

**26th Annual Symposium on
Sea Turtle Biology and Conservation**

Island of Crete, Greece, 3-8 April 2006

Book of Abstracts

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PREFACE

The 26th Sea Turtle Symposium is taking place on the Island of Crete, Greece from 3 through 8 April 2006. Crete, the fifth largest Mediterranean island, is located in about the middle of the eastern Mediterranean basin, surrounded by three continents, Africa, Asia and Europe. It is the first time that the Symposium comes to this region. There are several reasons why the Symposium came to the Mediterranean. Over the last few years, a boom in sea turtle research, monitoring and conservation efforts have pronounced the significance and contribution of this closed sea to the global perspective concerning sea turtles. Further, by bringing the Symposium in this region many colleagues from neighbouring areas, usually under-represented in previous Symposia, would benefit. Prominent examples are African and Middle East countries. Hopefully, we shall have many participants from these areas. This has been reflected in the Symposium's motto "Diverse Cultures, One Purpose" and the emphasis given to attract and accommodate participants from these areas.

An initial thought was to have this year the Symposium's Proceedings ready on-site. Nevertheless, last-minute cancellations would have left several non-presented abstracts in the Proceedings. This would certainly complicate things. For this reason we have resorted in publishing a Book of Abstracts instead. Hopefully, this will facilitate participants in choosing the presentations they would prefer to follow.

The Abstracts are arranged per subject and, within each subject, per alphabetical order of first author. Each abstract is given a serial number (Order No), and through this number you can locate any abstract for which you know anyone of its authors, by checking the Author's Index at the end of the Book. Although we have removed all cancelled abstracts before going to print, this might not be the case for some last-minute cancellations.

The Book of Abstracts was assembled with the tireless work of several people. I will mention first the Program Chair Dr Brendan Godley and the Program Committee Coordinator Dr Kartik Shanker, who inspired and guided the 35-person Program Committee through a fruitful sorting, reviewing and editing of the more than five hundred submitted abstracts. The Compilers, who managed to finish successfully a bulky work in less than two weeks time. This would not have been possible without the computerized skills of Michael Coyne, Director of Information Technology of our Society. Last but not least, I would like to mention the valuable assistance of my daughter Lenio, who transformed the original text in the "book" you have in your hands.

Further, I would like to thank the donors and sponsors of the 26th Symposium, the many participants from many countries and ARCHELON, the Sea Turtle Protection Society of Greece, which hosted locally the Symposium.

Dimitris Margaritoulis
President of the 26th Sea Turtle Symposium

INVITED SPEAKER

TURTLES AND TOURISM - THE INVOLVEMENT AND CONTRIBUTION OF THE TOURISM INDUSTRY IN MARINE ENVIRONMENT AND SEA TURTLE CONSERVATION

Dr Wolf Michael Iwand

Executive Director, Group Head Environmental Management of TUI AG

Nature is tourism's capital – our planet's coastal landscapes, the rich natural resources of oceans and seas, the variety of animal species. For our customers this is the main focus of their dreams, fantasies and yearnings. And the population in the holiday countries is playing an increasing role and having an increasing influence on sustainable ways of dealing with nature, sustainable ways of utilizing it and the long-term, cross-generational safeguarding of nature's heritage.

The concept pursued by TUI is called "invalorisation". Invalorisation involves the implementation, management and control of sustainable utilization concepts which generate more income in the long term and avoid environmental losses in the long term as well. [Having in mind an economist's approach - how to leverage the economic value of nature: Whale watching is more profitable than whale hunting in Iceland. One shark on the Maldivian fish market creates a one-time income of around 32 USD, one shark in Maldivian touristic diving sites generates a value of around 32,000 USD per year.] Achieving this invalorisation of nature, landscape, and biological diversity, does, however, require that the holiday countries use some of their foreign currency earnings to definitively and continuously make adequate financial means available for nature conservation concepts.

TUI actively supports a tiered policy for marine conservation areas in holiday regions (species conservation, nature conservation, coastal conservation) with firmly defined and inspected conservation and utilization regulations (ICZM). In our experience, the use of marine conservation areas for tourism purposes should be subject to a variety of "strict reservations":

- strict zoning according to IUCN utilization categories
- strict determination and compliance with the carrying capacity
- strict scientific, independent "tourism impact assessment"
- strict visitor management
- strict controls on complying with protected area standards ensuring no violations

Only marine conservation areas provide an ecological and social balance against the many conglomerations with a high tourist population density in coastal regions. Nature conservation by means of reserves is, for us, a necessary indicator of the quality of tourism infrastructure and an identifier for foresight and the preservation of values.

The major international conventions and treaties such as the Convention on Biological Diversity (CBD), the Washington Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), the Flora-Fauna-Habitat directive of the EU (FFH) and Natura 2000 form the environmental-policy framework for the activities of the TUI AG Group Corporate Environmental Management.

