting beaches in the Mediterranean from a previous study and individuals from three regular nesting beaches in the Atlantic. To test the effectiveness of the baseline for individual assignments, we analysed with the same methodology 114 individuals from four Mediterranean foraging areas (Catalano-Balearic Sea (CAB), Lampedusa (LAM), eastern Aegean Sea (EAG) and western Aegean Sea (WAG)) obtaining a total of 3,680 SNPs shared by 95% of the individuals. First, we conducted a genetic structure analysis with the baseline individuals and identified three groups corresponding to the previously described Regional Management Units (RMU). Additionally, we performed a hierarchical analysis with the samples from the Mediterranean nesting populations of the baseline and identified a clear differentiation between Greek nesting areas and the remaining populations, as reported in previous work. Finally, we carried out an individual assignment analysis of all individuals collected from the four feeding grounds, using the baseline and following a hierarchical approach from a global perspective (including the baseline of the three RMUs) to a more regional perspective (including only the Mediterranean nesting beaches as the baseline). We successfully identified the origin of each of the 114 individuals, both at the RMU level and at the regional level within

the Mediterranean. All turtles were assigned to the Mediterranean RMU, except for some individuals from LAM and CAT. When analysing at the regional level, the individuals from Greece were more prevalent in WAG, while those from the other Mediterranean populations were more prevalent in the remaining foraging areas. Our methodology allowed us to perform individual assignments on all samples at the RMU and regional levels, opening new perspectives to the research and conservation of sea turtles. By using this strategy, it is possible to reliably identify the populations impacted by threats at great distances outside their nesting areas or to research on turtles from a specific origin found in mixed foraging areas shared by individuals from multiple populations.

THE UMBILICAL CORD AS A NON-INVASIVE SAMPLING: GENOTYPE AND APPLICATIONS

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High throughput sequencing allows obtaining a high number of genome-wide loci, revolutionising the field of conservation genomics. However, it is often difficult to collect samples from elusive species, and the quantity and quality of the DNA extracted can be compromised by the type of samples. Sea turtles spend most of their life in the open ocean, making them a difficult group to obtain biological samples. In addition, common methodologies to obtain biological samples on sea turtles (e.g., blood or tissue sample) are often unsafe or unfeasible to perform on newborn hatchlings. Thus, exploring new non-invasive methodologies on sea turtles is essential to improve the possibilities of studying them. Here, we evaluated the potential of the umbilical cord (UC) as a non-invasive methodology in newborn turtles. To do so, we assessed whether the DNA retrieved from both sides of the UC i) is adequate for genomic research, ii) belongs to the mother or to the offspring, and iii) identified the prevalence of this tissue under natural and artificial incubation conditions. In brief, we generated 2b-RAD libraries for samples from 5 Spanish sporadic nests, including both extreme regions of 13 UCs, 50 blood or tissue samples (4 of them corresponding to hatchlings with genotyped UC and the remaining to hatchlings of the same nests) and the blood of one female that laid 2 of these nests. We generated a genome-wide catalogue of loci by mapping our sequences to the loggerhead reference genome. We calculated the Percentage of Shared Genotypes (PSG) from the following comparisons: 1) both regions of the UCs (hatchling side and egg side), 2) the UCs and the corresponding hatchling sample, 3) the UCs and the female sample whenever available, and 4) among all pairwise comparisons involving the UCs and the rest of hatchlings genotyped of the same and different nest. We also conducted differentiation analysis to test the clustering of the UC versus the other samples. Regarding the prevalence of UCs, we counted the number of nests with UC samples found in naturally emerged nests in a hatchery of an established nesting population of loggerhead turtle (Boa Vista, Cape Verde) and also in incubator-developed hatchlings from the management program of sporadic nesting in Spain. Our results revealed that the UC genotype belongs to the hatchling and not to the mother, obtaining PSG values higher than 95% between both sides of the UC and between the genotypes of this tissue and the corresponding hatchling. In addition, the PSG values of the UC with respect to the nesting female (if available) and with respect to the rest of the siblings were lower and coincident with the values acquired among any pair of siblings. Our data reported a lower prevalence of the tissue in naturally emerged nests (6.7% of the nests) in comparison with incubator-developed hatchlings (100% of the nests). In summary, we obtained high-quality genomic DNA from the UC and unveiled that the whole tissue has the same genotype and corresponds to the hatchling, with notable occurrence in incubator-hatched loggerhead eggs.

EVALUATING THE GREEN TURTLE NEW COLONISATION OF THE MEDITERRANEAN THROUGH GENOMICS AND SATELLITE TELEMETRY

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In the context of the global biodiversity crisis, it is crucial to identify management and conservation units of marine species as well as the potential colonisation of new habitats. The green turtle (*Chelonia mydas)* is a migratory species that can establish long-distance connections between widely separated areas while maintaining population differentiation due to philopatry. In the Mediterranean, nesting green turtle populations are concentrated in Turkey, Cyprus and Syria. However, in the last years, the species seems to be expanding its distribution as sporadic nests of this species have been found in new Mediterranean areas, and sexually mature individuals have been recorded in the western Mediterranean. To assess the origin of these potential colonising events, we genotyped with 2b-RAD individuals from the 3 green turtle Regional Management Units (RMU) that could potentially contribute to these events: North Atlantic, South Atlantic and Mediterranean (N = 15; 5 individuals from each RMU). With these genotypes, we assessed the current genetic differentiation among the three analysed RMUs to build a population genomic baseline. Additionally, we genotyped 7 hatchlings from 3 sporadic Mediterranean nests (2 in Crete, Greece and 1 in Tunisia), and 3 out of 4 adult individuals tagged with satellite telemetry in the western basin. By combining genetic and tagging information, we assigned tagged individuals to their potential source populations and assessed their dispersal patterns within the Mediterranean. The three RMUs were highly differentiated and all the individuals from the baseline clustered perfectly in the three RMUs, indicating the high potential of genomics for detecting population structure and for individual assignments. Furthermore, all the potential colonisers were satisfactory assigned to one of the source RMUs using genomic data. We detected that the breeders of one of the sporadic nests were from the distant South Atlantic RMU while the breeders of the two other nests were from the closest Mediterranean RMU, showing that this starting colonisation has

multiple origins. The four tracked individuals (all of them larger than 73 cm CCL) comprised a potential adult male, one confirmed adult male and two females with mature follicles, indicating their potential to nest. The three adult individuals with genomic data also originated in these two RMUs, while an Atlantic mtDNA haplotype could be sequenced from the remaining individual lacking genomic data. Our combined telemetry and genomic data provide for the first time the movements of individuals of Atlantic origin along the north Africa coast, where we detected the nest of Atlantic origin, and its exit trajectories out of the Mediterranean. Additionally, our findings shed light on the movements of an adult of Mediterranean origin through the western basin, thereby unveiling new migration routes for both Atlantic and Mediterranean populations. These evidences suggest an incipient double colonisation of green turtles in the Mediterranean probably associated with climate change, by two distant populations without historical mixing. Finally, our study provides a proof of concept for the application of genomics in sea turtles, enhancing the current knowledge of population structure and individual assignments for its implementation in management decisions.

IMPLICATIONS FROM LOW REMIGRATION RATES OF NESTING FEMALES IN THE NORTH PACIFIC POPULATION OF LOGGERHEAD TURTLES

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Nesting grounds for the North Pacific population of loggerhead turtles are restricted to beaches in Japan. Researches have been continued in some of the major nesting sites to identify individual loggerheads by tagging them. Those results indicate that only about 30% of the individuals remigrate to the same beaches after a few years of nesting. This means that either the tags have dropped off by the time of the return, they have shifted their nesting beaches, or the survival rate after nesting is low. Previous studies have shown that the percentage of all tags lost during the remigration interval is 2.3, 2.0, and 13.2% for 2-, 3-, and 4-year remigrations, respectively. Using PIT tags, which are unlikely to be lost, the effect of tag loss on individual identification will be reduced in this study. If many of the tagged nesting females had changed beaches, the new nesting sites should include beaches in Tanegashima Island, Kagoshima prefecture, which occupy higher percentage of total nesting counts in the population, and have not been surveyed for individual identification. Therefore, we began nighttime surveys for individual identification on Tanegashima Island since 2015, focusing on an area of high nesting densities. At the time females were found on the beach, flipper tags and PIT tags were attached after checking the presence of existing tags. Then, the straight carapace length (SCL) was measured. A total of 208 individuals were identified by the 2023 season. Remigrations over the years were confirmed 28 times by 21 individuals, with 3 individuals remigrating twice and 2 individuals remigrating 3 times. The remigration rate for loggerheads nesting on Tanegashima Island was estimated to be approximately 20-30%, taking into account areas and times when surveys could not be conducted. It was roughly at the same low level as other nesting sites. From the identification tags, the shift in nesting sites was confirmed for 5 individuals (2.4%): 4 from the neighboring Yakushima Island to Tanegashima Island and 1 from Tanegashima Island to Yakushima Island. It was strongly suggested that the low remigration rate was not primarily due to a shift in nesting sites. Thus, it is suspected that the main cause of the low remigration rate of nesting individuals is the low survival rate while remigration interval. The determinations of the factors that cause mortality after nesting need to be as specific as possible.

SHIFTS IN BODY SIZE FOR A GREEN TURTLE FORAGING AGGREGATION: LONG-TERM PATTERNS, PUTATIVE DRIVERS, AND HISTORICAL CONTEXT FOR A RAPIDLY CHANGING POPULATION IN THE EASTERN NORTH PACIFIC*

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Trends in abundance are generally the most straightforward indicators of population status, but robust estimates can be difficult to obtain. When clear information on abundance is elusive, other demographic indicators may provide key insight into population trajectories. Here, we present long-term patterns in size structure, i.e. body size distributions, for a green turtle (*Chelonia mydas*) foraging aggregation in the eastern North Pacific. We use measures of carapace length collected during 1990–2023 to make inferences into coincident population dynamics at San Diego Bay, California, USA. Our data show that mean body size increased over roughly the first two decades of monitoring, but has declined since. Finer exploration of size distributions through time suggests that this recent trend is explained by increases in the recruitment of young individuals. Green turtle foraging populations in California largely originate from multiple source rookeries in Mexico, and we relate patterns in foraging size structure to trends in nesting abundance at the most significant rookery known in the Eastern Pacific: Colola Beach, Michoacán, Mexico. Together, these lines of evidence (foraging size structure and nesting trends) point to a notable rebound for a regional population at risk of collapse as recent as two decades ago. Given an apparent increasing population trajectory in Southern California, we explore local historical context to attempt to compare current population status to an uncertain, pre-Anthropocene baseline. We ask: Are foraging abundances returning to states exhibited before human harvesting, or are we witnessing completely new patterns? Available historical records, such as news articles and archaeological evidence from indigenous peoples, do not provide any evidence for a significant presence of green turtles. Thus, we conjecture that we may be entering "new territory," with green turtles showing the potential to reach levels never before seen in California.

DEVELOPING A COST-EFFECTIVE MOLECULAR METHOD OF SEX DETERMINATION OF NORTHERN ATLANTIC JUVENILE SEA TURTLES USING GENE EXPRESSION

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The New York Marine Research Center (NYMRC): a non-profit responsible for the rescue, rehabilitation, and release of stranded sea turtles along the New York coastline, rescues four different species of sea turtles that strand due to entanglement, vessel interaction, cold stunning and debilitation. These genera include Kemp's ridley (*Lepidochelys kempii),* loggerhead (*Caretta caretta)*, Atlantic green (*Chelonia mydas),* and leatherback (*Dermochelys coriacea)*. Juvenile sea turtles do not have clear sexual dimorphism, which makes it difficult to determine their sex based on external characteristics. Sea turtles have temperature-dependent sex determination, which makes standard end-point PCR methods for amplifying gender specific genes found in chromosomal-dependent animals, useless. Current methods used to determine sex in juvenile sea turtles are costly and often inaccessible to non-profit organizations. Some of these methods include the Anti-Mullerian Hormone (AMH) test. The aim of this study is to develop a PCR based method that can be used on all four of the sea turtle genera that strand in New York State. From 2019-2023, 100 microliters of blood were obtained from three species of turtles, Kemp's ridley, green and loggerhead. All samples were then transferred for offsite analysis at Pace University. The sea turtle primers developed were for the SOX9, EIF1AD and IFNGR2 genes and were chosen for their differential gene expression among males and females. Preliminary data shows that both the SOX9 and EIF1AD genes are strong candidate for sex determination in all three sea turtle species.

OVERVIEW OF THE POPULATION GENETICS AND CONNECTIVITY OF SEA TURTLES IN THE EAST ASIA REGION AND THEIR CONSERVATION IMPLICATIONS*

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Understanding the current population genetics and connectivity of sea turtles and the recent development is crucial for effective conservation management of the species. Five sea turtle species, green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), hawksbill turtle (*Eretmochelys imbricata*), olive ridley turtle (*Lepidochelys olivacea*) and leatherback turtle (*Dermochelys coriacea*), are recorded in the East Asia Region situated in the western side of the North Pacific Ocean. We compiled information from 35 published genetic studies on the five sea turtle species, with a focus on green turtle and loggerhead turtle, which are the most studied species (in 30 studies) in view of their commonness and occurrence of nesting populations. This literature review provided an overview of the key methods and findings of these previous studies, addressing two main objectives on genetic structure of the rookeries and their differences compared to other populations, and connectivity of the rookeries and foraging aggregations. By identifying information gaps and conservation needs, we discussed future developments for sea turtle genetic studies and conservation implications in the region.

RECONSTRUCTING DEMOGRAPHIC HISTORY BETWEEN TWO CONTRASTING LEATHERBACK POPULATIONS USING GENOMICS*

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Over the last two decades, genetics has played a key role in the conservation and management of marine fauna such as whales, dolphins, and all sea turtle species. Assessing genetic variability is essential in effective conservation management, particularly for small populations that are disproportionately susceptible to extinction. The decrease in genetic variation not only limits the population's ability to adapt to changing environmental conditions but also heightens the risk of extirpation due to stochastic events. This situation often results in a positive feedback loop, where inbreeding depression exacerbates the reduction in genetic diversity. In the face of declining leatherback sea turtles (*Dermochelys coriacea)* globally, this study provides a critical examination of two contrasting groups: the Northwest Atlantic and the Southwest Indian Ocean (SWIO) populations. The Northwest Atlantic population, one of the largest in the world, has experienced a decline, with the Florida subgroup showing growth over the previous three generations. In contrast, the SWIO leatherback population is significantly smaller and has remained stable, despite significant conservation efforts over the last 50 years. These differences in population trend and size present a unique opportunity to understand the underlying genetic mechanisms that contribute to population resilience or vulnerability. Through restriction-site associated DNA sequencing, we evaluated the genetic makeup of the SWIO and Florida leatherback populations. We assess genetic diversity and inbreeding levels, crucial factors in understanding the adaptability and long-term viability. The genomic

data can reveal patterns of genetic variation, offering insights into how these populations have adapted or struggled in response to environmental changes and human pressures. Furthermore, we aimed to determine population trends over recent (approximately 100 generations) and ancient (over 1,000 generations) timescales to ascertain if the current populations have maintained continuity throughout history. Our findings can offer pivotal insights into the genetic dynamics and resilience of marine fauna populations, particularly leatherback turtles. Understanding the genetic makeup and historical trends of populations is crucial for informed, tailored conservation strategies. This ensures the continued survival of these marine species, especially in the face of mounting environmental impacts.

WHERE DID THEY GO? ALARMING LACK OF JUVENILES RAISES CONCERN AT TUBBATAHA

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The Tubbataha Reefs National Park is a World Heritage Site and an important foraging ground for green turtles *Chelonia mydas*. Since 2010 the population has been periodically assessed via in-water sampling that includes tagging, measuring, genetic sampling, and laparoscopy, with sampling of a average of 200 turtles of all age classes during each of the six seasons in which the study has been conducted. The data from the laparoscopy procedures is of critical importance to this presentation. In the first three seasons of sampling (2010, 2014 and 2015) the population was primarily comprised of juvenile sea turtles (~79 to 90% juvenile) but by 2016 and 2019 notable changes were apparent: Juvenile turtles comprised only slightly more than 50% of all turtles, and by 2023 juveniles comprised only 25% of all turtles, and less than both sub-adults and adults. Tubbataha was considered a juvenile development ground up until recently, and the smallest turtles on record were ~35cm which we classified as new recruits to the foraging area. No turtles smaller than this size have ever been recorded despite substantial diver and ranger activity, so that while there is a degree of nesting on the small islets in the TRNP, it is not believed these turtles remain resident from hatchling stages. It is presently unknown if turtles that hatch at Tubbataha return to Tubbataha in subsequent years as foraging animals. Laparoscopy data indicates that turtles previously classified as juveniles have progressed to sub-adults, and sub-adults have progressed to adults. We believe that Tubbataha continues to function adequately as a development feeding area. The gradual shift in proportions of juveniles versus sub adults and adults is of grave concern, as this signifies that somewhere along the ‘production line’ juvenile turtles are being removed from the population, or are not being produced. The Turtle Islands Park and the Turtle Islands Wildlife Sanctuary, the largest combined green turtle rookery in SE Asia, and also in the Sulu Sea where Tubbataha lies, continues to increase in number of nesters and production of hatchlings. Similarly, we are unaware of any ‘new’ foraging area where turtles may have shifted to. We believe that hatchling production is not the culprit, and this points to either bycatch or intentional poaching as potential reasons behind the gradual loss of juveniles at this site.