We have been involved in numerous activities to transfer the details of these treaties to the special issues affecting tourism development: involvement in the detail of the 1997 Berlin Declaration on Biological Diversity and Sustainable Tourism; technical conference organised together with the German Environment Ministry during the COP-4 Summit of CBD in Bratislava in 1998; involvement in the keynote paper on biological diversity as part of a

CBD expert panel in the Dominican Republic in 2001 in the run-up to the COP-6 summit; and active participation at COP-8 at Curitiba (Brazil), where we presented the study, “Wildlife Watching and Tourism”.

TUI AG is promoting the initiatives and work of the United Nations Convention on Migratory Species (UNEP/CMS) – also known as the Bonn Convention. The Bonn Convention has been signed and ratified by 92 states. The agreement obliges the states participating in the contract to take measures for the global protection and conservation of migrating wild animal species and their habitats, including the sustainable utilization of these species. There are approximately 10,000 migratory animal species worldwide, including sea turtles, whales and dolphins. Among other things, TUI is cooperating in marine conservation with the Whale and Dolphin Conservation Society (WDCS) in order to preserve the Mediterranean’s common dolphin population. The project is an integral part of the environmental policy framework of the agreement for the conservation of whales and dolphins in the Mediterranean and the Black Sea (ACCOBAMS), a regional agreement developed via the Bonn Convention as a component of the United Nations environment programme.

The preservation of biological diversity in the seas and oceans, on coasts and on islands is a special area of attention in TUI’s biodiversity strategy. Here are a number of cooperation projects with nature conservation organisations in this field as examples:

Protection of sea turtles

2006 has been recognised as the IOSEA-Year of the Turtle. In accordance with a number of marine-life institutions there is a determined plan of activities to combat the dangers that are facing this species. TUI has noted that there is a significant increase of clients’ awareness with regard to local marine environmental concerns. The TUI AG Group Corporate Environmental Management regularly carries out assessments of all destinations in order to establish the focus that is being given to environmental projects.

This resulted in a joint collaboration with the Mombasa Serena Beach Hotel. TUI was pleased to dedicate a specified amount of funds to the existing Sea Turtle Conservation Project that has been run successfully by the hotel since 1993. The hotels’ nest protection program protects turtle eggs from insecure nest sites and relocates the eggs to a safe site on the beachfront of the Serena hotel. The program is expanded to other TUI destinations in the Indian Ocean during 2006.

To protect the breeding grounds of the *Caretta caretta* sea turtles in a number of regions in Greece (Crete, Zakynthos) TUI AG, TUI UK, TUI Nordic, TUI Hellas and the TUI Hotel brand Grecotel continued their co-operation, which goes back over ten years, with the Greek nature protection organisation ARCHELON (former Sea Turtle Protection Society of Greece, S.T.P.S.).

For many years, local and international species protection organisations fought to have the Bay of Laganas on Zakynthos – one of the most important breeding areas in the Mediterranean of the sea turtle *Caretta caretta* – the “National Marine Park Zakynthos”. This initiative was actively supported over many years by TUI Environmental Management and led back in 1992 to TUI withdrawing this region from its tourism programme. A presidential decree was finally signed in December 1999 for designating this area a national park – a milestone for the international advocates of the National Marine Park Zakynthos. The protection zone has been controlled by a management committee since December 2000. ARCHELON received the 1994 “International TUI Environmental Award” for its exemplary work in protecting and carrying out research into sea turtles.

At the start of the International Year of Ecotourism, a practical workshop was organized in January 2002 on “The exchange of experience between the National Marine Park Zakynthos (Greece) and the National Park Archipelago de Cabrera (Majorca)” by the nature conservation organisations EURONATUR and GOB, as well as TUI. The aim was to promote partnerships between marine national parks in the Mediterranean area.

TUI AG supports TORTUGAS, a Swiss environmental organisation founded in 2002, which is dedicated exclusively to the protection of sea turtles. A 14km long stretch of beach in the state of Nayarit, Mexico is being

protected by the voluntary activists during the brooding season. It is mainly the Pacific Ridley turtle (*Lepidochelys olivacea*) that comes to this beach to lay its eggs. Turtle eggs are in great demand in Mexico owing to their ability to increase sexual potency - a misbelief. The TORTUGAS volunteers try to reach the nests before the egg thieves and then put the eggs in specially prepared nesting boxes. As soon as the young turtles have hatched, after about 50 days, they are returned to the sea. In cooperation with a state camp on the adjoining beach, which is run by the Mexican environmental organisation Seramat, TORTUGAS has, during the past years, been able to ensure the survival of several 10,000 turtles.

TORTUGAS also protects the fully-grown turtles when they are laying their eggs from poachers and gives free English lessons in Mexico. The involvement of TUI AG Environmental Management has enabled TORTUGAS again in 2004, 2005 and 2006 to set up a camp in Mexico.

TUI AG has signed a co-operation agreement to sponsor the Aldabra Marine Programme at the Aldabra Atoll for several years. The atoll lies in the Indian Ocean between Madagascar and the Seychelles and is a UNESCO World Heritage Site. The research programme was launched in 1999 by the Cambridge University Coastal Research Unit following the previous year's discovery of clear damage to the marine ecosystem (coral bleaching) as a consequence of an unusual increase in water temperature. The aim of the project is to install an underwater monitoring system for the quantitative long-term analysis of the atoll, and the development of a management plan to protect the marine flora and fauna of the atoll and its surrounding area. Corals are very sensitive ecosystems which react to minute environmental changes such as clouding of the water or risings in temperature, and are therefore seen as early warning systems; as rapid indicators of insidious environmental changes of human or climatic origin.

Through our pro-active environmental policy work we promote the forming of opinions among decision-makers at the holiday destinations and demonstrate – by means of test models, cooperation and our own commitment – that sustainable tourism development can make a valuable contribution to preserving biodiversity. Further information can be found at www.tui-environment.com.

CONTENTS

Anatomy, Physiology and Health

- 1. WHY ARE EGG FERTILIZATION RATES NOT CORRELATED WITH HATCHING SUCCESS IN SEA TURTLES?**
Elena Abella, Adolfo Marco, and Luis F. López-Jurado
- 2. POTENTIAL HUMAN HEALTH RISKS ASSOCIATED WITH THE CONSUMPTION OF SEA TURTLE MEAT AND EGGS: A GLOBAL PERSPECTIVE**
A. Alonso Aguirre, Susan C. Gardner, Jesse C. Marsh, Stephen G. Delgado, Colin J. Limpus, and Wallace J. Nichols
- 3. DETERMINATION OF THE HEMATOLOGIC VALUES IN FOUR SPECIES OF SEA TURTLES IN THE ORIENTAL VENEZUELAN CARIBBEAN**
Angela Arias-Ortiz and Pedro Vernet P.
- 4. THE FIRST RECORD OF DIGENEAN PARASITES (*PLATYHELMINTHES*) IN HAWKSBILL (*ERETMOCHELYS IMBRICATA*) IN VENEZUELA**
Angela Arias-Ortiz and Pedro Vernet P.
- 5. ECOTOXICOLOGY OF THE CYANOBACTERIUM *LYNGBYA MAJUSCULA* AND THE POTENTIAL EXPOSURE OF GREEN TURTLES, *CHELONIA MYDAS*, TO TUMOUR PROMOTING COMPOUNDS**
Karen E. Arthur, Colin J. Limpus, George H. Balazs, James W. Udy, and Glen R. Shaw
- 6. YOU ARE WHAT YOU EAT, UNLESS YOU ARE WHAT YOUR MOTHER ATE**
Karen E. Arthur, Michelle Boyle, and Colin J. Limpus
- 7. ABNORMAL AND ALBINO MARINE TURTLE (*CHELONIA MYDAS*) HATCHLINGS IN MERSİN, TURKEY**
Cemil Aymak, Serap Ergene, and Yakup Kaska
- 8. RESCUE, REHABILITATION AND LIBERATION OF A LOGGERHEAD TURTLE (*CARETTA CARETTA*) CAPTURED WITH LONGLINE FISHERY IN THE GULF OF VENEZUELA**
Hector Barrios-Garrido, Juan Aguilar, Maria Rincon, and Ma. Gabriela Montiel-Villalobos
- 9. ENDOSCOPIC EVALUATION OF THE COELOMIC CAVITY IN SEA TURTLES WITH GASTROINTESTINAL FOREIGN BODIES**
Antonio Di Bello, Carmela Valastro, Daniela Freggi, and Antonio Colucci
- 10. LEVELS OF HEAVY METALS AND ANTIOXIDANT ENZYMES IN THE GREEN TURTLE (*CHELONIA MYDAS*) IN THE ARABIAN SEA, SULTANATE OF OMAN**
Rita Bicho, Natércia Joaquim, Vanda Mendonça, Ali Al Kiyumi, Ibrahim Y. Mahmoud, and Abdulaziz Al Kindi
- 11. PBDE AND ORGANOCHLORINE CONTAMINANTS IN JUVENILE *CARETTA CARETTA* BLOOD: PARTITIONING AMONG BLOOD COMPARTMENTS AND TEMPORAL AND SPATIAL TRENDS**
Brianna K. R. Carlson, Mike Arendt, Al L. Segars, Joanne Braun-McNeill, Larisa Avens, John R. Kucklick, and Jennifer M. Keller
- 12. COMPARATIVE MORPHOLOGY OF THE REPRODUCTIVE SYSTEM IN NEONATE SEA TURTLES**
Simona Ceriani and Jeanette Wyneken
- 13. FACTORS THAT INFLUENCE THE WATER POTENTIAL DURING THE GREEN SEA TURTLE EMBRYOGENESIS**
I-Jiunn Cheng, Pou-Chung Ko, and Tsung-Shun Huang