REIMAGINING SEA TURTLE CONSERVATION IN INDIA: INSIGHTS FROM A LONG-TERM MONITORING STUDY

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Odisha is a prominent nesting and breeding ground for the east coast population of olive ridley turtles in India. Historically, the population experienced drastic declines in the 1980s and 1990s due to direct take and fisheries by-catch. This resulted in policy changes and conservation initiatives that led to blanket fishing bans and the implementation of spatial closures. Over 2 decades later, we examine various population parameters to inform future conservation needs and directions. We monitored the nesting and nearshore population of olive ridleys in Rushikulya, a major mass nesting site in Odisha, between 2008 – present. We conducted nearshore boat surveys, regular beach patrols for solitary nesting estimates, carried out arribada census, measured hatching success and hatchling sex ratios. We observed that this population is stable or even increasing, despite fisheries by-catch related mortality in the region. Annual arribada nesting numbers have increased from ~40,000 to >200,000 over the last 15 years. The density of turtle aggregations in the nearshore waters has remained stable with minor inter- and intra-annual fluctuations throughout this period. High hatching and emergence success, relative to other mass nesting beaches, indicates a potentially steady hatchling recruitment rate. The hatchling sex ratios, however, are found to be rapidly becoming more female-biased (71%). These results underscore the need to re-evaluate current perceived threats and conservation measures for this population. It also provides valuable empirical evidence to show that the olive ridley turtles in the region might be more resilient than earlier believed and suggests that future conservation efforts should address the effects of climate change and habitat loss that pose a bigger threat to the long-term stability of the population.

THE RIDLEY SAGA: PAST, PRESENT AND FUTURE HATCHLING SEX RATIOS OF THE EAST COAST POPULATION OF OLIVE RIDLEYS IN INDIA*

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Temperature has a profound influence on various life history parameters across taxonomic groups. In sea turtles, which exhibit temperature-dependent sex determination, rapidly changing global temperature ranges pose a significant threat to the viability of populations by producing heavily female-biased sex ratios. Globally, population sex ratios of sea turtles have been studied extensively, enabling the tracking and prediction of changes through decades. However, the east coast population of olive ridleys in India, considered genetically significant, remains grossly understudied. In this study, we modeled the relation between nest temperature and sex ratios in the region from primary data on hatchling sex at Rushikulya from 2008-2023 based on the histology of ~1200 hatchlings from >100 nests. We then predicted historical sex ratios at arribadas for the past 50 years at two important mass nesting sites, Gahirmatha and Rushikulya. Additionally, we forecasted future sex ratios for arribadas with varying phenology under different models of climate change. Our results indicate that at Rushikulya, the primary sex ratios are female biased (71%), with occasional years producing a high proportion of male hatchlings (65%) across the season. The pivotal temperature was found to be 29.4℃, established by modeling hatchling sex ratios and nest temperatures. The results of the historical analysis indicate a progressive female bias in sex ratios at arribadas in Gahirmatha over the past four decades, while sex ratios remain stable but slightly female biased in Rushikulya. Notably, we also observed a shift in nesting phenology, with the occurrence of arribada increasing towards warmer months in Gahirmatha over the last 40 years. For future predictions, we used climate models under 4 different scenarios (SSP 126, 245, 370, and 585) to predict potential sex ratios at two-decade intervals until 2100. The predicted climate warming, coupled with a potential shift in arribada phenology, predicts a strong feminization of the population under the business-as-usual and extreme scenarios at all timescales in the future. Therefore, while the population is currently stable or increasing, climate change still poses a considerable threat, especially given that there are no beaches further North along this coast for future colonization.

THE EFFECTS OF MATING FUNCTION AND MICROEVOLUTION ON THE PERSISTENCE OF GREEN TURTLES IN THE FACE OF CLIMATE CHANGE*

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As climate change progresses, sea turtle nesting beaches are warming and producing increasingly more female-skewed hatchling sex ratios. Whether or not this translates to lower reproductive success depends on the breeding ecology of males. However, given the difficulty in finding and sampling males, the role of males in sea turtle reproductive dynamics is not yet well understood. Specifically, the mating function, or the relationship between the operational sex ratio (the proportion of adults that are available to breed that are male) and reproductive success (in this case, defined as emergence success), is unknown. A two-sex, age-based population dynamics model was constructed to explore the survival probabilities of a green turtle (*Chelonia mydas*) population within 3 lifespans (255 years) into the future, under different temperature change scenarios and with different mating functions. Nesting and genetic data collected across three and a half field seasons from Fernando de Noronha, Brazil were incorporated into the model, with other demographic parameters borrowed from previous studies on the same population and filled in with data from the geographically closest population as needed. Preliminary results show that as changes in incubation temperatures increase, persistence requires that individual males are able to fertilize a larger proportion of breeding females. Furthermore, microevolution of the thermal reaction norm is unlikely to sufficiently increase the probability of population persistence for moderate to severe thermal scenarios. These simulations, when paired with ecological and genetic analyses, will help to bound realistic sea turtle mating functions and further quantify the probability of population persistence in a changing climate, while informing research and conservation priorities.

GENETIC STOCK IDENTIFICATION OF FISHERIES BYCATCH PROVIDES INSIGHTS INTO DIFFERENCES IN BROAD-SCALE DISTRIBUTION PATTERNS OF LEATHERBACKS IN THE NORTH AND SOUTHEAST PACIFIC

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Leatherback turtles use waters throughout the Pacific as foraging grounds where fisheries interactions occur, resulting in incidental catch in commercial and artisanal longline and gillnet fisheries. This bycatch is of concern due to severely depleted Pacific nesting populations, prompting leatherback conservation as an international priority. This study uses molecular genetic analysis to build on previous satellite telemetry research in order to advance the overall understanding of connectivity and migration patterns of Pacific leatherbacks. Analysis of a comprehensive set of samples collected by observers from US-based fisheries in the North Pacific as well as artisanal and commercial fisheries in the southeast Pacific (Peru and Chile) between 1995 and 2022 reveals that while almost all leatherbacks bycaught in the North Pacific originated from the western Pacific nesting population, a portion of the Chile and Peru leatherback bycatch originated from both western and eastern Pacific nesting stocks. The connectivity between the western Pacific nesting populations and the fisheries in the eastern Pacific is notable, and is something that satellite telemetry studies, largely based on tracking nesting females, has tended to overlook. We present details of these results and discuss conservation implications and future research directions that leverage new genomics resources for improving genetic stock identification of Pacific leatherbacks.

GENETIC COMPOSITION AND ORIGIN OF UNDESCRIBED LEATHERBACK TURTLES AGGREGATIONS (DERMOCHELYS CORIACEA) ALONG THE BRAZILIAN COAST

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The leatherback turtle (*Dermochelys coriacea)* is widely distributed and occurs in tropical and temperate areas around the world, spending most of their life cycle in the open ocean. The species perform long migrations between nesting and feeding areas, and most genetic studies have analyzed only rookeries. In the Southwest Atlantic, the subpopulation of *D. coriacea* is Critically Endangered, comprises few individuals, and nesting activity frequently occurs on the northern coast of Espírito Santo (Brazil), although it can occur in other Brazilian states. This study aimed to characterize the diversity and genetic composition of leatherback turtles for the first time in one nesting area in northern Brazil (Piauí state) and three feeding areas, one in Southeast Brazil (Rio de Janeiro state) and two in Southern Brazil coast (Paraná and Santa Catarina states), and compare data with other published nesting and foraging areas around the Atlantic Ocean. Epithelial tissue samples were collected in 2012, 2019, and 2022 from dead hatchlings in Piauí (N = 6) and from stranded adult and juvenile individuals between 2016 and 2022 in feeding areas (Rio de Janeiro - RJ, N = 13; Paraná - PR, N = 19; and Santa Catarina - SC, N = 16). We sequenced 763 bp fragments from the control region of mitochondrial DNA and combined them with data from published studies on nesting areas for a regional perspective (Africa, Espírito Santo, and North and Central America) and from one feeding area in Southern Brazil (Rio Grande do Sul state, RS). For dead hatchlings samples from Piauí we found only Dc1.1 (the most common haplotype within Atlantic), for stranded animals from foraging areas we found five haplotypes (Dc1.1, Dc1.3, Dc1.4, Dc3.1 and Dc13.1), two of them exclusively found in African rookeries. The genetic diversity of the undescribed foraging areas evaluated varied from 0.20 for RJ to 0.45 for SC. Paraná, Santa Catarina and Rio Grande do Sul were grouped into a single aggregation due to genetic homogeneity (F_{ST} values between -0.005 and -0.056; $p > 0.05$) and presented a haplotype diversity of 0.493. The pairwise F_{ST} revealed that individuals from feeding areas in the southern region (PR, SC and RS) exhibited genetic homogeneity with those from Gabon ($F_{ST} = 0.003$; $p > 0.05$) and Ghana ($F_{ST} = 0.020$; $p > 0.05$), indicating a possible migratory flow between Africa and Brazil. The lack of genetic structure provides scientific information for conservation strategies, suggesting the critical importance of southern Brazil's coast, with about 1000km long, for African populations. While mtDNA analyses are useful to characterize the genetic diversity and trace the origin of individuals in feeding areas, we suggest further analyses with biparental nuclear DNA for a deeper understanding of the genetic composition, structure, and migratory routes for these populations, guiding future management and conservation initiatives.

GENOME-WIDE SNPS REFINE POPULATION CONNECTIVITY AND SHOW PROMISE FOR FINE-SCALE GENETIC STOCK IDENTIFICATION IN GULF OF MEXICO LOGGERHEAD TURTLES*

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Genetically discrete, demographically independent populations serve as a framework for structuring management efforts in wild and imperilled species. In species with broad, complex dispersal or recently established populations, evidence of demographic independence in neutral genetic markers can be weak or contradictory, and it can often be beneficial to seek additional evidence. Genome-wide single nucleotide polymorphisms (SNPs) have been shown to reliably detect weak population structure in these species, and may produce informative loci for genetic stock inference (GSI). Sea turtles comprise seven species with well-known broad, sex-biased dispersal and complex population structure, for which informative loci for accurate GSI do not always exist. We therefore generated genome-wide SNP data for four genetically discrete management units (MUs) of loggerhead turtles in the Gulf of Mexico, to determine if SNPs would reflect demographic independence between MUs and could elucidate informative loci for GSI. Analyses of 30,776 SNP-containing loci across 69 individuals from the Northern Gulf of Mexico (n=18), Central Western Florida (n=18), Southwestern Florida (n=15) and the Dry Tortugas (n=18) showed weak but significant structuring (F_{ST}=0.001) between MUs. We subsequently identified 238 outlier loci for GSI, which were able to re-assign individuals to MUs with 100% success. Analyses of genome-wide SNPs provided deeper insights into the eco-evolutionary dynamics governing demographically independent populations in sea turtles and demonstrated the potential of SNP-containing loci to serve as informative markers for accurate GSI in species with broad dispersal and shallow phylogeographic histories. Future work will include expanding sample sizes at MUs to validate loci for GSI, expanding genome-wide SNP data generation to other loggerhead MUs, and developing genotyping in sequencing by-thousands panels (allowing for parallel sequencing of hundreds to thousands of targeted, informative loci) for GSI in loggerheads in the Northwest Atlantic Discrete Population Segment.

SIZE MATTERS: HOW SAMPLE SIZE AND MOLECULAR MARKER CHOICE AFFECT MIXED STOCK ANALYSIS

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Sample size is a fundamental aspect of scientific studies, but statistically derived results can be misleading due to an inadequate number of samples. Some publications suggest a minimum number of samples for regression models based on data variance, but there is a lack of guidance for several statistical approaches, in particular, genetic studies. Mixed stock analysis (MSA) is a powerful tool to evaluate the composition of mixed stock aggregations. Still, no direct guidance exists on the minimum number of samples needed for accurate estimates using such models. To address the sample size issue, we used computer simulations to better understand the effect of sample size on MSA and make recommendations for future studies. Our simulations considered three source sea turtle populations (rookeries) and four mixed stock aggregations. We ran 30,000 simulations using a combination of variables to understand the impact of sample size on mixed stock model estimates. Variables included: rookery size (500, 1,000, 10,000, and 50,000 individuals), mixed stock aggregation size (500, 1,000, and 5,000 individuals), and sample size from rookeries and mixed stock aggregations (as a continuous variable from 25 to 200 samples). In addition, we considered two different scenarios to simulate the use of different genetic markers to evaluate rookery contributions: use of genetic markers with higher and lower resolution to distinguish rookeries – 400 bp vs 800 bp mtDNA fragments. We compared the estimates from each simulation against the true contribution from rookeries to mixed stock aggregations to assess model accuracy. Our results indicate that, regardless of population size, 30-50 samples can accurately characterize mtDNA markers in the rookeries for MSA studies. We also found that model accuracy can be maximized by using a combination of higher-resolution molecular markers (e.g., 800 bp fragments to distinguish rookeries) and sample sizes from mixed stock aggregations of 100 samples or more. Using lower-resolution markers, model accuracy is only maximized by using >150 samples from mixed stock aggregations. Considering that large sample sizes may be hard to achieve in multiple regions, we strongly recommend the development of higher resolution markers to better distinguish rookeries. Simultaneously, rookeries must be reassessed using these higher-resolution markers, allowing future studies to use lower mixed stock aggregation sample sizes. Insufficient sample size associated with poor genetic markers can generate misleading MSA estimates, hampering our understanding of connectivity and sea turtle dispersal patterns across habitats and, ultimately, conservation efforts for specific populations.

SHOUT-OUT TO LOGGERHEADS IN BRAZIL: NESTING TRENDS FROM 1991 – 2019

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Population size is a critical metric for endangered species population assessments. Abundance can be particularly challenging to estimate for migratory and complex life cycle species, in which individuals may be distributed across an entire ocean basin. For sea turtles, one of the main parameters used for population assessment is the annual number of nests. Loggerhead sea turtle (*Caretta caretta*) nesting in the Southwest Atlantic Regional Management Unit (RMU) occurs along the coast of Brazil, where the main nesting sites have been monitored since the 1980s by Projeto Tamar. Here, we present a reassessment of nest abundance trends for the main loggerhead sea turtle rookeries in Brazil. Nesting sites were grouped into three areas, based on geographic distribution and genetic substructuring: Sergipe and northern Bahia states (SE/BA), northern Espirito Santo state (ES), and northern Rio de Janeiro state (RJ). Nest abundance was estimated using daily nest count data from each nesting season in the period 1991-2019 for SE/BA and ES and 2001-2019 for RJ. We evaluated trends in nest abundance for each rookery (SE/BA and ES from 1991 to 2019 and RJ from 2001 to 2019) and for all rookeries combined (from 2001 to 2019) using generalized additive mixed models with a negative binomial distribution. We observed an overall increasing trend in the number of nests for all evaluated areas over time. The number of nests increased from 1,464 in 1991 to 5,330 in 2019 in SE/BA, from 485 to 2,711 in ES during the same period, and from 809 in 2001 to 2,389 in 2019 in RJ. For all rookeries combined, the number of nests increased from 4,274 in 2001 to 10,430 in 2019. Clutch frequency and remigration intervals for this RMU have not changed since the 1990s, indicating that the increased number of nests observed could be linked to a greater abundance of nesting females. This is a major finding that supports the recent change in the conservation status of loggerheads in the Brazilian Red List from Endangered to Vulnerable. Fundação Projeto Tamar uses an adaptive threat management approach with environmental education and social inclusion as the backbone for local community engagement toward conservation. Eradication of nesting female killing and nest poaching are likely the main reasons for the nest abundance recovery reported here. However, other threats, such as fisheries bycatch, coastal development, and animal nest predation, require continuous monitoring and implementing adaptative mitigation measures to ensure persistent population growth.

PREVALENCE OF MALE-PRODUCING NESTING SITES FOR ENDANGERED SEA TURTLES IN THE ASIA-PACIFIC REGION AND GLOBALLY*

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Projection models are being increasingly used to manage threatened taxa by estimating their responses to climate change. Sea turtles are particularly susceptible to climate change as they have temperature-dependent sex determination and so increased sand temperatures could result in the ‘feminisation’ of hatchling sex ratios. Additionally, the implications of temperature data logger accuracy and precision are rarely considered prior to their application in many ecological studies. We assessed the accuracy and precision of three commonly used temperature data loggers (Hobo®, iButton® and TinyTag®) for ecological studies. Through water bath laboratory studies, we found that the accuracy was highest in TinyTags (±0.23°C) and lowest in HOBOs and iButtons (±0.43°C and ±0.49°C respectively). Our results suggest that these temperature loggers can provide reliable descriptions of sand temperature if they are not over-interpreted. We then wanted to consider the risk of climate-induced feminisation for nesting sites within the Asia-Pacific region, as there has been a significant gap in our knowledge of the sand temperatures and hatchling sex ratios for this important region. We modelled the likely long-term trends in sand temperatures and hatchling sex ratios at a nesting site for endangered green turtles (*Chelonia mydas*) and critically endangered hawksbill turtles (*Eretmochelys imbricata*) in eastern Papua New Guinea (PNG). A total of 1078 days of sand temperature data were collected from 28 logger deployments at nest depth between 2018 and 2022 on two islands within the Conflict Island Group, PNG. Long-term trends in sand temperature were generated from a model using air temperature as an environmental proxy. The influence of rainfall and seasonal variation on sand temperature was also investigated. Between 1960 and 2019, we estimated that sand temperature increased by ~0.6°C and the average hatchling sex ratio was relatively balanced (46.2% female, SD = 10.7). Additionally, the sex ratio models were unlikely to be influenced by changing rainfall patterns, as our analyses indicated that there were no trends in historical rainfall anomalies and projections indicated no further changes to rainfall until 2100. A relatively balanced sex ratio such as this is starkly different to the extremely female-skewed hatchling sex ratio (>99% female) reported for another Coral Sea nesting site, Raine Island (~850 km west). This PNG nesting site may be rare in the global context, as it is less threatened by climate-induced feminisation. Although there is no current need for ‘cooling’ interventions, the mean projected sex ratios for 2020–2100 were estimated to be 76%–87% female, so future interventions (such as irrigation) may be required to increase male production. This research is part of the ‘Turtle Cooling’ Project and is a broader collaboration with many independent monitoring groups across seven different countries. These relationships have facilitated our ability to fill a substantial knowledge gap on the likely hatchling sex ratios for these important turtle rookeries in the Asia-

Pacific. Through this research, we hope to expand on existing hatchling sex ratios datasets for global sea turtle populations and highlight the variables that drive cool sand temperatures at male-producing sites.