14. **MICROBIAL POPULATIONS ASSOCIATED WITH UNHATCHED LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) EGGS: A COMPARISON OF TRADITIONAL AND MOLECULAR IDENTIFICATION TECHNIQUES**
Kathryn S. Craven, Judy Awong-Taylor, Laura M. Griffiths, Crystal Bass , and Mario Muscarella
15. **BLOOD BIOCHEMISTRY AND HEMATOLOGICAL VALUES FOR JUVENILE PELAGIC LOGGERHEADS, *CARETTA CARETTA*, OFF MADEIRA ISLAND, NORTH-EASTERN ATLANTIC**
Cláudia Delgado, Isabel Quaresma, Margarida Neves da Costa, and Thomas Dellinger
16. **CARAPACE WEIGHTING AS TREATMENT FOR LONG-TERM FLOATING DISORDER IN A LOGGERHEAD: A CASE STUDY**
Niki Diogou, Lito Kritseli, and Rebecca Webster
17. **CARAPACIAL SCUTE VARIATION IN LOGGERHEAD TURTLES AND GREEN TURTLES (*CARETTA CARETTA* AND *CHELONIA MYDAS*)**
Serap Ergene, Cemil Aymak, and Askin H. Ucar
18. **EFFECTS OF TEMPERATURE ON THE GROWTH RATE AND FOOD CONSUPTION OF POST-HATCHLING LOGGERHEAD TURTLES IN CAPTIVITY**
Fulvio Maffucci, Mariapia Ciampa, and Flegra Bentivegna
19. **REVIEW OF CLINICAL CASES OF SEA TURTLES UNDER VETERINARY TREATMENT IN URUGUAY**
Fiorella Gagliardi, Virginia Ferrando, and Victoria Pastorino
20. **CURRENT CONCEPTS IN THE HUSBANDRY AND MEDICAL MANAGEMENT OF SEA TURTLES IN AQUARIUMS**
Robert H. George and W. Mark Swingle
21. **BODY MASS IN THE LEATHERBACK TURTLE *DERMOCHELYS CORIACEA***
Jean-Yves Georges and Sabrina Fossette
22. **CONSISTENCIES BETWEEN YEARS IN SEASONAL VARIATION OF HEMATOLOGY AND PLASMA BIOCHEMISTRY VALUES OF JUVENILE LOGGERHEAD TURTLES IN NORTH CAROLINA, USA**
Craig A. Harms, Joanne Braun-McNeill, Terra R. Kelly, Larisa Avens, M. Andrew Stamper, Nicole Mihnovets, Lisa Goshe, April Goodman, Aleta A. Hohn, and Matthew H. Godfrey
23. **CLOACAL BACTERIAL ISOLATES AND ANTIMICROBIAL RESISTANCE PATTERNS IN JUVENILE LOGGERHEAD TURTLES IN NORTH CAROLINA, USA**
Craig A. Harms, A. Nicole Mihnovets, Joanne Braun-McNeill, Terra R. Kelly, Larisa Avens, April Goodman, Lisa Goshe, Matthew H. Godfrey, and Aleta A. Hohn
24. **THE EXPOSURE OF SEA TURTLES TO PERSISTENT ORGANIC POLLUTANTS WITHIN MORETON BAY, QUEENSLAND**
Siobhan Hermanussen, Colin J. Limpus, Olaf Paepke, Des Connell, and Caroline Gaus
25. **COMPUTED TOMOGRAPHIC ANATOMY OF THE HEAD OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*)**
M. Rosario Hidalgo, Jorge Orós, Miguel A. Rivero, Carlota Isasi, José M. Vázquez, and Alberto Arencibia
26. **MAGNETIC RESONANCE IMAGING ANATOMY OF THE HEAD OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*)**
M. Rosario Hidalgo, Samuel Contreras, Jorge Orós, Miguel A. Rivero, Ana Belén Casal, Patricia Monagas, and Alberto Arencibia

- 27. IDENTIFICATION OF SEX IN HATCHLING GREEN TURTLES (*CHELONIA MYDAS*) BY MORPHOMETRIC HISTOLOGICAL MEASUREMENTS**
Maria P. Ikonomopoulou, Joan M. Whittier, Rachel C. Aland, and Ibrahim Kamarruddin
- 28. ALLOMETRY OF REPRODUCTIVE ORGANS AND IMMATURE MEMBRANE OF LOGGERHEAD TURTLES, *CARETTA CARETTA***
Takashi Ishihara, Naoki Kamezaki, Futoshi Iwamoto, Suguru Yamashita, and Akinori Hino
- 29. ORGANIC CONTAMINANT CONCENTRATIONS ARE HIGHER IN DEBILITATED LOGGERHEAD TURTLES COMPARED TO APPARENTLY HEALTHY TURTLES**
Jennifer M. Keller, John R. Kucklick, Craig A. Harms, Al L. Segars, Wendy Cluse, Matthew Godfrey, Allison Tuttle, Joanne Braun-McNeill, A. Michelle Lee, Rusty Day, Margie Peden-Adams, Kelly Thorvalson, Mark Dodd, and Terry Norton
- 30. A SURVEY OF HEAVY METAL ACCUMULATION IN THE FORAGING HABITATS OF GREEN SEA TURTLES (*CHELONIA MYDAS*) AROUND ST. CROIX, UNITED STATES VIRGIN ISLANDS**
Kemit-Amon Lewis
- 31. INTERACTION BETWEEN THE GREEN SEA TURTLE (*CHELONIA MYDAS*) AND AN ALIEN GASTROPOD (*RAPANA VENOSA*) IN URUGUAY**
Cecilia Lezama, Milagros López-Mendilaharsu, Fabrizio Scarabino, Andrés Estrades, and Alejandro Fallabrino
- 32. ULTRASTRUCTURAL CHANGES OF EGGSHELLS BEFORE AND AFTER HATCHING IN THE GREEN TURTLE, *CHELONIA MYDAS* AT RAS AL-HADD**
I.Y. Mahmoud, S.N. Al-Bahry, Issa Al-Amri, A.Y. Al-Kindi, A.E. Elshfie, and S.S. AlSiyabi
- 33. FIELD AND EXPERIMENTAL EVIDENCE ABOUT THE INFLUENCE OF THE SUBSTRATE WATER CONTENT ON HATCHING SUCCESS OF LEATHERBACK TURTLE EGGS**
Adolfo Marco, Juan Patiño-Martínez, and Liliana Quiñones
- 34. NATURAL COLONIZATION OF LOGGERHEAD TURTLE EGGS BY THE PATHOGENIC FUNGUS *FUSARIUM OXYSPORUM***
Adolfo Marco, Javier Diéguez-Uribeondo, Elena Abella, María P. Martín, María T. Tellería, and Luis F. López-Jurado
- 35. CONTRIBUTION ON LIFE-HISTORY PARAMETERS IN OLIVE RIDLEY SEA TURTLES (*LEPIDOCHELYS OLIVACEA*) IN TOMATLÁN, JALISCO, MEXICO**
Enrico Marcon-Domenico and Rodrigo Castellanos
- 36. TREATMENT OF TRAUMA, FRACTURES, WOUNDS AND LESIONS IN INJURED SEA TURTLES**
Mariapia Ciampa, Luigi Ferretti, Gianluca Treglia, and Flegra Bentivegna
- 37. VETERINARY MEDICINE IN SEA TURTLES AT THE CENTRO MEXICANO DE LA TORTUGA, MAZUNTE, OAXACA, MEXICO**
Christian Martinez-Zamora, Martha Harfush, Elpidio Marcelino López-Reyes, Exain Acevedo, and Alberto Abreu-Grobois
- 38. THE SUSPENSION VEST, A BREAKTHROUGH HOLDING TECHNIQUE FOR LEATHERBACK SEA TURTLE REHABILITATION**
Connie Merigo, Charles Innis, Scott Weber, Kathy Streeter, and Jenny Montague