UNCREWED AERIAL SYSTEMS AS TOOLS FOR GREEN TURTLE POPULATION ASSESSMENT IN COASTAL MARINE PROTECTED AREAS IN URUGUAY*

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The green turtle (*Chelonia mydas*) is a highly migratory endangered species. Several direct threat-related strandings of turtles (i.e. bycatch and marine pollution) are reported yearly in the Southwestern Atlantic Ocean (SWAO), and consequently critical areas for sea turtle conservation have been identified in the region, including the coast of Uruguay. This region is an important foraging ground for juveniles feeding on macroalgae, which is a key component of rocky marine ecosystems and provides food and shelter to many species. To date, several efforts have been made to protect sea turtles and reduce threats, however, little attention has been given to evaluating habitat degradation at feeding grounds in SWAO, mainly due to cost and complex logistics. Long-term monitoring programs represent a valuable tool for decision-makers to prevent and mitigate possible threats to sea turtles, and due to their spatially complex life cycle and biology, research and conservation efforts for these animals have been relying on new technology and more efficient protocols to achieve a better understanding of population trends and threats. Recently, Uncrewed Aerial Systems (UAS, or drones) have been introduced for such studies. However, their implementation has been neglected in the SWAO, due in part to the limited sampling protocols available and low water visibility. This aims to develop a holistic approach to the conservation of juvenile green turtles by using UAS to conduct aerial surveys in Uruguayan feeding areas and to determine if this tool is viable to be implemented in long-term population studies. We used a UAS to survey juvenile green turtles in Cerro Verde e Islas de la Coronilla Coastal-Marine Protected Area (CMPA), Uruguay. We conducted aerial surveys over the water between December 2021-May 2022. We deployed the UAS from the shore, collecting video of the coastal foraging grounds while flying 200m linear transects at an altitude of 35 - 40 m. We conducted 123 missions in four survey areas over 25 field days. Mission duration depended on the survey area and flight times ranged from 7 to 16 minutes, totalling 20.4 hours of video. Days in the field were limited due to high wind and Beaufort Sea State, with operations only possible at mean wind speeds below 28kph (max gusts of 35kph) and sea state of 3. Depending on the survey area, we counted 0 – 70 turtle sightings with an outlier of 126 individuals. These results are preliminary with 30% of videos still being processed. The next step will be to calculate Observations-per-Unit-Effort and to estimate Relative Density of green turtle in CMPA accounting for individuals not available to being seen (Probability of being visible). This ongoing work demonstrates that UAS are effective tools for performing sea turtle monitoring in a region that was previously understudied due to environmental factors such as water clarity.

Furthermore, we show the potential benefit of using UAS in sub-optimal environmental and oceanographic conditions, providing information and opportunities to study habitat use, distribution and density of the juvenile green turtle in the main feeding area in Uruguay.

POPULATION GENETICS OF FORAGING GREEN (CHELONIA MYDAS) AND FORAGING AND NESTING HAWKSBILL TURTLES (ERETMOCHELYS IMBRICATA) IN GRENADA, WEST INDIES*

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Grenada, a tri-island nation in the southeastern Caribbean Sea, supports aggregates of foraging green turtles (*Chelonia mydas*) and foraging and nesting hawksbill turtles (*Eretmochelys imbricata*). Conservation strategies are currently limited by a lack of detailed knowledge of the genetic make-up, life history and migration patterns of the local aggregates of these species. Genetic characterisation provides a means for inferring population diversity and origins for these aggregates and to assess potential impacts from regional and worldwide management strategies. Additionally, chelonid alphaherpesvirus-5 (ChHV5) and ChHV5-associated fibropapillomatosis (FP) have recently been reported within Grenada's green turtle aggregation, but the epidemiology of the disease in Grenada remains poorly understood. We genetically characterised Grenada's foraging green (n = 57), nesting hawksbill (n = 18), and foraging hawksbill turtle aggregates (n = 22), and used mixed stock analysis (MSA) to assess the level of genetic connectivity of Grenada's populations with other populations in the Atlantic region. Furthermore, foraging green turtles were assessed for prior exposure to ChHV5 using a serological assay to examine associations between origins and infection status. Mitochondrial DNA (mtDNA) sequencing data revealed seven haplotypes within Grenada's foraging green turtle aggregation, including one novel haplotype (CM-A82.1), and a total of seven haplotypes across Grenada's nesting and foraging hawksbill turtle aggregations, including one (Ei-A68) and two rare haplotypes (Ei-A45, Ei-A72), respectively. We identify Grenada's Isle de Caille rookery as a nesting population of origin for haplotype Ei-A68, which was an orphan haplotype prior to this study. MSA results indicate that Grenada's green and hawksbill turtle populations are associated with that of 15 other countries throughout the Atlantic region. Grenada's hawksbill turtle rookery contributes 3.6% to the foraging hawksbill turtle aggregation within Grenada, whilst the foraging aggregation contributes 14.5% to the rookery, according to foraging-ground-centric and rookery-centric MSA results, respectively. ChHV5-specific antibodies were identified in serum samples in 9.38% of green turtles, with no apparent association of ChHV5 serology status and green turtle haplotype. Though a small percentage of Grenada's hawksbill turtle population appears to be residential, mixed stock analyses strongly indicate that Grenada's sea turtle populations are regionally shared resources and should be managed as such. Furthermore, the rare and/or unique haplotypes present within Grenada's sea turtle populations offer valuable genetic diversity to the wider region and further conservation strategies are warranted to protect these at-risk haplotypes.

BREEDING SEX RATIOS OF LEATHERBACKS (DERMOCHELYS CORIACEA) IN THE SOUTH WEST INDIAN OCEAN*

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As climate change and global warming continue to increase global average temperatures, species that exhibit temperature-dependent sex determination (TSD), like sea turtles, increasingly produce biased primary sex ratios. For leatherback sea turtles, incubation temperatures beyond the pivotal temperature (PT; where a 50:50 sex ratio is produced) produce substantially more females such that global warming may alter population demographics through limiting the number of males produced and genetic diversity within the population. However, understanding how primary sex ratios affect the breeding sex ratio and other demographic parameters has been complicated by only females coming ashore to nest with limited observations of males. One way to study the breeding sex ratio is through sequencing nesting female and hatchling deoxyribose nucleic acid (DNA) to construct paternal genotypes so that fathers can be assigned to each nest. By counting the number of different paternal genotypes constructed, the number of breeding males within the population can be determined and the breeding sex ratio estimated. Assessing population demographics and breeding sex ratio is critical for the accurate assessment of population viability of the critically endangered leatherback sea turtles in the Southwestern Indian Ocean (SWIO). It is therefore fundamental to quantify the ratio of breeding males to nesting females to understand population demographics. The overall aim of this project is therefore to determine the incidence of multiple paternity (MP) and breeding sex ratio of the critically endangered leatherback population in the SWIO. Through the use of genotyping-in-thousands by sequencing (GT-sequencing), paternal genotypes will be constructed from maternal and hatchling DNA sequences to estimate the number of males contributing to each nest (MP) and quantify the ratio of breeding males (number of male genotypes detected) to nesting females (number of unique nesting females identified through flipper tags throughout the study period).It is hypothesized that there will be no incidence of multiple paternity within the SWIO population of leatherbacks, since leatherbacks generally have low incidences of MP and that the breeding sex ratio will be balanced. The results of this project will contribute to the understanding of leatherback population demographics in the SWIO and can be used as a case study for other sea turtle populations around the world. Understanding male contribution to sea turtle populations will help gain insights into sea turtle mating systems, which is currently understudied due to data restrictions, but could assist in management of the species through fully understanding their structure, function, and behaviour.

GENETIC CHARACTERIZATION AND DIVERSITY OF AN UNDESCRIBED LOGGERHEAD TURTLE (CARETTA CARETTA) REPRODUCTIVE POPULATION AND NEW INSIGHTS ON THE GENETIC STRUCTURE FOR THE SOUTHWEST ATLANTIC

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The loggerhead turtle (*Caretta caretta*) is a cosmopolitan species globally listed as vulnerable by the International Union for Conservation of Nature. This species is notable for its extensive migrations and its reproductive philopatry behavior, wherein it nests on specific beaches. In Brazil, the loggerhead turtle nests primarily on the coasts of Sergipe (SE), northern Bahia (BA), northern Espírito Santo (nES), and the extreme north of Rio de Janeiro (RJ), but secondary nesting areas can also be observed in the southern Espírito Santo (sES) and southern Bahia. Based on the control region of mitochondrial DNA (D-loop), this study aimed to characterize the genetic diversity of an undescribed nesting loggerhead turtle population in southern Espírito Santo, increase the sample size of the northern Rio de Janeiro nesting population, evaluate the genetic structure among Brazilian rookeries and test whether their genetic composition has changed over time. Epithelial tissue samples were collected from females from sES (N=33) over three reproductive seasons (2020/21, 2021/22, and 2022/23), and dead hatchlings (N = 43) from nests in northern Rio de Janeiro in 2023. The obtained data were complemented with sequences available in the literature from RJ (N= 49), SE (N= 35), BA (N= 62), and nES (N= 236) to perform the genetic structure analyses. The lowest haplotype diversity value was found for sES (0.316), followed by RJ (0.320), and the highest for SE (0.548). The haplotype CC-A4.3, previously found only in the nES population, was identified for the first time in the RJ region and in sES population. Pairwise F_{ST} analysis indicated genetic similarity between sES and RJ and among SE, BA, and nES, but significant genetic differences between these two groups of populations. These indicated two genetic stocks for Brazilian nesting loggerhead turtles (Genetic stock 1 = SE/BA/ES; and Genetic stock 2 = RJ), now expanded to include a population in the southernmost group (Genetic stock 1 = SE/BA/nES; and Genetic stock 2 = sES/RJ). The temporal analysis did not show any statistically significant difference between periods. This study emphasizes the low diversity and significant genetic differentiation of loggerhead turtle populations in sES and RJ compared to those further north, highlighting the relevance of molecular tools in understanding population limits. While mtDNA analyses are useful to characterize genetic diversity, we suggest analyses with biparental nuclear DNA in future studies for a deeper understanding of the genetic structure guiding future management and conservation initiatives.

NON-LETHAL SEX DETERMINATION IN TURTLES USING DNA METHYLATION*

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Global environmental change poses a significant threat to turtle populations worldwide. Understanding sex ratios and sex determination in turtles is therefore critical for effective conservation and management efforts. However, traditional sex determination methods in turtles tend to be invasive or require head starting neonates. There is hence a pressing need for accurate, non-lethal techniques to determine sex in hatchling. DNA methylation, the addition of a methyl group on DNA nucleotide, has been associated with gene regulation including of sex-related genes. Here, we developed a non-lethal sex determination method focusing on DNA methylation from blood samples of hatchling loggerhead turtles. This method was applied to a field split-clutch design experiment where nests were exposed to either male producing depth (lower temperatures) or female-producing depth (higher temperature). We identified several sex-specific differentially methylated genomic regions, which allow for highly accurate molecular sexing of turtles from blood samples. In this presentation we will also show the feasibility of the sequencing approach in the field. Overall, these findings indicate that DNA methylation analysis of blood samples provides a straightforward, non-lethal method to evaluate sex ratios in sea turtle populations. Widespread application of this technique will substantially improve knowledge of turtle primary sex ratios, enabling better targeted conservation strategies. Portable sequencing technology makes in-field molecular sexing possible, giving researchers an invaluable new tool to understand and protect turtle populations in a rapidly changing global environment.

REHABILITATION, HEALTH, AND VETERINARY CARE

CARING FOR LONG-TERM SEA TURTLE PATIENTS: EXPLORING THE POTENTIAL OF ENVIRONMENTAL ENRICHMENT STRATEGIES THROUGH THE EXPERIENCE OF LAMPEDUSA RESCUE CENTER, ITALY

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The goal of rescue and rehabilitation efforts is to provide assistance to injured sea turtles, primarily due to human interactions, with the ultimate aim of releasing them back into their natural habitat. Assessing the long-term well-being of patients is a challenging task, especially for those individuals that may not be suitable for release due to their specific conditions, such as amputated flippers or severe illnesses. These turtles may exhibit various behaviors and adaptations to their disabilities, influenced by factors like the duration of captivity and the characteristics of their holding tanks. Additionally, it's essential to consider the outcomes of turtles released after extended periods of rehabilitation and those with pre-existing disabilities before being rescued. Prolonged confinement and sedentary behavior in tanks, as well as enduring stereotyped movements, can lead to a decrease in muscle mass in turtles and, consequently, potentially lower survival rates after release. The impact of these factors on their overall well-being and behavior remains relatively unknown. One potential approach to address these issues may be represented by environmental enrichment, combined with spacious tanks that allow the individuals to move freely and choose whether to interact or not. Environmental enrichment (EE) encompasses a range of strategies designed to improve the well-being of animals in captivity or during rehabilitation. There are few documented cases in the literature of EE applied to sea turtles (all concerning captive animals in aquariums). Our goal was to test this procedure and quantify the potential enhancement of sea turtles' well-being during rehabilitation activity and whether this strategy can be considered a tool to increase the chances of survival of the animals and potentially their successful reintroduction into the natural habitat. In this research, we conducted an EE experiment involving four long-term resident sea turtles, each facing specific challenges, such as missing or damaged flippers. We implemented four distinct types of environmental enrichment. In this research, we conducted an environmental enrichment (EE) experience involving four of our long-term resident sea turtles, each of them facing specific challenges, such as missing or damaged flippers. We implemented four distinct types of environmental enrichment, including food-based, tactile, sensory, and mixed approaches, to improve their overall well-being. We closely monitored individual behaviors and interactions with the enrichments to assess their effectiveness and potential benefits for long-term residents. The EE sessions occurred over two-week intervals, alternating with two-week silent periods, and they were repeated over a span of six months. Subsequently, we analyzed the animals' interactions during these sessions to determine their engagement with the enrichment tools, potential improvements in their skills and whether this strategy could offer support to permanent residents unable to be released.

HOW HEMATOLOGICAL AND PLASMA BIOCHEMICAL PROFILES BENEFIT TURTLES UNDERGOING REHABILITATION IN THE SOUTHWEST INDIAN OCEAN*

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Marine turtles face numerous threats, both natural and anthropogenic. Around the world, care centers take in hundreds of injured or sick turtles each year and through their rehabilitation, contribute to the collective effort of turtle conservation. The temporary stay of turtles provides an opportunity to gather a multitude of data that can be used to improve knowledge and veterinary medicine. On Reunion Island, located in the southwest Indian Ocean, the Kelonia care center received 4 different species of sea turtle since 2000: *Chelonia mydas*, *Caretta caretta*, *Eretmochelys imbricata a*nd *Lepidochelys olivacea*. Each new turtle undergoes a thorough veterinary examination, which also includes blood sampling. Blood tests (i.e., Pack Cell Volume, White Blood Cells, total protein, glucose, calcium, creatinine, albumin, globulin, phosphorus and acid uric) are analysed to help with diagnosis and to guide treatment protocols. We therefore have the results of haematological and plasma biochemical values for 412 marine turtles since 2007: 312 loggerheads, 51 greens, 30 hawksbills and 19 olive Ridleys. Blood characteristics vary according to certain criteria (i.e., specie, wild versus captive, population) and are generally limited in our area. The aim of this study, in addition to establishing a hematology baseline for the region, is to compare survival outcomes considering physical examination findings and hematology and plasma biochemistry profiles. The average PCV per species is 33.9% (+/- 0.3), 31.1% (+/- 1.0), 26.4% (+/- 1.5) and 21.9% (+/- 1.9) respectively for loggerhead, green, hawksbill and olive Ridley turtles, confirming significant differences between each species. As for the fate of the turtles, the hematocrit of turtles that died during rehabilitation was significantly higher for loggerheads and hawksbills and lower for greens. Would this be species-specific (greens seem more prone to anemia) or show clinical signs (dehydration for loggerheads and hawksbills)? Also, the WBC levels for loggerhead turtles that died during rehabilitation were significantly lower than those of successfully rehabilitated turtles, suggesting a poor immune response in those cases. We are still investigating the results to shed more light on haematological and biochemical values of injured and sick sea turtles brought to Kelonia, to find possible correlations between those values and (i) the fate of the patient, (ii) the turtle size classes, (iii) the pathologies encountered and (iv) how caregivers can adapt treatments. Although the standards established in Reunion are not always comparable with the literature, partly due to differences in populations and the distinct geographical area, this recently developed baseline is already useful to Kelonia for adapting the rehabilitation process and the animal welfare. In addition, it will support the perpetual need for data acquisition and contribute to improve knowledge of marine turtles in the region by supplementing standards in the southwest Indian Ocean.