- 39. DETECTION OF ORGANOCHLORINES IN MARINE TURTLES STRANDED IN THE CANARY ISLANDS: A PRELIMINARY REPORT**
Patricia Monagas, Jorge Orós, Javier Araña, and Óscar M. González-Díaz
- 40. MYCOBACTERIOSIS IN LOGGERHEAD SEA TURTLE, *CARETTA CARETTA*, STRANDED IN ITALY: A CASE REPORT**
Giordano Nardini, Daniela Florio, Andrea Gustinelli, Francesco Quaglio, and Laura Fiorentini
- 41. INJURY ASSESSMENT OF SEA TURTLES UTILIZING THE NERITIC ZONE OF THE SOUTHEASTERN UNITED STATES**
April D. Norem and Raymond R. Carthy
- 42. HUMAN IMPACTS ON THE MORTALITY OF SEA TURTLES STRANDED IN THE CANARY ISLANDS, SPAIN (2003-2004)**
Jorge Orós, Pascual Calabuig, Patricia Monagas, and Ana B. Casal
- 43. TURTLES AS PHYSIOLOGICAL MODELS FOR ENVIRONMENTAL STRESS: CAN THEY BE “USED” AND IS IT ETHICAL?**
David W. Owens, Russell D. Day, Gaëlle J. Blanvillain, Jeffrey A. Schwenter, Steven J. Christopher, and William A. Roumillat
- 44. HEAVY METAL ACCUMULATION IN THE LIVER OF HATCHLINGS AND EGG YOLK OF GREEN TURTLES, *CHELONIA MYDAS***
Salim H. Al Rawahy, Abdulaziz Y. AlKindi, Abdulkadir Elshafie, Mahmoud Ibrahim, Saif N. Al Bahry, Tabisam Khan, Sultan Al Siyabi, and M. Almansori
- 45. SKULL ALLOMETRY WITH RESPECT TO CARAPACE MEASUREMENTS OF EAST PACIFIC GREEN TURTLES *CHELONIA MYDAS AGASSIZII* FROM SECHURA BAY, PERU**
Luis Santillan and Joanna Alfaro Shigueto
- 46. ENDOPARASITIC FAUNA OF *CARETTA CARETTA* FROM SPANISH AND ADRIATIC SEAS: FIRST COMPARISONS**
Dino Scaravelli, A. Gustinelli, F.J. Badillo, F.J. Aznar, J. Tomás, M.L. Fioravanti, M. Trentini, and J.A. Raga
- 47. TEMPORAL VARIATION IN THE ACTIVITY OF ANTIOXIDANT ENZYMES IN THE BLOOD OF BLACK TURTLE (*CHELONIA MYDAS AGASSIZII*) IN PUNTA ABREOJOS, BAJA CALIFORNIA, MEXICO**
Paola Tenorio-Rodriguez, Tania Zenteno-Savin, and Susan C. Gardner
- 48. NORMAL COMPUTED TOMOGRAPHY, MULTIPLANAR AND THREE-DIMENSIONAL RECONSTRUCTION OF THE RESPIRATORY TRACT OF LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) USING A MULTIDETECTOR-ROW SPIRAL SCANNER**
Ana Luisa Valente, Maria Angeles Zamora, Rafaela Cuenca, Maria Luz Parga, Santiago Lavin, Ferran Alegre, and Ignasi Marco
- 49. TOPOGRAPHIC ANATOMY AND NORMAL MULTI-DETECTOR COMPUTED TOMOGRAPHY OF THE COELOMIC STRUCTURES OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*)**
Ana Luisa Valente, Maria Angeles Zamora, Ignasi Marco, Maria Luz Parga, Santiago Lavin, Ferran Alegre, and Rafaela Cuenca
- 50. ANTHROPOGENIC AND NATURAL CAUSES OF MORTALITY IN OLIVE RIDLEY SEA TURTLES (*LEPIDOCHELYS OLIVACEA*) ON OSTIONAL BEACH ON THE PACIFIC COAST OF COSTA RICA**
Carlos Mario Orrego Vasquez

51. **INCIDENTAL ENTOMOFAUNA ON EGG CLUTCHES OF *LEPIDOCHELYS OLIVACEA* (ESCHSCHOLTZ, 1829) IN THE WILDLIFE REFUGES “ISLA JUAN VENADO”, “RIO-ESCALANTE-CHOCOCENTE” AND “LA FLOR” IN NICARAGUA**
Walter Vaughan-Rojas, Andreas Linde, Cesar Hernandez, Jose Munguia, Rolando Martinez, Jean-Michel Maes, and Mario Vaughan
52. **EVALUATION OF METAL CONCENTRATIONS FROM LOGGERHEAD, *CARETTA CARETTA*, EGGS FROM THE FLORIDA GULF AND ATLANTIC COASTS.**
Aaron White, Mark Harwell, Michael Abazinge, Dragoslov Marcovich, and Peter Lutz
53. **CROSS-REACTIVITY OF ANTIVTG ANTIBODIES FROM *CHELONIA MYDAS AGASSIZII* WITH *CARETTA CARETTA* VTG - A PRELIMINARY WORK**
Marina Zucchini, Matteo Gamberoni, Daniela Freggi, Susan Gardner, Pier Attilio Accorsi, and Annalisa Zaccaroni

Behavior and Movements

54. **BEHAVIOR OF GREEN TURTLE, *CHELONIA MYDAS*, HATCHLINGS DURING EMMERGENCE AT RAS AL-HADD, OMAN**
Abdulaziz Y. AlKindi, Ibrahim Y. Mahmoud, Salim H. Al-Rawahy, Sultan S. AlSiyabi, Saif N. Al-Bahry, and Abdelkadir E. Elshfie
55. **CANCELLED**
56. **STUDY OF THE STRANDINGS ASSOCIATED TO THE MIGRATORY MOVEMENTS OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) ALONG THE ANDALUSIAN COAST**
J.J. Bellido, J.J. Castillo, J.J. Martín Jaime, J.L. Mons, M.A. Farfán, and R. Real
57. **MOVEMENTS OF EASTERN ATLANTIC LEATHERBACKS DURING AND AFTER THE NESTING SEASON: CONSERVATION IMPLICATIONS AT THE ATLANTIC SCALE**
Alexis Billes, Jean-Yves Georges, Sabrina Fossette, Manjula Tiwari, and Jacques Fretey
58. **INSIGHTS INTO HABITAT UTILIZATION AND DIVING BEHAVIOR OF JUVENILE HAWKSBILL TURTLES, *ERETMOCHELYS IMBRICATA*, IN CARIBBEAN FORAGING HABITAT**
Janice Blumenthal, Joni Solomon, Jeremy Olynik, Timothy Austin, Gina Ebanks-Petrie, Matthew Witt, Annette Broderick, and Brendan Godley
59. **MOVEMENT OF GREEN TURTLES (*CHELONIA MYDAS*) BETWEEN NESTING SITES AND SEA GRASS BEDS IN THE SOUTH INDIAN OCEAN: A COMPONENT OF THE S.W.I.O.F. PROJECT**
Jérôme Bourjea, Henri Grizel, and Stéphane Ciccione
60. **FORAGING SITE FIDELITY OF ADULT GREEN AND LOGGERHEAD TURTLES**
Annette C. Broderick, Michael S. Coyne, Fiona Glen, Wayne J. Fuller, and Brendan J. Godley
61. **NEW OBSERVATIONS ON THE REPRODUCTIVE LONGEVITY OF THE LOGGERHEAD SEA TURTLE IN A BRAZILIAN NESTING AREA**
João C. Thomé, Cecília Baptistotte, Luciana M.P. Moreira, Juarez T. Scalfoni, Antonio P. Almeida, and Denise Rieth
62. **LOGGERHEAD (*CARETTA CARETTA*, LINNAEUS 1758) AND LEATHERBACK (*DERMOCHELIS CORIACEA*, VANDELLI 1761) DISTRIBUTION IN THE GULF OF CADIZ (SW OF THE IBERIAN PENINSULA)**
Juan A. Camiñas, Jose C. Báez, Davinia Torreblanca, and Ricardo Sagarminaga

- 63. NEW RECORD OF THE ENDANGERED KEMP'S RIDLEY TURTLE IN SOUTHWESTERN EUROPE**
Carlos Carreras, Adolfo Marco, José Luis Mons, Juan Jesús Martín, Juan Jesús Bellido, Juan José Castillo, Ciro Rico, and Severine Roques
- 64. CLEANING SYMBIOSIS BETWEEN HERBIVOROUS REEF FISHES AND GREEN TURTLES (*CHELONIA MYDAS*) AT PUAKO, HAWAII**
Alima C. Catellacci, Alexandra K. Wooddell, and Marc R. Rice
- 65. NEST-SITE SELECTION BY LEATHERBACK SEA TURTLES ON PLAYA GRANDE BASED ON BATHYMETRIC DATA OF TAMARINDO BAY**
Patricia Clune, Cassondra Williams, Eric Flodin, James R. Spotila, and Frank V. Paladino
- 66. SATELLITE TRACKING OF CAPTIVE-REARED JUVENILE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) RELEASED IN SOUTHERN NEW ENGLAND**
Robert W. Cooper, Erin Ellis, Connie Merigo, Sally R. Murphy, and Scott Weber
- 67. HABITAT DESTRUCTION AND REPRODUCTIVE SUCCESS OF THE HAWKSBILL TURTLE, *ERETMOCHELYS IMBRICATA*, IN THE PEARL CAYS, NICARAGUA**
Victoria A. Cordi, Cynthia J. Lagueux, and Cathi L. Campbell
- 68. DIVING BEHAVIOUR OF FREE RANGING JUVENILE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN A PELAGIC HABITAT**
Thomas Dellinger, Paulo Branco, and Telma Ferreira
- 69. USING OPERANT CONDITIONING TO TRAIN HATCHLING LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN CAPTIVITY**
Erin K. M. Ellis and Sherrie A. Floyd-Cutler
- 70. GREEN TURTLE AND HAWKSBILL GENETIC ANALYSIS IN THREE FEEDING GROUNDS IN THE UK OVERSEAS TERRITORIES IN THE CARIBBEAN: PRELIMINARY RESULTS AND CONSERVATION IMPLICATIONS**
Angela Formia, Annette Broderick, Michael Bruford, Claudio Ciofi, Wesley Clerveaux, Shannon Gore, James Gumbs, John Jeffers, Andy McGowan, Arlington Pickering, Sue Ranger, Peter Richardson, Damon Wheatley, Jim White, and Brendan Godley
- 71. SATELLITE-TRACKING OF GREEN TURTLES (*CHELONIA MYDAS*) IN RAJA AMPAT, PAPUA, INDONESIA**
Geoffrey Gearheart, Ferdiel Ballamu, and Betwel Samper
- 72. SEA TURTLES IN THE FLOW: COUPLING SATELLITE-TRACKING AND REMOTE-SENSING OCEANOGRAPHIC DATA TO ANALYZE NAVIGATION BEHAVIOUR**
Charlotte Girard, Joël Sudre, Simon Benhamou, David Roos, and Stéphane Ciccione
- 73. AN APPROACH FOR MAXIMIZING LIMITED SATELLITE DATA FOR A SEA TURTLE HOME RANGE: CREATING A COMPOSITE SEA TURTLE**
DuBose B. Griffin, Sally R. Hopkins-Murphy, Thomas M. Murphy, Michael G. Frick, and Kristina L. Williams
- 74. A SATELLITE TRACKING PROJECT IN THE WINDWARD ISLANDS OF THE NETHERLANDS ANTILLES**
Emma Harrison, Dominique Vissenberg, and Robert Van Dam
- 75. CONTRASTING DEPTH UTILIZATION BY ADULT FEMALE LOGGERHEAD TURTLES AROUND JAPAN DURING FORAGING PERIODS**
Hideo Hatase, Kazuyoshi Omuta, and Katsumi Tsukamoto