HELMINTH INFECTION OF THE LOGGERHEAD SEA TURTLE CARETTA CARETTA ALONG THE TUNISIAN COASTS

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Despite their potential ecological and environmental effects, parasites of sea turtles remain an underestimated component of ecosystem functioning. In Tunisian coasts, despite the Gulf of Gabès is an important foraging and wintering area in the Mediterranean Sea, the parasite fauna of the loggerhead sea turtles, *Caretta caretta*, remain poorly known. Here, we provide a new data on the presence of 9 parasite species in 10 individual loggerhead sea turtles *Caretta caretta* stranded along the Gulf of Gabès between June 2021 and August 2022. Analysis of variance (ANOVA) was applied among localities of stranded loggerhead sea turtles and prevalence of endoparasites was used to highlight any relationship between the parasites and the origin of the hosts. The necropsies revealed the presence of three helminthic species found in the stomach and intestine (3 Digenea, 2 Nematoda and 2 Cestoda) and two species of ectoparasites (one Copepoda and one Annelida). Among the Helminth parasites of *Caretta caretta*, Nematodes present the highest prevalence of infection (83.3%) followed by Digenea (66.6%) and Cestoda (33.33%). ANOVA showed significant differences ($p < 0.001$) among the data used. This work provides valuable information on the parasite fauna of loggerhead sea turtles. Due to the scarcity of sea turtle parasite studies in Tunisia (only one), it is reasonable to suppose that parasite species diversity in sea turtles of Tunisian coasts is considerably higher than reported to date. Further studies appear necessary to outline the parasitic fauna of *C. caretta* on Tunisian coasts.

CLINICAL EVALUATION, ENDOSCOPIC AND MICROBIOLOGICAL INVESTIGATIONS FOR THE DIAGNOSIS OF LUNG PATHOLOGIES IN SEA TURTLES (CARETTA CARETTA): SURVEILLANCE IN THE SOUTHERN ITALIAN SEAS*

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Assessment of the respiratory system in sea turtles is crucial due to their unique anatomy, with the lungs situated beneath the carapace, making them susceptible to injuries, particularly from vessel strikes. These injuries can result in open lung wounds, leading to aspiration, loss of buoyancy control, and secondary infections. Pulmonary diseases in sea turtles can stem from various causes, including entanglement in marine debris such as plastic waste, fishing lines, and ghost nets, which can directly harm the airways or lead to severe secondary infections. This study aimed to outline the diagnostic methods and treatments for pulmonary diseases in sea turtles. It involved 40 turtles, all of which exhibited radiographic signs of pulmonary pathology. Among them, four underwent more extensive diagnostic procedures, including bronchoalveolar lavage, which allowed for fluid retrieval from the lower airways. This fluid was then subjected to cytological and bacteriological examinations in all 40 subjects. The findings indicated that

radiographic examination proved instrumental in diagnosing pulmonary disorders in sea turtles. Bacterial cultures predominantly showed gram-negative strains, with a high level of antibiotic resistance, particularly against beta-lactams, Colistin sulfate, and Tetracycline. Treatment involved specific antibiotic therapies, such as Enrofloxacin and Ceftazidime, for a portion of the sea turtles. However, in cases where antibiotic resistance was prevalent against all antibiotics tested, lung disease resolution was achieved through techniques like coupage and environmental management, without antibiotic intervention. Ultimately, the study emphasizes the significance of thorough diagnostic procedures to attain accurate and early diagnoses, preventing unnecessary treatments and addressing antibiotic resistance in sea turtles. It underscores the importance of radiographic examinations as a primary screening tool for turtles displaying respiratory symptoms or abnormal buoyancy. Additionally, susceptibility testing with antimicrobials played a pivotal role in tailoring appropriate therapies, and contributing to the reduction of antibiotic resistance. All 40 sea turtles involved in the study were successfully released back into the sea following the treatments.

SURVEYING ANTIBIOTIC RESISTANCE OF GRAM-NEGATIVE BACTERIA ISOLATED FROM WILD-CAUGHT GREEN SEA TURTLES (CHELONIA MYDAS) AND LOGGERHEAD SEA TURTLES (CARETTA CARETTA) OF FLORIDA, U.S.A.

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Antibiotic resistance is a growing concern due to the improper use of antibiotics. Not only is antibiotic resistance increasingly occurring in human populations, but it appears to be spreading in wildlife populations as well due to their overuse and misuse in medicine, farming, and industrial settings, and their subsequent release into watersheds. This project examined the prevalence of antibiotic resistant bacteria in the hindgut microbiome of green (*Chelonia mydas*) (n=61) and loggerhead (*Caretta caretta*) (n=47) sea turtles in Florida, USA. Using cloacal swabs, wild-caught juvenile to adult turtles were sampled from two sites in Florida: wild-caught, apparently healthy turtles were netted at the St. Lucie Nuclear Power Plant and turtles in rehabilitation were sampled from the Gumbo Limbo Nature Center. Samples were plated and incubated using MacConkey agar to select for gram negative bacteria. Bacteria were then transferred to Mueller Hinton agar plates and tested for antibiotic resistance against six antibiotics. These antibiotics were selected to represent the main classes of antibiotics as well as the antibiotics frequently used in rehabilitation settings: (amikacin (30 µg), ceftazidime (30 µg), ampicillin (10 µg), tetracycline (30 µg), ciprofloxacin (5 µg), and azithromycin (15 µg)). 83.3% of samples were resistant or intermediately resistant to at least one antibiotic, and 27.7% of samples were resistant or intermediately resistant to three antibiotics. Of the specific antibiotics, 61.1% of samples were resistant to ampicillin, 27.7% of samples were resistant to azithromycin, 50% of samples were intermediately resistant to ciprofloxacin, 11.1% were resistant to tetracycline, and 16.6% were intermediately resistant to amikacin. There were no statistically significant differences between species regarding antibiotic resistance profiles. Interestingly, the greatest degrees of resistance were found to antibiotics used in human medicine, rather than those commonly used in sea turtle rehabilitation facilities. The concern was that turtles could spread pathogenic antibiotic resistant bacteria to turtles and other marine wildlife in their own habitats, especially since release back into the wild is the goal of wildlife rehabilitation facilities. Beyond aiding in digestion and nutrient uptake, the gut microbiome impacts host health by producing metabolic compounds, excluding pathogenic microbes, and contributing to the development of host intestinal immune homeostasis and systemic immune systems. The overall goal of this study is to provide more information about the relationship between health and the presence of

antibiotic resistance in the hindgut of Florida sea turtles, determine the types of bacteria found in the hindgut, and determine the prevalence of antibiotic resistance in wild Florida turtles. All work was performed under FWC Marine Turtle Permit #053.

NEW APPROACHES TO SEX IDENTIFICATION IN SEA TURTLES*

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Sex determination at early developmental stages in sea turtles continues to be an issue of primary interest and research priority. Despite recent advances in the field, determining the natural sex ratio of sea turtles remains a challenge for a variety of reasons, as does a complete understanding of the factors that influence embryonic sex determination. In the context of climate change, with global temperature increases, the description of a non-invasive, reliable, reproducible sexing method at different stages of development, applicable on a large scale, would represent a breakthrough in the study of populations and their ability to adapt to global warming. In this context, the use of traditional methods of measuring steroid hormones was re-evaluated as a tool for sexing 100 loggerhead sea turtles (*Caretta caretta*) of different age groups, post-neonates, juveniles, and adults, of known sex by endoscopy. At the same time, a metabolomic approach was applied to another group of 100 loggerhead turtles: 50 post-neonates and 50 juveniles (in the case of targeted metabolomics), and 24 neonates and 24 juveniles (in the case of untargeted metabolomics) with the aim of finding biomarkers of sex in plasma samples. The results obtained in both approaches have allowed us to identify the sex of the specimens according to those validated by endoscopic techniques. These results promote the development of useful tools for the study of sea turtle population dynamics and the impact of climate change on species with temperature-dependent sex determination.

TRAUMATIC FIBROMAS IN LEPIDOCHELYS OLIVACEA DURING REHABILITATION: CASE REPORT

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Fibroma is a benign neoplasm of fibroblasts with abundant collagenous stroma, of unknown etiology. However, there are occurrences of reactive, non-neoplastic lesions related to irritations/chronic trauma, common in the oral cavity of humans, called traumatic fibromas. In July 2022, an adult *Lepidochelys olivacea* with a curved carapace length (CCL) of 63 cm was brought to the Rehabilitation Center of Araruama (PMP-BC/ES) in Praia Seca, Rio de Janeiro, Brazil. The animal displayed good body condition and clinical signs of drowning, which were later confirmed in radiographs. Additionally, the examination revealed the presence of free air in the coelomic cavity (pneumoceloma). Due to the complexity of the condition and the persistent buoyancy alteration and swimming asymmetry, the rehabilitation period extended for approximately 10 months. Although the clinical condition gradually improved, the animal started to show stress-related behavioral changes, including reduced appetite and repetitive movements, often bumping into the walls of the 10,000L tank. Upon being moved to a larger 60,000L tank, the turtle's appetite returned, and there was a notable improvement in its behavioral patterns. Nonetheless, the growth of skin masses was noted in areas that had experienced greater friction within the smaller enclosure. In May 2023, following the remission of the initial clinical signs, the skin masses were surgically removed from the animal using a high-power surgical laser. Macroscopically, the lesions were nodular, with well-defined boundaries, measuring between 3 and 8 cm, and had a pedunculated insertion, smooth surface, soft consistency, and a rose coloration when cut. Some of the masses were still ulcerated due to constant friction with the enclosure's edges. Samples obtained during the surgery were preserved in 10% buffered formalin, subsequently processed, embedded in paraffin, cut into 4 µm sections, and stained with hematoxylin and eosin. The microscopic analysis revealed the proliferation of spindle cells in organized bundles, with slight anisocariosis and no mitotic figures, amidst abundant collagenous stroma, dilated blood vessels, moderate irregular acanthosis, and frequent ulceration. The clinical-pathological findings are consistent with traumatic cutaneous fibromas. The turtle recovered from the procedure in two weeks and was successfully returned to its natural habitat. Cases of cutaneous fibromas in chelonians are uncommon, and most described lesions were not linked to chronic trauma. While sea turtles might develop visceral fibromas associated with fibropapillomatosis, the localization and clinical-morphological aspects differ from those in this report. However, the findings resembled traumatic fibromas found in the oral cavity of humans, with the etiology attributed to constant friction with the tank edges. In such cases, it is recommended to reduce captivity-related stress and eliminate the traumatic factor, followed by the excision of the lesions, thereby minimizing the chances of recurrence. This report underscores the significance of identifying behavioral changes and potential chronic injuries during the rehabilitation of sea turtles, as well as the accurate diagnosis and treatment of this condition.

FACING UNEXPLORED DEPTHS: A NEW SURGICAL APPROACH TO REACH A CHALLENGING ESOPHAGEAL SEGMENT IN CARETTA CARETTA SEA TURTLES*

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The ingestion of hooks and/or lines, often resulting from sea turtle interaction with fishing activities, frequently leads to severe injuries in the digestive tract, ultimately resulting in fatality. In cases where foreign objects become lodged in the cervical oesophagus, their removal is performed through the ventral surface of the neck. For hooks firmly wedged in the intracoelomic portion of the oesophagus, a supraplastron approach is employed. Injuries caused by lines tend to be more severe, often resulting in intussusceptions and tears in the gastrointestinal tract. The development of new surgical procedures for accessing the coelomic cavity has significantly improved the survival rates of these patients. The preferred approach allowing to reach the stomach is through the left axillary region; hooks and lines in the intestine or pyloric area are removed by accessing the coelomic cavity through the right or left prefemoral fossa. Despite these advanced techniques, they may not always ensure access to all portions of the digestive tract.

Some segments may remain concealed by vital organs, as it is the case with the caudal area of the oesophagus before reaching the cardias valve. In this specific tract, the oesophagus is surrounded by the left bronchus, near the subclavian artery, presenting difficulties to be exposed for surgery. A new surgical procedure here is presented to have access to this challenging oesophageal segment: the "gular approach" has been conceived for the first time in a loggerhead sea turtle with a hook perforating the left bronchus. A skin incision of 8-10 cm is performed between neck and shoulder, following the dorsal edge of the gular plate on the plastron. Subsequent to the subcutaneous tissue dissection, the superficial deltoid muscle is incised and the deep deltoid and supracoracoid muscles are then gently parted along the dorsal side. This procedure exposes the end portion of the subclavian artery, which is carefully cranio-laterally shifted and safeguarded using a retractor. The procedure is finalized by an incision into the antero-lateral portion of the coelomic cavity's dome in order to reach the final portion of the oesophagus. Through images and videos, step by step the novel procedure, complex and requiring advanced surgical skills, is described with the aim to provide guidance to expert surgeons looking to adopt this advanced technique in similar scenarios.

CLINICAL AND RADIOGRAPHIC EVALUATION OF MORTALITY LEADING CAUSE IN ACCIDENTALLY TRAWLED SEA TURTLES: DROWNING OR GAS EMBOLISM?

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In the Mediterranean, very intensive fishing activity has a strong impact on the marine ecosystem and represents one of the main threats to large vertebrates of conservation interest, such as sea turtles. Trawling fishery results in the highest probability of incidental catches of sea turtles and a high mortality rate in these animals (18%); in reference to mortality, to date drowning has been recognized as one of the main causes. In 2014, a clinical-pathological condition called "Gas embolism" (GE) was identified and linked to a high mortality rate (30-41%). The aim of the present study was to identify the main cause of death of accidentally trawled sea turtles in the south Adriatic Sea, through clinical and radiographic evaluation, and to define their mortality rate in a significant sample. Between November 2017 and April 2023, a total of 1440 Loggerhead sea turtles (*Caretta caretta*) were referred for clinical evaluation at Sea Turtle Clinic (STC) of the Department of Veterinary Medicine of University of Bari. All the turtles were caught in trawl nets along the coastline of the southern Adriatic Sea and, of these, 33% showed radiographic signs compatible with GE, 3% radiographic signs compatible with drowning and 9% radiographic signs compatible with GE associated with drowning. Out of 1440 turtles accidentally trawled in the southern Adriatic Sea, covered by this study, a total of 61 died (overall mortality rate: 4.24%) of which: 38/1440 (mortality rate: 2.64%) died from GE, 2/1440 (mortality rate: 0.14%) died from drowning, 13/1440 (mortality rate: 0.90%) died from GE associated with drowning, 8/1440 (mortality rate: 0.56%) died for other pathological conditions not related to trawling. 96% (1379/1440) of the turtles accidentally trawled and delivered to the STC over a 7-year period were released back into the sea. More precisely, the following were released: 697 turtles without clinical and radiographic pathological signs, 551 affected by GE or GE associated with drowning, 91 affected by other pathological conditions not related to trawling and 40 affected by drowning. 92% (591/644) of the turtles affected by GE, drowning and GE associated with drowning, recovered in a period of time varying from 2 to 13 days, without any supportive pharmacological therapy, but thanks to housing in tanks outside from water or with a low water level, inside a room with a temperature of approximately 25-30 °C. Only in 5 turtles that suffered from severe drowning was the bronchial tree washed with sterile water. The present study suggests that the leading cause of mortality in accidentally trawled sea turtles in south Adriatic Sea is Gas embolism.

INCIDENCE AND OUTCOMES OF HEAD TRAUMA IN INJURED SEA TURTLES IN SOUTH ADRIATIC SEA*

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Traumatic injury to sea turtles can occur due several causes such as vessel strikes, interaction with dredges, fishing activity, inflicted by humans, natural predation. Among traumatic injuries, those involving the skull can be complicated by brain exposure; turtles with severe skull injuries that have nervous system impairment, emaciation and dehydration can't often survive. Since July 2014 the Sea Turtle Clinic took in charge all cases of head injuries in sea turtles with the purpose of studying: 1) the incidence of head trauma in injured sea turtles in South Adriatic sea, 2) the severity and type of the injuries and the role of CT in these evaluation, 3) the neurological deficits and damages to the sense organs and whether there is a correlation between these deficits and the extent of head injuries, 4) the possible treatments, 5) the sequelae and complications of this condition and 6) the rate of mortality. In this retrospective study 2081 *Caretta caretta* were evaluated, 36 of which showed head trauma. The severity of head injuries was assessed by clinical and neurological examination. Physical and neurological evaluations were performed to assess and grade the lesions and neurological deficits. CT examination was essential to evaluate impaired central nervous system and sense organs. In 25/36 sea turtles with more severe head trauma, computed tomography (CT) findings in combination with physical and neurological evaluation, enabled to evaluate whether there is a correlation between deficits and the extent of head injuries. External head injuries were classified, and 6 turtles presented with mild, 8 with moderate and 22 with severe trauma. Mentation was classified as alert in 18 turtles, depressed in 10, and lethargic/comatose in 8. In 13 subjects, the head trauma involved the orbital, nasal, and squamosal bones with a possible compromise of the sensory organ (eyeball, nose, ear). A complete neurological examination, including observations made both in and out of the water, performed in all 36 traumatized sea turtles revealed that 48% had no impairment of the nervous system (NS) and mentation state was alert; in 31% the mentation state was depressed, and in 21% the mentation state was lethargic/comatose. In the present study, 28% of the turtles showed head damage related to severe neurological deficits. According to our scoring classification set for the grading of skull injuries, 65% were severe lesions, while 21% and 14% were moderate and mild wounds, respectively. In animals that have survived, we observed a progressive recovery of neurological reflexes during or after complete healing of the head. All sea turtles underwent curettage of the skull wounds: the treatment protocol included the use of a plant-derived dressing (Neem oil and *Hypericum perforatum*). Twenty-seven out of 36 sea turtles were released after a time ranging from a few days to 1-8 months.

COMORBIDITIES IN LIVE STRANDED COLD-STUNNED SEA TURTLES FROM THE PACIFIC COAST OF NORTH AMERICA*

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Along the Pacific coast of North America, hard-shelled sea turtles using coastal and offshore foraging habitat may disperse into new areas following currents or warm water thermal corridors. As ectothermic marine reptiles, they are susceptible to cold-stunning (hypothermia) when ocean temperatures drop causing them to wash ashore. Thus, their stranding patterns on temperate foraging grounds may reflect real-time shifts in ocean temperature. Previous cold-stunning research has focused primarily on juvenile sea turtles during periodic mass stranding events along the Atlantic and Gulf coasts of the United States; however, little is known about how this phenomenon impacts large immature and adult turtles in eastern Pacific foraging and over-wintering areas where relatively fewer strandings occur. The goals of this study were to develop a working case definition for cold-stunning for this region and document comorbidities present at the time of stranding for the species and stage classes affected. Criteria for case inclusion were hard-shelled sea turtles that stranded alive north of Point Conception (Santa Barbara County, California, USA) from 2009 to 2022 with a corresponding minimum sea surface temperature at stranding and/or cloacal temperature at intake examination ≤15.0℃. This temperature cut-off was selected based upon the observed thermal threshold of inactivity for resident green turtles in southern California and documented conditions associated with live sea turtle sightings in the study region. A total of 53 cases met the inclusion criteria, including 39 Pacific olive ridleys (*Lepidochelys olivacea*), 10 East Pacific greens (*Chelonia mydas*), and 4 North Pacific loggerheads (*Caretta caretta*). In collaboration with partners from the NOAA West Coast Stranding Network and Department of Fisheries and Oceans Canada, all available stranding, clinical, and necropsy data were compiled from the first two weeks in care. Live strandings occurred year-round as far north as British Columbia with the majority of cases between November and January. A mentation scoring system was developed to categorize subjective descriptions of mental alertness and responsiveness at the time of initial assessment; none of the turtles that presented as comatose and unresponsive survived beyond 5 days. On initial physical examination, turtles exhibited signs of malnutrition, mild to moderate epibiota coverage, acute external trauma, dermatitis, corneal ulcers, peripheral edema, and cloacal prolapse. Approximately 25% (13/53) survived to release or remain in care to date. Of the 75% (40/53) that did not survive, 33 died within 2 weeks of stranding with the vast majority surviving less than 3 days in

rehabilitation. Of the cases that were necropsied with histopathology (n=25), significant findings included fungal pneumonia, severe fibrinonecrotic gastroenteritis, intestinal impaction, coelomitis, severe fat atrophy, steatitis, myonecrosis, renal granuloma, and yolk embolism. Confirmation of gonad maturity at necropsy revealed misclassification of stage class for 30% of turtles based on mean female nesting size alone. Further analyses will focus on the relationships between temperature, severity of clinical and pathological abnormalities, and survival outcomes to develop prognostic indicators and standardize data collection across the region to improve rehabilitation outcomes for these protected species.

SKIN LESION IN AQUACULTURE GREEN SEA TURTLE, CHELONIA MYDAS

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The green sea turtle, Chelonia mydas (*C. mydas)* travels thousands of ocean miles for most of its life, which makes it difficult for us to observe its physiological personalities and life histories. For that reason, sanctuaries are established to protect, closely monitor, and observe the various threats to the species and conserve the population of these species, given its current endangered status. In Malaysia, The Turtle Conservation and Information Centers (TCICs) was established by the Malaysia Department of Fisheries to provide information on sea turtles and support conservation efforts through rehabilitation, research, hatchery establishment, and awareness programs. Unfortunately, there has been an increase in skin lesion disease in the captive *C. mydas* population in TCICs especially in Segari, Perak which causes are still a biological mystery. Skin lesion is a complex group of diseases that can have a genetic-related basis which raises concern among the conservation team. The causes of the skin lesion may include external factors such as humidity, conservation center environment, water pollution, pool capacity, and diet. At the same time, genetic mutation may also be the contributing factor of the increasing skin lesion in *C. mydas*. As of to date, the genomic profile of the *C. mydas* has never been explored, which inquires whether the disease affects the species to its genome. To investigate this issue, blood samples from six *C. mydas* were collected where the DNAs had been extracted; two samples from the healthy wild *C. mydas* from Chagar Hutang, Pulau Redang, Terengganu and two samples from healthy and unhealthy captive *C. mydas* in TCIC Segari, Perak respectively. Using genome sequencing technology, the whole-genome sequence data of *C. mydas* were obtained from their DNA samples and the entire genome were reconstructed through genome assembly processes. In this study, we intend to explore and use two potential computational techniques based on deep learning methods known as DeepVariant calling and DeepSV calling to identify genetic variants that can unravel some clues on skin lesion issues of *C. mydas* in captive population. The predicted genetic variant results of all group of *C. mydas* genome sequences from both deep learning methods will be compared, integrated and validated accordingly. Variant annotation will then be conducted to interpret potential impacts of these genetic variants on *C. mydas* gene functions, disease risks and therapeutic responses.

CHANGES IN CORTICOSTERONE LEVELS OF NEW YORK'S COLD STUNNED SEA TURTLES FROM RESCUE TO RELEASE*

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In response to prolonged stressful events, sea turtles produce the hormone corticosterone, which circulates in the bloodstream and contributes to mobilization of energy reserves. When sea turtles strand on beaches in the northeastern U.S. in the late fall and winter due to cold stunning, a process akin to hypothermia, exposure to cold conditions triggers corticosterone production. Release of this hormone is an important physiological component of the cold stunning response. Life stages and species most prone to stranding from cold stunning on New York's beaches are juvenile Kemp's ridleys and Atlantic greens, along with subadult loggerheads. This study documented the change in plasma corticosterone that sea turtles experienced following rescue and rehabilitation, aiming to understand how levels change over time, and to correlate plasma levels to successful rehabilitation and release. During 4 cold stun seasons (2020-2023), blood samples were obtained by a senior staff member from the New York Marine Rescue Center (NYMRC) for all live stranded sea turtles. Samples were taken at three intervals: during the intake physical (day 1), after the animal was warmed to optimal body temperature (day 5, approximately 24˚C), and shortly before the individual's release following rehabilitation (6-9 months post-rescue). Animals that died during rehabilitation were sampled post-mortem. Plasma samples were processed at Manhattanville College with a Corticosterone ELISA kit (Enzo Scientific) optimized for vertebrates. Corticosterone levels were indeed highest following cold stunning and showed a progressive decrease over time. However, trends seen across the three species differed, with Kemp's ridleys exhibiting higher average corticosterone levels throughout the rehabilitation period. Analysis of this data will allow us to further understand the physiology of recovery from cold stunning, which supports broader conservation efforts of sea turtles along the northeastern US coastline.

CRACKING THE CODE OF SEA TURTLE REHABILITATION: INSIGHTS FROM 23 YEARS AT LAMPEDUSA TURTLE RESCUE (SOUTH MEDITERRANEAN, ITALY)*

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The Lampedusa Sea Turtle Rescue Center, which has been in operation since 1990, has established strong relationships with the local fishery fleet in the archipelago, allowing the rescue of over 6,000 loggerhead sea turtles. In this study, we analyzed data from 3,275 hospitalized *Caretta caretta* turtles up to the year 2023. Our primary goal was to identify factors that could impact the success of rehabilitating injured sea turtles at our facility. We thoroughly examined several key factors, including the type of clinical case, the health condition of the animals, the type of therapy administered and the presence of qualified surgeons. For the first factor, we assessed the survival percentage among animals with various clinical cases, such as infections, flipper/carapace/head fractures or wounds, and the presence of hooks or fishing line entanglements in the digestive tract. Among these clinical cases, a few displayed a rehabilitation success

rate below 50%, particularly cases involving head fractures and those with entanglements in various locations. For the second factor, we evaluated therapy outcomes (recovery or death) and the health condition of the turtles (good health, depressed, or comatose) using the Fisher exact test. The results from the Fisher's test confirmed the significant influence of the turtles' health condition on the success of sea turtle rehabilitation (Fisher test=369.894; d.f.=2; P<0.001). Regarding the last factor, we divided the study period into five subperiods (2001-2005, 2006-2010, 2011-2015, 2016-2020, 2021-2023) based on the evolution of surgical techniques and the presence of expert surgeons with direct experience in sea turtle surgery. Our ANOVA analysis further supported the significance of the professionals' experience (univariate ANOVA=4.953; d.f.=4; P=0.016). It became evident that bycatch and the health condition of the turtles significantly influenced the success of rehabilitation, while the presence of competent surgeons led to a substantial increase in sea turtle survival, aligning with our expectations.

A MULTIDISCIPLINARY APPROACH ON THE HEALTH ASSESSMENT OF LOGGERHEAD TURTLES UNDERGOING REHABILITATION: SUPPORTING THEIR ROLE AS SENTINELS OF MARINE LITTER

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Sea turtles are proposed as sentinel species through Descriptor 10 of the European MSFD on marine litter with the goal "Properties and quantities of marine litter do not cause harm to the coastal and marine environment" in the assessment of ocean health. In the marine environment, microplastics (plastic material of < 5mm) constitute an emerging threat by itself, but also for the additives they structurally contain and/or the organic pollutants from the surrounding media that may be adsorbed to their surface. Marine turtles are long-lived animals with a life style and pelagic habits that make them particularly vulnerable to plastic litter. In addition to the use of sea turtles as bioindicators, the combined efforts between fishermen, researchers, veterinary and recovery centers should act together in the direction of improving not only their survival rates after incidental bycatch but also improving their health status after rehabilitation and before entering the natural marine environment. In this sense, the cooperation so far between ten research institutes has led to the CAOUA project "Assessment of the impact of micro-plastic pollution on the intestinal microbiota and the vulnerability of loggerhead turtles (*Caretta caretta*) in the Gulf of Lion. This project conducted in the NW Mediterranean region focusses on the use of about 100 loggerhead turtles undergoing rehabilitation in recovery centers during the period 2021-2023. Its main goal is to determine the link between turtle's overall health status assessed with the aid of 1) well-established biochemical blood parameters, 2) the activity of plasmatic B-esterases, 3) the intestinal microbiota composition and microplastics content on their excreta. The existence of an association between microplastic incidence and intestine flora alterations (dysbiosis) could consequently affect their health performance that could be traced through immune alterations and neurotoxicity. Given the evidences of the link between microplastic exposure, immune depression and neural disorders in other animal groups, it is our goal to test the adequacy of loggerhead turtles as sentinels of microplastic pollution in the Mediterranean. Not only for the health implications it reports to this IUCN Red List Threatened Species but also to humans in the frame of the One Health concept. CAOUA is a pioneer successful project, which will be followed by the TORPP One Health consortium initiatives encompassing human health. These new proposals will include hospital and researchers from Nantes in France (Europe) and an additional partner, the overseas Pointe a Pitre Hospitals in La Guadeloupe (French Antilles). These new MIGUD and MIPMAT projects are under evaluation.

HEALTH AND HEMATOLOGICAL EVALUATION OF CAPTIVE HAWKBILLS SEA TURTLE IN A REHABILITATION FACILITY IN THAILAND

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Ensuring optimal health for captive sea turtles poses a significant challenge due to difficulties in replicating their natural diets and environments. Routine health monitoring is crucial to evaluate health status and to reflect their husbandry. In this study, the health status and haematological parameters of 13 captive hawksbill turtles (*Eretmochelys imbricata*) were examined. The turtles were from a rehabilitation station of by-catch sea turtles in Chonburi Province, Thailand, consisting of 1 male and 12 female adults of unknown age. The average straight carapace length and width were 59.13 cm and 44.96 cm, respectively. The overall mentation and health of the turtles were in average condition. Five out of 13 turtles have few visible external lesions on the head, neck, or flippers, which are possibly due to overcrowding. Some individuals have the presence of purulent exudates on the lesions. Blood samples were taken from the dorsal cervical sinus in a heparinized tube. The samples were submitted for haematological, and blood chemistry analysis. The average haematological values were as follows; hematocrit 29.77%, RBC 1.03×10^6 cells/ul, WBC 9.22×10^3 cells/ul. Differential WBC counts showed that some individuals expressed low monocyte counts. The RBC counts in 11 turtles were slightly higher than the reference values. Other haematological values and Blood morphology were within the normal limits. No blood parasite was found. For blood chemistry values, elevated Alkaline Phosphatase (ALP), blood urea nitrogen (BUN), and plasma albumin values were observed in all turtles, with an average ALP of 133.15 U/L, BUN of 52.15 mg/dl, and Albumin of 2.11 g/dl. Phosphorus and uric acid were observed to increase in 2 different individuals. On the other hand, the AST value was lower than the reference value in 4 individuals. An individual showed an increased phosphorus (P) level despite normal Calcium (Ca). The Ca:P ratio in most individuals was close to 1, with an average of 1.03. Two individuals show an inverted Ca:P ratio with a value lower than 1. Hypernatremia was also observed in 4 individuals, which is usually caused by dehydration. The plasma chloride and potassium were within normal limits. Captive sea turtles usually receive diets that are different from their natural preference. Hence causing alterations in haematological and plasma chemistry value, or consequently impairing health status. In our case, these turtles received only assorted fish chunks, which are high in protein and phosphorus contents. This can lead to an increase in plasma BUN and phosphorus levels, which are commonly reported from captive sea turtles. Both parameters are direct metabolites from protein catabolism. In many published studies, regarding high P intake and low Ca intake, the plasma Ca:P ratio of captive sea turtles can be as low as 0.5. In summary, this population of captive hawksbills exhibited average health, with potential diet-related haematological alterations. Ongoing monitoring is essential for the overall well-being of captive turtles and establishing baseline blood parameters aids veterinarians in providing timely care and interventions for any future health issues.

VIRTOPSY-LED SEA TURTLE STRANDING AND SALVAGE PROGRAMME IN HONG KONG: IMPLEMENTATION, PITFALLS AND WAY FORWARD*

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Understanding the status of sea turtle populations, and threats that may impact their survival are important for effective conservation. Stranding data represents a valuable opportunity for research by providing knowledge on the occurrence and spatiotemporal trends of different species and life stages, their biological health status, as well as morbidity and mortality caused by both natural and anthropogenic threats. However, the use of stranding data could be limited by biological and oceanographic factors (e.g., carcass decomposition, ocean current), as well as unstructured post-mortem investigation protocol, leading to unquantifiable survey effort and inconsistent data collection, forbidding precise health and mortality assessment. Virtopsy (virtual necropsy), the application of post-mortem imaging techniques, has been applied extensively in veterinary forensic medicine and is proved to be conducive to the ease of operation, enhanced reproducibility, digital storage, and opportunity to seek second opinion. Virtopsy provides initial or complementary evidence on the health status and cause of death of stranded animals, and serves as a guide for veterinary pathologists, improving the accuracy in subsequent diagnosis and facilitating disease surveillance. Since 2014, a pioneer virtopsy project has been implemented to advance the local cetacean stranding programme in Hong Kong, and since August 2019 the application has been extended to sea turtles (both live and deceased). Computed tomography (CT) and three-dimensional surface scanning (3DSS) have been routinely performed to document the internal and external conditions of each subject whenever possible. To date, 52 live stranded and 42 deceased sea turtle carcasses of 5 different species (*Caretta caretta*, *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata*, *Lepidochelys olivacea*) were studied using the virtopsy approach. The role of virtopsy has become pivotal as veterinarians and stranding response personnel became more aware of its strengths. Previously, necropsy was often omitted for carcasses of advanced decomposition in view of limited findings anticipated. Through virtopsy, biological health conditions can be documented without disrupting the body integrity. This allows the *in situ* detection of various pathologies, including skeletal dislocation, fluid accumulation, gas embolus, foreign body ingestion, and parasitic infection. These additional findings largely improved the assessment of injuries and deaths caused by anthropogenic threats, especially for decomposed carcasses. The non-invasive approach also minimized the risk of contracting zoonotic diseases for the personnel involved. Discussions regarding the modification of stranding response workflow to accommodate virtopsy, including concerns over manpower, logistics, equipment, and safety, were followed by the standardisation of protocols and techniques for clinical and post-mortem investigation. Pitfalls encountered were addressed with corrective measures to ensure the structural and practical management of the first virtopsy-led sea turtle stranding and salvage programme worldwide. The novel scheme of image data reconstruction methodologies has substantially modernised the characterisation and documentation of external and internal conditions of sea turtles. By advocating the use of virtopsy, we aimed to address knowledge gaps in the biological health and stressors that caused morbidity and mortality that conventional necropsy may not be able to answer, which will inform better veterinary practice, conversation management and policymaking for the protection of sea turtles.

A SUMMARY OF TWENTY-FIVE YEARS OF SEA TURTLE REHABILITATION AT THE KAREN BEASLEY SEA TURTLE RESCUE AND REHABILITATION CENTER, NORTH CAROLINA, USA*

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The Karen Beasley Sea Turtle Rescue and Rehabilitation Center (KBSTRRC) is a non-profit sea turtle conservation organization in North Carolina. Its mission includes rescuing, rehabilitating, and releasing stranded sea turtles. Since its founding in 1997, KBSTRRC has acquired a 25-year data set of sea turtles admitted for rehabilitation. The recent implementation of RaptorMed, a medical records database, is allowing exploration of the organization's rehabilitation trends over time. Over the past 25 years, KBSTRRC has treated 1,313 sea turtles, including 591 greens, 430 loggerheads, 290 Kemp's ridleys, one post-hatchling leatherback, and one known hybrid (green x loggerhead). Most of KBSTRRC's admitted turtles stranded in North Carolina, although some patients were transferred from organizations in Massachusetts and elsewhere. Between 1997 and 2007, loggerheads represented the highest percent of admissions. After 2007, there are increasing numbers of Kemp's ridley and green turtle admissions. Sea turtle admissions peak from November through January, with January seeing the highest overall admission numbers. This is primarily due to an annual cold stunning event that occurs during this time. There is a smaller peak from April through June. Many of these strandings involve human interactions such as fish hooks, boat strikes, and entanglements in line. We attribute this peak to the seasonal increase in people on and around the water, coupled with concurrent large numbers of migrating, nesting, and foraging turtles in the area. Most fish hooks, internal and external, can be removed and the animal released quickly. Many boat strike injuries, on the other hand, are fatal. Natural illnesses seen include cold stunning, nonspecific "debilitated turtle syndrome," which is often presumed related to past cold stunning events, and shark bite injury. This preliminary summary presents our first comprehensive review of the data. We hope continued data examination will offer additional insight into sea turtle health, disease, and rehabilitation.

SOCIAL, ECONOMIC AND CULTURAL STUDIES

CORPORATE PARTNERSHIPS: GREENWASHING OR VALUABLE SUPPORT FOR SEA TURTLE ORGANIZATIONS?*

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Sea turtle organizations have diverse funding options. This presentation will take a closer look at corporate partnerships. Corporate social responsibility (CSR) is becoming increasingly important for both companies and non-governmental organizations, partly due to the social and environmental consequences of globalization and climate change. Many companies are willing to take on social responsibility and engage in philanthropic activities, often in collaboration with non-profit organizations. The nature of these collaborations is diverse, ranging from monetary donations to cause-related marketing campaigns, sponsorship activities or collaborative projects. Companies engage in philanthropy driven by varied motives—some for altruism, others for marketing advantages, reputation enhancement, or employee motivation. Legal obligations or tax benefits also prompt donations. For sea turtle organizations, corporate contributions can serve as a funding source and support them to realize their projects. However, the mere establishment of a partnership does not guarantee successful implementation. Both parties should build a relationship and consider different preferences regarding support. Successful collaborations between companies and non-profit organizations can be mutually beneficial, creating a widely touted "win-win situation" if both sides are aware of their interests and needs. One challenge in this context is the phenomenon of greenwashing. Here, companies try to create an environmentally friendly image through PR and marketing measures, while the company's primary activities are still environmentally harmful and anything but sustainable, creating a misleading public image. Partnerships with sea turtle organizations, which are often perceived positively by the public, are particularly popular as greenwashing tools. Despite the financial incentives, the organization should remain true to its values and choose its partner carefully. A negative corporate image or loss of reputation can have a negative impact on the public perception of the NGO, too. The effort an NGO has to put into managing a corporate partnership must also be taken into account. Some collaborations can require a considerable amount of work from the NGO, which is often not sufficiently compensated for by the company's financial support. One recommendation is that NGOs should draw up guidelines and conditions for cooperation and sponsorship projects. These guidelines could evaluate partnership requests based on the proposed funding, duration and type of company involved. In addition, existing collaborations should be regularly evaluated and deviations from expectations should be openly communicated. Collaboration between companies and non-governmental organizations (NGOs) will become increasingly important in the coming years. We will explore the drivers and expected outcomes of partnerships between companies and sea turtle-focused NGOs. The session will provide insights into successful and fruitful collaborations, as well as instances where partnerships have faced challenges. In addition, the discussion will explore best practices and the valuable lessons learned from these collaborative efforts.

INCIDENTAL DISCOVERY OF MATERIALS, EQUIPMENT, AND METHODS THROUGH THE WORDS OF A CAREY CRAFTSMAN

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The hawksbill sea turtle (*Eretmochelys imbricata*) is critically endangered according to the IUCN Red List and the Venezuelan Red Book of Threatened Species. As recognized globally, their populations have been significantly reduced, primarily due to the use of their carapace for utilitarian instruments initially (cutlery, buttons, pipes, brushes, combs, musical instruments, guitar nails, etc.), followed by jewellery, ornaments, and spurs for fighting roosters. In Venezuela, these crafts experienced significant growth from the late 19th century until the 1970's when the prohibition on capturing wild species, including sea turtles, came into effect. This prohibition includes the use of their products and by-products. Despite this, the illicit production of objects using hawksbill shell persisted. Interestingly, over time, artisans grew older and passed away, reducing the number of skilled craftsmen. The younger generations showed less interest, alleviating pressure on the hawksbill sea turtle. This trend began in the 1940's when plastic gained popularity. Those who remained gradually focused almost exclusively on making spurs for roosters, partly due to an inability to compete with the prices of illegally imported jewellery from Cuba, and partly because of the ongoing illegal demand for spurs. Illegality surrounding this practice has hindered researchers from understanding the details and secrets of this art. Presently, in Venezuela, amidst political and economic challenges, some artisans are abandoning these practices. During a casual conversation with one of them and through direct observation, convenient sampling was conducted, yielding the materials and recordings as a gift. The artisan noted that due to the "level of difficulty and time required to work with the shell," as expressed by a fisherman and artisan from eastern Venezuela, a resident of Los Roques National Park, the most critical nesting area in the southern Caribbean and collaborator of the conservation project, "alternative sources of income must be sought quickly." Unfortunately, many of these alternatives are also illegal. The collaborator has generously provided us with a complete set of tools for working with the shell, including elements he personally crafted for cutting, shaping, and polishing garments. Additionally, he provided a detailed explanation in his own voice, allowing us to record how each instrument or material is used. Here, we present the transcribed recording and photographs of each component exactly as they were received, in order to generate knowledge for the general population, to have the ability to identify, based on the objects used, if there are carey craftsman in the locality, since it allows them to know the tools and instruments for their production. Even though in Venezuela this activity is disappearing, some processes were known, but to date the complete set of tools and their functions were not available. Knowledge of its production will help identify the artisan and then be able to report and suppress said illegal activities.

HISTORICAL ECOLOGY APPLIED TO SEA TURTLES*

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The conservation of sea turtles is of utmost importance in the face of increasing anthropogenic pressures and changing environmental conditions. Exploring the ecological history of these iconic marine reptiles using bioheritage collections, including specimens from archaeological sites or museums, provides a unique opportunity to compare historical sea turtle populations to the present day. Historical ecology explores how ecosystems have changed over time and the implications for present ecosystems. By analysing stable isotopes of archaeological green turtle bones from the Levant, we found indications that foraging habits changed across different time periods. This shift was potentially in response to varying environmental conditions or climate change, offering insights which could aid in the understanding of how sea turtle populations may react to future scenarios. Furthermore, investigating the genomics of past sea turtle populations offers potential for valuable insights into the historical dynamics of these species. Understanding how genetic diversity has shifted between past and present can provide essential context for assessing potential genetic bottlenecks within contemporary populations. Here we explore the preservation of genomic ancient DNA in archaeological and museum specimens to explore the feasibility of population genetic analyses comparing past and present. In addition to ecological parameters, historical ecology may enable the quantification of human exploitation of sea turtles in the past. By examining historical records, such as those from the Dutch East India Company, there is an opportunity to gain a better understanding of historic removal numbers from respective geographic areas. These insights may serve as important baselines for assessing the current status of sea turtle ecology and determining the level of human impact over time. By including examples of how historical ecology has been applied to sea turtle research, this presentation highlights the opportunities the field holds for biologists and conservation practitioners. By combining data from bioheritage collections, stable isotope analysis, genetic studies, and historical records, researchers can better understand historical changes and their drivers. This underexploited information can contribute to developing strategies to ensure the conservation of sea turtles in the Anthropocene, offering a longue durée perspective on their ecology.

ROLE OF COMMUNITY PARTICIPATION IN THE PREVENTION OF SEA TURTLE ILLEGAL ACTIVITY IN BOCAS DEL TORO, PANAMA*

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The Sea Turtle Conservancy (STC) has been working in Panama since 2003. During all these years the main goal of our organization has been to preserve the sea turtle populations in the Caribbean Sea developing different conservations strategies. The most important strategy is to decrease illegal sea turtle activities. To this end, involving the local communities in conservation activities is a priority, and offering an economical alternative to local families that use the turtles as a recurse to survive is necessary. Thanks to our conservation efforts during those years in Panama, the number of nests poached, and turtles hunted

at the beaches where we work have decreased considerably, and the number of turtles and successful nests increased every year. Basically, our conservation strategies and efforts implemented in the region have focused on the nesting beaches and the results are very encouraging. However, we know that there is a lack of information about what is happening in the sea, where the fishermen and poachers are hunting turtles. Sometime locals accidentally kill a turtle due to bycatch, but other times hunting activities are directed to the turtles, especially during the mating season, when it is easiest to find them and catch them both, male and female at the same time. During the last few years, neighbors in the area have contacted us to inform us about boats hunting turtles, nets taken from nesting beaches, and others illegal activities. Recently, we started an in-water program to identify the different areas in of Bocas del Toro archipelago to determine where the turtles are, which development stages are more abundant, and which are the areas of highest risk due of the presence of poachers. Different operatives are being conducted between the Police, Navy and STC staff, trying to decrease those illegal activities. However, we realized that that during the operatives it was very difficult to find the poachers. We think that the poachers and fishermen are probably being informed about the operatives. Fortunately, even without catching any poachers, the presence of the authorities in the sea serves as a deterrent to poaching activities. Since 2020, a local fisherman from the Bocas del Drago area is working with us, helping with the morning track surveys, and providing us information about where the poachers are hunting turtles. Thanks to this information, the number of poached turtles found in the last three years in the Drago area is higher than any other years, which demonstrates the importance of having people from the area working together with the conservation organizations and local authorities to be able to do a better job and to document poaching activity.

COMMUNITY LIVELIHOODS DEVELOPMENT AS A SEA TURTLE CONSERVATION TOOL IN SRI LANKA

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Five of the world’s seven species of marine turtle come ashore to nest in Sri Lanka. They are the Green turtle (*Chelonia mydas*), Leatherback turtle (*Dermochelys coriacea)*, Loggerhead turtle (*Caretta caretta*), Hawksbill turtle (*Eretmochelys imbricata*) and the Olive Ridley turtle (*Lepidochelys olivacea*). Coastal communities of Sri Lanka depend on their surrounding natural resources for their survival and as a result of this, very important coastal habitats and coastal biodiversity such as the coral reefs, sea grass beds, mangroves, marine turtles and other coastal vegetation are under the threat of extinction. Coastal communities continue to use the coastal resources in destructive manner by violating the existing environmental laws due to their poor income. This complicated socio economic problem causes a great challenge to the government of the country. Marine turtles are slaughtered for their meat in some coastal villages and turtle eggs are robbed by poachers for sale or personal consumption. Coastal habitats are rapidly degrading due to anthropogenic causes such as hotel constructions, coastal cultivation, fisheries activities and aquaculture projects etc. TCP aims to provide alternative livelihood options to those coastal communities whose lives are dependent on coastal resources as a conservation and management tool. TCP has employed former turtle egg collectors as turtle nest protectors and trained them as tourists’ guides to show the turtle nesting activities to the visiting tourists in 1996. Furthermore, TCP has introduced community Batik, sewing, coconut coir products, ornamental fish breeding, soft toys making, organic farming, beauty culture training, food processing, and tourism initiatives etc. as community livelihood development programmes. These programmes are not limited to a training programme. After the training programme, materials are given to the beneficiaries and further training on accounting, packaging, marketing and branding is provided. Loan schemes have been introduced to provide the initial capital for local businesses. TCP links these community livelihood projects with tourism initiatives and TCP volunteer programme. Foreign volunteers and tourists are actively engaged with activities such as making batiks, farming, fish breeding etc. and also, they purchase many community products. In addition, TCP forms community-based organizations (CBOs) to enable the community beneficiaries to work and act as a group increasing their efficiency and capacity. TCP conducts capacity development programmes and exposure tours to enhance the community skills and capacities. Diversification of community livelihoods is an important fact since there can be a conflict among the community members if too many community members are doing the same business. Furthermore, there can be a shortage of supply in raw materials if they are locally collected. Factors such as the Corona Virus Pandemic, financial crisis, lack of tourism etc. have caused problems and disrupted the financial flow of community businesses but regaining slowly. In recognition of TCP's community livelihood development initiatives, the Ministry of Environment has awarded TCP the "Green Employment Award" in 2009 and most of these community livelihood development activities are still continuing.

TURTLE FRIENDLY VILLAGE: AN APPROACH TO A SUSTAINABLE COMMUNITY-BASED STRATEGY FOR THE CONSERVATION OF HAWKSBILL TURTLE IN MELAKA, MALAYSIA*

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The state of Melaka is one of the important key nesting grounds for Hawksbill turtles (*Eretmochelys imbricata*) in Malaysia and has a regional conservation value due to its critically endangered global status and significant annual nest numbers. However, the highly developed coastline of Melaka leads to severe habitat loss and degradation (e.g., coastal erosion, unsustainable development and land use, excessive light pollution, installation of the sea wall, etc.) and uncontrolled coastal human activities (e.g., mass tourism, fisheries, and coastal pollution) are examples of the challenging scenarios for the nesting turtles. To address these threats, a Turtle Friendly Village (TFV) initiative was first introduced in 2016 at Padang Kemunting, a small coastal fishing village known as one of the main nesting areas. TFV integrates multiple conservation efforts and improves the economic livelihood of local communities that depend on these turtles. The strategy intends to (1) transform a high human-turtle interaction area into a rehabilitated nesting habitat by incorporating and empowering the local communities, and (2) benefit their livelihood through the involvement of turtle conservation-themed activities (e.g., eco-voluntourism, recycling and waste management, cultural handicrafts, and tree replanting). With support from local agencies, this initiative aims to achieve the first turtle sanctuary gazettement and a total egg ban legislation in the state of Melaka. Our study highlights a community-based strategy to address threats to hawksbill turtles in the state.

TECHNOLOGY AND SEA TURTLES

THE POTENTIAL OF PASSIVE ACOUSTIC MONITORING TO HELP INFORM CONSERVATION STRATEGIES OF NORTHWEST ATLANTIC LEATHERBACK SEA TURTLES (DERMOCHELYS CORIACEA)

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The northwest Atlantic leatherback sea turtle (*Dermochelys coriacea*) migrates vast distances between subtropical nesting grounds and high latitude foraging grounds. While satellite telemetry is often used to track long-distance migrations, acoustic telemetry also provides presence data when animal-borne transmitters pass within an acoustic receiver's detection range. As a result, acoustic telemetry can generate more detections, improve spatial resolution, and reduce positional errors compared to satellite tags, when within the detection radius of an acoustic receiver. Leatherback turtles that nest in Pacuaré, Costa Rica and southeastern Florida, USA forage along the continental shelf and/or in the Gulf of Mexico, where numerous active acoustic arrays are present. These arrays provide a unique opportunity to use acoustic telemetry to identify post-nesting locations of tagged individuals. This study aims to understand long-term post-nesting leatherback presence within the northwest Atlantic Ocean (NAO) and Gulf of Mexico from acoustic telemetry. During 2019–2023, 23 leatherbacks were tagged with Vemco V16-4x (Innovasea Systems Inc.) in Pacuaré Nature Reserve (PNR), Costa Rica (N=8), and Juno Beach, Florida, USA (N=15). As of July 2023, four PNR leatherbacks have been detected 66,783 times (mean ± SD: 16,710 ± 28,642 detections/female) by six acoustic receiver groups in the northeastern Gulf of Mexico (N=3), Scotian Shelf (N=2), and Mid-Atlantic Bight (N=1), with detections occurring up to 2.5 years after tag deployment. Fifteen leatherbacks tagged on Juno Beach have been detected 1,260 times (mean ± SD: 84 ± 66 detections/female) by 17 acoustic receiver groups ranging from the southeast Florida Shelf to the Scotian Shelf, with detections occurring up to ten months after deployment. As we continue to receive acoustic detections from the Ocean Tracking Network, results indicate that acoustic telemetry can be a viable method to obtain leatherback presence data if individuals are foraging in areas with an abundance of acoustic receiver arrays, as seen in the Gulf of Mexico. So far, leatherbacks in the NAO have displayed fewer detections, likely due to transiting and foraging in areas devoid of acoustic receivers; however, acoustic tagging efforts should continue to gain a better representation of leatherback presence in NAO shelf waters. Additionally, acoustic telemetry should be incorporated with other research techniques (i.e., satellite tracking) to improve in-water monitoring methods, particularity increasing resolution of coastal movements in areas where leatherbacks are susceptible to human interactions (i.e., fisheries and recreational vessel traffic). These data can also provide valuable information for the conservation and

management of this endangered subpopulation. For instance, working with fishermen to affix acoustic receivers to crab and lobster fishing gear (i.e., crab pots) can help identify when and where leatherbacks are interacting with fishing gear, and expanding acoustic receiver coverage in proposed offshore wind farm sites can shed light on how leatherbacks and other marine animals could interact with these structures. As such, continued passive acoustic telemetry studies of leatherbacks is necessary to obtain animal presence and behavior data to aid in developing mitigation strategies that minimize potential negative effects on leatherback welfare.

ADOPT, TRACK, PROTECT: LEVERAGING DIGITALIZATION FOR SUSTAINABLE SEA TURTLE CONSERVATION IN MALAYSIA

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Digital tools are revolutionizing conservation efforts by providing innovative solutions for engaging the public. By leveraging the power of digital platforms, we can connect with people from all walks of life, inspiring them to take action and make a difference for the planet. As we move forward, it is clear that digital tools play an increasingly important role in ensuring the success of conservation efforts by allowing efficient data collection, management and storage. The Sea Turtle Research Unit (SEATRU) of Universiti Malaysia Terengganu (UMT) is embarking on this digitalization journey, starting with the implementation of the Turtle Imprinting Database System (TIDES). This public web-based database application system brings a multitude of benefits to SEATRU conservation efforts by enhancing sea turtle data management and analysis of vast amount of data. TIDES gathers and stores data on sea turtles' movements and behaviors using tagging and tracking technologies and offers adoption programs to the public based on this data. Adopters of the program receive regular updates and educational materials about their individual sea turtle, which aims to inspire ongoing commitment to sea turtle conservation and raise awareness about the importance of protecting these animals and their habitats. With the implementation of this database, stakeholders, researchers, organizations and even communities can communicate, collaborate on projects, and easily share information that could lead to more effective conservation initiatives.

NOVEL MINIATURIZED SATELLITE TAGS REVEAL DIVING BEHAVIORS OF EARLY-LIFE STAGE LEATHERBACK TURTLES

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After hatching, sea turtles disappear into the ocean and are not seen until many years later when they return to nest at natal regions or occupy adjacent waters. Within the sea turtle community, this period is commonly referred to as the “Lost Years”. Until recently, the very small sizes and prolonged dispersal phases of juveniles posed many challenges for the development of satellite tracking studies. Recent advances in tag miniaturization technologies and data compression algorithms have enabled researchers to undertake groundbreaking studies on the movements and dispersal of early-stage turtles. Among others, new tags are now equipped with solar cells and pressure sensors, extending tag lifetime while providing first-ever dive data for extended movements (> 3 days) of very small early-stage turtles with Straight Carapace Lengths ranging from 7.4 to 9.7 centimeters and weights ranging from 75 to 146 grams. This study harnesses an unprecedented dataset gathered since 2020 from 25 very young juvenile leatherback sea turtles released off eastern Florida. In addition to providing baseline data on dive behavior, the tags provide metrics such as the distribution of time spent at distinct depths, the daily maximum depth reached, and the temporal fraction of the day spent underwater. Tag-derived data present an opportunity to examine intricate relationships between diving behavior and other variables such as the time since the release, the carapace length of tracked individuals or physical variables of the dynamic marine environment of the Gulf Stream, using a suite of remotely sensed and modeled data (i.e., water temperature, significant wave heights). The findings derived from this novel dataset offer new perspectives into the diving behavior of early-stage leatherback sea turtles and, relating dive behavior to environmental variables and others, provides an understanding of how oceanic conditions can affect dispersal during early life stages. Notions of adaptation to the open ocean, thermoregulation behavior or optimization of the swimming conditions are addressed in the present study, and some correlations are found. This study promises to offer new insights into the adaptation strategies, and survival mechanisms employed by early-life stage turtles, effectively demystifying the "Lost Years". This research informs sea turtle conservation and management by bolstering our understanding of the ecological dynamics governing the enigmatic and poorly understood early life stages.

TEENY TINY NEON TURTLES: A RELIABLE, ACCESSIBLE, AND SCALABLE MINIMALLY-INVASIVE REMOTE TRACKING METHOD FOR POST HATCHLING NEONATE SEA TURTLES

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Due to the logistical difficulties of tracking true neonate post-hatchling sea turtles, there are considerable knowledge gaps in our understanding of their in-water behaviors and dispersal within this age class. Tracking technologies have historically been restricted by the small body size and rapid growth of post-hatchlings and pose accessibility constraints by being cost-prohibitive. Here, we present a pilot study for two novel, inexpensive, and minimally invasive tagging options to remotely track and quantify post-hatchlings' dispersal, oceanic movements, and dive depth profiles. Our study aimed to discover uncomplicated, cost-effective treatments that will result in long-term retention of tag attachment along with remote detectability. We tested UV, fluorescing, and retroreflector treatments on the carapace of a deceased red-eared slider (*Trachemys scripta elegans*) turtle shell. Although *Trachemys scripta elegans* is a semi-aquatic freshwater species, we found this to be an acceptable replacement due to the lack of required permits and access to sea turtle hatchlings. Triangular-shaped 1cm marking tags weighing between 0.073 g and 0.126 g were applied using clear aquarium silicone, a product currently used in sea turtles for solar tag attachment. After a short curing period, we submerged the shell into a continuous flow seawater tank at 0.76 m with treatments; treatment replicates, and controls. The shell was mounted on a mechanical arm with a synchronous rotating motor at 3 rpm to imitate vertical movement in the water column. In addition, we also submerged one 1.27 cm corner cube retroreflector in the same tank for underwater clarity and reflectance testing. We captured images throughout the study to test emission detectability, material degradation, and tag stability. We investigated UV, fluorescence, and reflectance detectability levels using corresponding UV, blue, and green LED lights and UV and green handheld lasers for excitation. We tested treatment degradation using ImageJ to quantify the percentage of treatment materials lost over time. We used ImageJ to analyze the area loss of tags over the initial eight weeks. All UV, fluorescent, and retroreflector treatments readily persisted and were detectable for eight weeks. When writing this, our preliminary calculated degradation rate is less than 10%. Due to the low rate of decay and ease in detectability of these treatments, our work identifies a high success rate in using UV, fluorescent, retroreflectors, and corner cube marking tags as novel and practical tools for accessible and scalable remote tracking of marine organisms. Hyperspectral or multispectral optic communications instruments on remote sensing drones, wave gliders, long-range AUVs, and a suite of additional marine-specific monitoring devices which can be programmed to detect UV, fluorescing, retroreflector, and corner cube pattern emissions for use in individualized tracking of oceanic movements and dive depths in many marine animals across the globe. Our methodology indicates a high probability of success in tracking initial dispersal patterns, oceanic movements, and dive depths of post-hatchling neonate sea turtles from nesting beaches across the globe. (*Manuscript in prep.)*

USE OF SUPERPIXELS IN GRAPH CONVOLUTIONAL NETWORKS FOR THE IDENTIFICATION OF SEA TURTLES*

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Classification and identification of segmented images into superpixels using Graph Convolutional Networks (GCNs) is an emerging and useful research area. These identification algorithms represent the image content in superpixels, which are the nodes, thus generating a characteristic graph for each image. The different nodes are linked based on similar characteristics. Using GCN with superpixels, better identification can be achieved by transforming complex image information into graph signals to apply deep learning algorithms. Manual monitoring of sea turtles is a practice that allows for the collection of precise and detailed data. requiring highly trained and experienced human observers to accurately identify different species of sea turtles. Algorithms such as HotSpotter have been developed for animal species identification through photo-identification. These technological tools provide valuable information for research evaluating aspects such as geographic distribution, population density, migration, survival, reproduction, and growth of these species. Additionally, they are quite useful for monitoring the success of sea turtle conservation and protection programs. The aim of this work is to present a solution to address the limitations of manual monitoring through automated identification of individual sea turtles, using their morphological uniqueness and natural patterns such as head structure, shell coloration, fins, and the patterns of characteristic shields of each species in GCNs. The deep learning algorithm is based on the generation of graph structures, where each edge represents the distance and the color intensity relationship with the different color space channels. Node generation in the graph structure must be coherent with the image content to obtain information in algorithm training, emphasizing the most unique and inherent characteristics of each individual. The GCN algorithm is considered efficient in terms of processing operations compared to other methods. This efficiency stems from processing only 150 superpixels instead of all pixels in the images. The proposed algorithm is robust for images taken in marine and terrestrial environments and under different angles and lighting conditions. The proposed GCN for sea turtle identification presents high performance in terms of precision and accuracy. Additionally, it offers a significant improvement in sea turtle identification compared to other algorithms, such as Hotspotter. This advancement is achieved by using segmentation to simplify images and leveraging the turtle morphology to generate the graph. Additionally, the use of different color channels for the graph allows for the use of images in various environments, thus eliminating the need for images with specific characteristics for training GCN. We present a new algorithm as a robust and versatile tool to support the monitoring and protection of these species, thus contributing to the understanding of marine life.

NEST DOMES: AN INNOVATIVE STRATEGY TO MITIGATE THE IMPACT OF CLIMATE CHANGE IN THE SEX DETERMINATION OF SEA TURTLES

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Temperature is an essential factor in the development and biology of sea turtles and is crucial for their sex determination; currently, critical scenarios are being experienced as a result of climate change. A solution was required to this drastic scenario, so in collaboration between Rancho San Cristobal, the Program for the Conservation of Turtles and Marine Mammals of Colombia (PROCTMM) and Banana Boat, Nest Domes were created: the first natural domes that have the function of regulating the sand temperature, whose purpose is to serve as a tool for protection of sea turtle nests. Six specimens were placed in the hatchery at Rancho San Cristobal, located in Cabo San Lucas, Baja California Sur, Mexico. After collecting and buried the nests, the dome was placed over them during the entire incubation period (45 days). The temperature inside the nests was lowered to 4°C, allowing the hatchlings to fully develop until hatching. It is worth mentioning that everything was done on an experimental basis, that is, obtaining empirical results, observing the number of live hatchlings and comparing with other turtle seasons. For the next turtle season that is about to begin, data loggers will be placed to have more precise data on the effectiveness of Nest Domes and to check if sex parity is achieved.

HOW DOES FASTLOC-GPS TELEMETRY IMPROVE CONSERVATION PLANNING?*

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The introduction of Fastloc-GPS technology to marine animal tracking in the 2010s revolutionised the study of spatial ecology and improved our knowledge of home range sizes. The technology enabled an increased volume of high-accuracy GPS locations, revealing that home ranges of marine vertebrates such as sea turtles are smaller than previously thought in certain populations. Fastloc-GPS data have contributed to quantifying habitat use, understanding the role of environmental variables like oceanic currents in sea turtle movements, and estimating nesting populations when monitoring was not feasible etc. Despite the quality and quantity of its data, Fastloc-GPS tags are seldom employed due to their high costs. Instead, Argos satellite transmitters are the most widely used tool for tracking sea turtles. Considering the low accuracy associated with Argos locations, it is important to understand how these data translate into home range estimates of sea turtles. To test the potential impact of tracking methods on habitat use estimates, we conducted a meta-analysis of green turtle (*Chelonia mydas*) and hawksbill turtle (*Eretmochelys imbricata*) home ranges at their foraging grounds (1983-2024). We also generated simulated locations resembling those produced by Fastloc-GPS and Argos tracking technologies to check for variation in estimates due to tracking methods. Further, we explored differences in estimates due to analytical approaches such as Minimum Convex Polygon (MCP), kernel density estimation using package adehabitatHR, Biased

Random Bridge and dynamic Brownian Bridge Movement Model. A one-way ANOVA comparison of foraging home ranges of hawksbill and green turtles from 91 studies showed that estimates recorded by Argos differed significantly from other tracking methods including Fastloc-GPS ($F=44.76$, $df=3$, $p<0.05$). There was no significant difference in home ranges as MCPs or utilisation distributions ($F=1.78$, $df=1$, $p=0.19$). Similarly, there were significant differences in 50% and 95% isopleths of home ranges for simulated data of tracking methods i.e., simulated low-accuracy and high-accuracy Argos data, and both Argos data and simulated Fastloc-GPS data (50%: $F=114.7$, $df=2$, $p<0.05$; 95%: $F=102.3$, $df=2$, $p<0.05$) but not between estimates calculated using the four analytical approaches (50%: $F=0.06$, $df=3$, $p=0.97$; 95%: $F=0.08$, $df=3$, $p=0.97$). Based on published studies and simulated data analysis, sea turtle home ranges could sometimes be massively overestimated (by >100-times) using Argos data compared to Fastloc-GPS data. Methodological bias in home range estimation can be attributed mainly to tracking methods and a lesser extent, analytical approaches. Argos locations may overestimate home ranges and could skew our understanding of sea turtle space use and behaviour. While the costs associated with Fastloc-GPS tags are a constraint, their multi-fold application and accuracy are crucial in implementing practical spatial conservation strategies. Fastloc-GPS data provide reliable measures of animal space use that can be used to assign regions of importance for species protection and serve as indicators of habitat quality to inform ecosystem-level conservation efforts. Its application can extend to testing the efficacy of existing Marine Protected Areas boundaries in protecting coastal and marine habitats. Thus, the use of Fastloc-GPS technology could improve designing, monitoring and maintenance of very large Marine Protected Areas or other area-based solutions.

COMPARING AERIAL AND BOAT-BASED SURVEYS TO MONITOR OFFSHORE AGGREGATIONS OF OLIVE RIDLEYS IN INDIA

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Olive ridley turtles annually aggregate in nearshore waters adjacent to the mass nesting sites in Odisha. Estimation of their densities has traditionally been carried out using manual survey techniques such as boat transects in nearshore waters. With the advancement of the use of aerial vehicles to monitor wildlife populations, unmanned aerial vehicles (UAVs) can be used to conduct robust, safe, and cost-effective assessments of marine turtle populations in coastal ecosystems. In this study, turtles observed on the surface were counted using aerial videos captured by UAVs. These followed a line transect mirroring the travel path covered during the boat surveys, enabling a comparison between both survey methods. The UAVs were flown at a height of 95m above ground level and the surveys were conducted during daylight hours (0600-1200 hours) in a Beaufort Sea State range of 0-2. The number of sea turtles observed during the aerial survey in each photograph was determined manually by three independent reviewers and the angle and distance from the transect line were calculated after identifying all the turtle locations on the imagery. This was compared with the results from the boat transects which were estimated through the line transect surveys. As the image frame of the aerial surveys was 140-150m in width, a fixed-width transect design was used for the analysis. In comparison, the boat transects had longer sighting distances (>100m), making the encounter rate higher in some transects. As the offshore aggregations of olive ridley turtles are known to be quite dynamic prior to mass nesting, the usage of aerial vehicles can be instrumental in reducing the effort of field monitoring. In this case, the use of UAVs resulted in reducing the transect survey duration by 2 hours. Additionally, with the advancement in Artificial Intelligence and Machine Learning tools the data analysis from the aerial surveys can be automated, thereby reducing reporting time.

PHOTO IDENTIFICATION FOR SEA TURTLES: FLIPPER SCALES MORE ACCURATE THAN HEAD SCALES USING APHIS*

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Photo identification involves classifying unique features of a specific individual. The distinguishing feature used in most sea turtle photo ID studies are the scale patterns on the head. Yet the scale patterns on the turtles' flippers are arguably more complex and could provide an alternative and more robust area for photo ID. Here, we compared the accuracy of the Automatic Photo Identification Suite (APHIS) software to identify individual juvenile and subadult green turtles (*Chelonia mydas*) based on scale patterns on either the head or the flippers. Photographs were taken using standardized guidelines and then analyzed via APHIS after manually placing marks at intersection points between all scales around a predefined area. We tested whether using 6, 10, or 14 scales influenced accuracy of identifications, and determined that incorporating 14 scales provided the most correct identifications (1st rank) for both head and flipper photo ID. After determining the most accurate location for identification for the head and flippers (dorsal view of the head and digits of the fore-flipper), we conclude that photo ID using flipper scales in APHIS can identify individuals with higher accuracy (100%) than head scales (86%). Nevertheless, as turtles may contort the shape of their flippers during natural movements while the surface of the head remains rigid, photo ID for flippers may currently only be suitable when the flipper can be maintained in a flat position.

DRONE FIGHT TO FAIR DATASET

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Drones have become an important tool in monitoring coastal and marine ecosystems, for researchers, managers and local communities. Currently there is a lack of standardization and automation in workflows. Delivering analysis ready datasets is a difficult and challenging task, especially with the rapid development of drone technology. Building workflows based on open-source tools to deliver standard products that are ready for use in machine learning can enable researchers and communities to deliver FAIR (Findable, Accessible, Interoperable, and Reusable) datasets. We present a workflow that has been developed using open-source Python tools, to accept images from a range of drones, apply corrections to their position estimates and stores images with meaning full names in a regular directory structure while providing quality data management metrics and feedback. For habitat assessment the system builds a series of machine learning ready geo referenced tiles using direct geo referencing. This approach is fast, efficient and allows for multiple looks at the same area. For object identification we have adapted a popular opensource tool LabelImg to allow for efficient human classification of marine objects such as turtles and sharks. The workflow then produces a training set ready to be shared for use in machine learning.

AUTOMATIC DETECTION AND ABUNDANCE ESTIMATION OF GREEN TURTLES FROM VIDEO FOOTAGES OF UNMANNED AERIAL VEHICLE*

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To develop appropriate conservation and management methods for endangered sea turtles, it is necessary to efficiently monitor abundance and size composition of foraging aggregations. Unmanned aerial vehicles (UAVs) have recently been used for this purpose, but detecting green turtles foraging in coastal seagrass beds using an automatic object recognition algorithm has been difficult owing to the relatively high false positive rate in the complex natural environment of mixed seagrass beds and coral reefs. Therefore, this study aims to develop a deep learning model to automatically detect green turtles foraging in coastal areas and estimate abundance and size composition from UAV video footage. We constructed a dataset (n = 103,308) of green turtles from UAV video footage taken on Ishigaki Island and Chichijima Island, Japan. The automatic detection model was trained based on the YOLOv7 network. Then, Multi Object Tracking (MOT) was implemented to track each of the green turtles in the video and to assign ID numbers. After threshold filtering by the minimum number of consecutive detections of individuals, the IDs were counted. The automatic detection model based on YOLOv7 resulted in a precision of 0.850 and a recall of 0.859,

and mAP@0.5 (mean average precision for the intersection-over-union threshold of 0.5) of 0.922. The model achieved the lowest frequency of false positives when compared to previous studies. Transfer learning did not improve the model performance, and increasing classification classes for status or behavior of green turtles decreased the model performance. Nonetheless, relatively high accuracy in this automatic detection model based on YOLOv7 will help to automatically detect green turtles in natural environments from UAV video footage. We are also developing automatic body size estimation of green turtles.

MORPHOLOGICAL IDENTIFICATION OF CHELONIANS THROUGH A MULTIMODAL NETWORK MODEL WITH SEMANTIC SEGMENTATION*

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Instituto Politécnico Nacional

Sea turtle species are important for preserving marine ecosystems and the maintenance of their biodiversity. The conservation of these species is carried out through scientific studies focused on population monitoring, migration patterns, behavior and the reduction of environmental threats. These studies rely on biochemical analysis and morphological characteristics of each species and individual. Individual identification of sea turtles through manual methods, semi-automatic, photo-identification, of advanced technologies such as artificial intelligence and neural networks are of great relevance in these scientific studies. Photo-identification, geometric morphology of facial scales and dorsal carapace scutes present significant challenges due to their complexity. Natural variability within the same species, changes in morphological characteristics over time, required detailed analysis, and the need for meticulous comparisons complicate the process of individual identification. Current methods, often manual or semi-automatic, require through and sometimes subjective analysis to distinguish between individuals, resulting in a laborious and error-prone process. Additionally, current photo-identification algorithms such as WildID, Hotspotter and I3S-Pattern require images with acceptable quality and where users manually select the rectangular region of interest. In image processing, automatic semantic segmentation techniques precisely delimit specific areas within them. This allows the detection, identification and differentiation of objects through the analysis of meticulous mathematical methods at the pixel level and visual patterns, highlighting contours and specific characteristics of objects in the image content. In this work we propose an artificial intelligence and deep learning model for individual identification of chelonians through multiple convolutional neural networks and mathematical algorithms, with a fundamental role in diverse tasks, ranging from automating semantic segmentation of regions of interest in sea turtle images to edge detection and multimodal understanding of text with natural language models and images. Individual identification is based on geometric morphology of facial scales, shape of carapace scutes and consideration of scales present on flippers and neck. This approach makes possible a significantly more accurate and detailed identification, using specific features of the anatomy of these animals. The semantic segmentation model of content in images SAM (Segment Anything Model), is based on convolutional neural networks. It is distinguished by its ability to detect and isolate a wide variety of objects, regardless of their shape, size or context within the image. Given SAM's versatility, we integrate scenarios from more specialized areas, such as the identification of sea turtles. In our implementation, the results reflect high performance in accuracy. These data are supported by metrics evaluation, such as accuracy and sensitivity, providing a quantitative measurement of the model's ability to identify individuals. Individual identification of sea turtles has a significant impact by providing detailed data on the status and health of populations. This allows it possible to identify and protect critical areas, nesting areas and migratory routes for the balance and health of marine ecosystems.

FLIGHTS OF FANCY: REFINING AERIAL SURVEY TECHNIQUES TO MONITOR MARINE TURTLES ACROSS REMOTE NESTING SITES*

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Reliable access to remote marine turtle nesting sites remains a persistent challenge when attempting to monitor nester abundance and distribution. These difficulties are further increased where large areas across multiple locations need to be surveyed to accurately quantify population trends. Here, we present case studies demonstrating how unmanned aerial vehicles (UAVs) have been successfully used in Western Australia to monitor marine turtle nesting activity and adult orientation behaviour along remote sections of the mainland and at offshore islands of the Pilbara region. Specifically, we discuss the use of UAVs around industrial developments, and at locations where coastal access points may be over 50 km away from the survey area of focus. We discuss methodological and logistical considerations in flight planning, image capture, and survey frequency, as well as in post-processing and analysis procedures. Additionally, we highlight the financial, safety, and time-saving benefits of aerial surveys when compared to more traditional, boots-on-the-ground monitoring approaches, and future avenues of research arising from the latest wave of technological advancements, including three-dimensional modelling of nesting habitat. Finally, we demonstrate that short-term investment in UAVs can provide long-term value to monitoring programs, field studies, and management efforts for marine turtles.

EATS SHOOTS AND LEAVES; THE ECOLOGY OF GREEN TURTLES IN THE LAKSHADWEEP ARCHIPELAGO*

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In the last two decades, some green turtle populations around the world have recovered to high densities. In Lakshadweep, India, systematic studies have documented the loss in productivity and shifts in seagrass species composition in response to green turtle herbivory. Our long-term monitoring programme spanning a little over a decade found that green turtle densities were positively correlated with seagrass shoot densities. A decline in green turtle abundance recorded in each lagoon coincided with low seagrass shoot densities post a period of heavy grazing. This implies that green turtles exhausted forage resources in one

lagoon before moving to the next. Evidently, movements of these turtles en-masse to new foraging grounds can cause trophic cascades and modify entire seagrass ecosystems. Hence, environmental drivers that trigger the behavioural ecology of green turtle movements need to be examined. In collaboration with Arcturus Inc, an indigenous tech company, we supported the development of a low-cost LoRa-based GPS telemetry system at 10-20% of the cost of commercially available tags. Inexpensive radio tags confer a numerical advantage to sample sizes that most research on animal movements lack. With a network of receivers across the lagoons of Lakshadweep, we plan to track multiple green turtle movements to explore their interactions in a larger seascape. The data generated by this study can provide insights into the process and mechanism of establishing new foraging sites, which will prove to be vital for the conservation and management of this species. We aim to make this technology open source to benefit researchers and organizations working in similar systems but particularly in the global south. We have also initiated a non-intrusive photo-identification citizen science study to create a repository of individual green turtles inhabiting the archipelago. In addition to engaging the local community, the movement of individual green turtles will be monitored over the long term.

COMPARATIVE ANALYSIS OF SEA TURTLE IDENTIFICATION ALGORITHMS FOCUSED ON NON-INVASIVE TECHNIQUES*

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Photo-Identification (ID) allows to individually identify animals using their unique marks. However, the challenge of ID arise when dealing with large datasets, as manually processing the images can be very time-consuming. Leveraging the advancements in Artificial Intelligence (AI) methods, such as machine learning (ML) algorithms, particularly the deep learning (DL), facilitates automatic processing of image content, and results in higher accuracy in identifying each individual. In this paper, a self-developed algorithm based on ML and DL methods for ID is presented, we compare this algorithm with the HotSpotter ID algorithm for individually identifying sea turtles within populations. Both algorithms employ classical matching methods but differ in their image pre-processing and processing techniques, which involve feature extraction, as well as their approach to One-vs-Many matching evaluation. This paper analyses the characteristics of both methods used for morphological pattern comparison, evaluating the performance of these algorithms within the context of a shared database of sea turtles. The database includes images with acquired content information with various characteristics, i.e., these images present content in different environments, in different light conditions, with a variety of qualities and resolutions, at varying distances, and in different turtle positions and angles. For this comparison, raw images are employed. These unprocessed images offer significant flexibility for post-processing and analysis. Therefore, regardless of how the algorithms operate, the input images they receive do not impact any of the processes conducted by the algorithms. Our approach involves of automatically detecting the head of the turtle with the modified YOLOv5 convolutional neural network, extraction of pixels with high variation to emphasize head scale patterns and utilizing the ORB algorithm for individual identification. The in-house developed algorithm requires no manual intervention for dataset preprocessing. Using fewer computational resources, it allows for the highly accurate identification of individuals in images of standard quality. On the other way, HotSpotter works by manually defining a Region of interest (ROI), indicating by the user the orientation of each image, additionally it also requires manual intervention in selecting the query image that will be compare with the rest of the others. Afterward, it involves extracting distinctive features from images, to

identify the closest match. Our proposed photo-identification algorithm, using non-invasive techniques, provides with standard quality images an automatic identification of individual sea turtles with 98% accuracy, whereas the HotSpotter algorithm achieves 96% accuracy. These algorithms are less accurate with images to which motion blur has been added. AI and computer vision tools can be applied to assist in tracking and monitoring wildlife, supporting researchers in conservation efforts. By helping the study of sea turtle populations through non-invasive techniques for individual identification. By simplifying the identification process through AI and computer vision tools, it reduces the need for manual intervention, providing valuable support to researchers and conservationist in their efforts to track, monitor and protect these endangered species.

UTILIZATION OF ARTIFICIAL INTELLIGENCE (AI) TO AUTOMATE SEA TURTLE IDENTIFICATION IN LOW WATER VISIBILITY IN URUGUAY, SOUTH WESTERN ATLANTIC

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Sea turtles are highly migratory and emblematic species that are threatened by multiple anthropogenic factors. To guarantee the sustainability of sea turtle populations, it is essential to have innovative tools and technologies that complement traditional research techniques. Recently, Artificial Intelligence (AI), built from neural networks, has emerged as a promising and revolutionary tool for the conservation and monitoring of species due to its efficiency and accuracy, processing speed and recognition of complex patterns in big databases. For this reason, AI promises to become an asset for the study of sea turtles. Consequently, our goal is to apply an AI-based tool to automate the recognition of sea turtles in population studies. Specifically, we aim to automate the sea turtle detection process from video images collected with unmanned aerial vehicles (UAVs or drones) in low water. For this, we used the Yolov7 model (convolutional neural networks) to analyze videos obtained with drones collected between December 2021 - May 2022 in Cerro Verde e Islas de La Coronilla Coastal-Marine Protected Area, Uruguay. The model analyzes the set of frames that make up each of the videos. The process requires two phases, first a training period with one set of images followed by validation with a different dataset. The second phase involves the application of the model to a third dataset which represents a testing process. Finally, we extracted the model metrics that were used to quantify the quality and accuracy of the model. Subsequently, we compared the results from the model to a manual count of turtles in the videos. We started by training the model to identify turtles in low water clarity. The model was trained with a set of images with 66% training images, 17% training validation images and 17% training testing images. Turtles were detected in validation videos with a confidence coefficient above C=0.60. Although these results are preliminary, they are a first step to continue training the model to detect individuals in different water conditions and indicate that it is possible to detect turtles from the rest of the image over the water. The adoption of AI tools, particularly neural networks, have proven to be an effective strategy for identifying different taxa in optimal

environmental and oceanographic conditions before. Here we showed that AI is also useful for areas with low water visibility, like the study region. Next steps include to use more images of estuarine or high turbidity areas in the South Western Atlantic Ocean.

SIREN MOBILE APPLICATION: A TOOL FOR SEA TURTLE CONSERVATION. THE CASE FOR COMBINING CITIZEN SCIENCE AND TECHNOLOGY TO OPTIMIZE NESTING MONITORING*

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In many low-income countries, the distribution and status of aquatic megafauna species, such as sea turtles, are poorly known, and their populations are mostly threatened by poaching, accidental catch, and habitat degradation. Without a good understanding of the population dynamics, distribution, and threats, these species may face local extinction. Surveys and monitoring in the aquatic environment can be time-consuming and demand skills that are often unavailable and unreliable locally, even for simple field observations. Many NGOs also lack the staffing and financial resources to patrol long distances of coastlines. In response to this knowledge and skill gap, we developed the Siren mobile application to facilitate the acquisition of field observations of marine animals like sea turtles and enable researchers to streamline program operations and transform sightings into actionable conservation data. Based on a citizen science approach since its inception in 2014, Siren has significantly improved our conservation strategy, making our program pertinent and economically viable:

(i) By putting Siren in the hands of local people, we increased the number of sightings to more than 20,000 observations of marine animals along the 400km coast of Cameroon. Out of those, the volunteering opportunistic sightings of female sea turtles and their nests that over 80 fishermen reported during their normal fishing activities allowed our team of just four observers to better target priority areas and optimal distribution of patrol effort along the beach. This resulted in an increased volume of sea turtle nesting data that otherwise would have been sparse, spaced over time and distance, and ultimately less relevant.

(ii) While we were initially patrolling 80kms of coastline to look for nests, Siren helped reduce the patrol distance to 15kms, resulting in a remarkable 81.25% gain in efficiency.

(iii) Reported observations of sea turtles now provide a trove of information that we can use as visual proof for our broader conservation and educational activities, such as the documentation of dead female turtles due to ingestion of plastics in our plea with The Minister of The Environment, Nature Protection and Sustainable Development (MINEPDED) of Cameroon.

(iv) Overall, the use of technology instead of paper forms is less error-prone and provides a more accurate estimate of patrol effort, particularly by ensuring that observers actually conduct patrols through the systematic collection of GPS coordinates.

Although similar technologies exist in the market, Siren is the first multi-language application (English, French, Spanish, Arabic, and Portuguese) maintained by a community of scientists and technologists through open collaboration. It is paired with a web interface for administrators of sea turtle monitoring programs to visualize and analyze aggregated data following scientific community standards.

ANIMAL MOCA-UP: INSTRUMENTING SEA TURTLES FOR MULTIDISCIPLINARY OCEANOGRAPHIC RESEARCH IN THE CANARY ISLANDS*

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Traditionally, satellite telemetry has been instrumental in tracking and studying sea turtles' movements, biology, and ecology in the Canary Islands. In parallel, research on the Canary Current and its Upwelling System has relied on a combination of in-situ measurements, remote sensing, and model data. Unfortunately, these two fields of research have largely remained isolated from each other. ANIMAL MOCA-UP (ANIMAL telemetry to Monitor the Canary current and the UPwelling system) represents a newly established collaborative initiative that unites researchers from these disparate disciplines. Our goal is to leverage animal telemetry for monitoring the Canary Current and the Upwelling System, merging telemetry data with in-situ measurements from various platforms, remote sensing information, and model data. This multidisciplinary approach enables us to delve deeper into the study of climate change effects in this region. Sea turtles possess two key attributes that make them ideal candidates for oceanographic research as 'sentinels of climate change': their impressive migratory behavior and their preference for spending a significant portion of their time in the upper meters of the water column. Capitalizing on these characteristics, we have successfully tagged five loggerhead sea turtles with devices capable of recording their position, seawater temperature, and depth (specifically, model Splash10-F-351 from Wildlife Computers). These tagged turtles are providing us with invaluable insights, shedding light not only on sea turtle biology and ecology but also on the intricate workings of the Canary Current and the Upwelling System. Furthermore, we are gaining a deeper understanding of how climate change is impacting these oceanic phenomena.

ASSESSING THE UTILITY OF THE MATRICE300 RTK UAS FOR IMPROVING THE EFFICIENCY OF SEA TURTLE PATROLS IN THE MATURA REGION OF NORTH-EAST TRINIDAD*

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Trinidad is a vital location since it supports a third of one of the world's largest population of leatherback turtles, with over 10,000 turtles nesting on the island. This accounts for 80% of the leatherback turtle population in the Caribbean Region. This study identifies some of the challenges faced when conducting traditional beach monitoring and data collection campaigns in the ‘sea-turtle nesting’ Matura region of North-east Trinidad and evaluates a method to reduce them. A lack of funding during the critical ‘sea-turtle nesting’ months has led to a decline in patrolling efforts, resulting in limited data collection and turtle tagging exercises being conducted. In response to this challenge, this research focuses on an evaluation of the utility of the Matrice300 RTK Unmanned Aerial System (UAS) as a transformative technology to enhance the efficiency of turtle patrols along the extensive Matura beach coastline. The primary objectives include: 1) evaluating the capability of the Matrice300 RTK UAS in identifying nesting Leatherback turtles using a Thermal Infrared (TIR) camera, 2) assessing the feasibility of deploying the UAS to scout remote beach areas for nesting turtles, and 3) determining the UAS's efficacy in detecting unauthorized activities at the Matura Turtle Nesting Site (MTNS). Sea-turtles were identified from drone imagery based on their morphological features, heat signatures and track formation. After conducting numerous surveys, the UAS proved to be highly successful in identifying Sea turtles from an altitude of 45 meters. Different stages of nesting were also discernible, and the drone quickly became a critical part of a nightly patrolling regime, thereby optimizing the existing workforce. This study hopes to contribute insights into the integration of drone technology for sea-turtle conservation and provides guidelines for enhancing monitoring with UAS support on the island of Trinidad. Recommendations for the involvement of UAS in other conservation programs are also made.

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