- 76. AVOIDING THE HARSH WINTER: LOGGERHEAD SURVIVAL SKILLS**
Lucy A. Hawkes, Annette C. Broderick, Michael S. Coyne, Matthew H. Godfrey, and Brendan J. Godley
- 77. RELATIONSHIP BETWEEN DURATION OF CAPTIVITY AND SWIM FRENZY IN OLIVE RIDLEY HATCHLINGS**
Alberto Ángel Hernández-Olazo, Elizabeth Arista De la Rosa, Martha Harfush, Adrián Becerril-Toral, Rosendo Arturo Velásquez Cabrera, and Alberto Abreu-Grobois
- 78. THE DIVING BEHAVIOUR OF HIBERNATING LOGGERHEAD TURTLES IN TEMPERATE MEDITERRANEAN WATERS**
Sandra Hochscheid, Flegra Bentivegna, Paolo Luschi, Carola Vallini, and Graeme C. Hays
- 79. HYDRODYNAMIC DRAG CHARACTERISTICS OF THE LEATHERBACK SEA TURTLE**
Mark Hyman and Kennard Watson
- 80. SATELLITE TRACKING OF PRE-NESTING MIGRATION IN LOGGERHEAD TURTLES, *CARETTA CARETTA***
Naoki Kamezaki, Yoshimasa Matsuzawa, Tatsuya Oshika, Tatsuya Shima, Kojiro Mizuno, and Koki Tanaka
- 81. RELATION OF LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) MIGRATORY PATTERNS TO OCEANOGRAPHIC PROCESSES IN EASTERN MEDITERRANEAN BASIN**
Alexandra Kavvadia, Alan F. Rees, Isidora Katara, Vasilis D. Valavanis, and Dimitris Margaritoulis
- 82. THE INFLUENCE OF OCEANOGRAPHIC CONDITIONS ON THE MIGRATORY BEHAVIOUR OF SOUTH AFRICAN LEATHERBACKS**
Paolo Lambardi, Resi Mencacci, Johann Lutjeharms, George R. Hughes, Silvano Benvenuti, and Paolo Luschi
- 83. CAN HATCHLINGS EXPOSED TO BEACH LIGHTING RECOVER, AND ORIENT NORMALLY OFFSHORE?**
Jacquelyn K. Lorne, Ashley Mustakas, and Michael Salmon
- 84. FORAGING STRATEGIES OF THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) ALONG THE NORTHWEST COAST OF AFRICA**
Alvaro G. de los Ríos y Loshuertos, Scott A. Eckert, and Oscar Ocaña Vicente
- 85. INVESTIGATING SEA TURTLE NAVIGATIONAL ABILITIES THROUGH SATELLITE TELEMTRY**
Paolo Luschi
- 86. *CHELONIA* IN AND OUT OF THE JACUZZI: DIEL MOVEMENTS OF EAST PACIFIC GREEN TURTLES IN SAN DIEGO BAY, USA**
Boyd Lyon, Jeffrey A. Seminoff, Tomoharu Eguchi, and Peter H. Dutton
- 87. A POSSIBLE EFFECT OF LOW FREQUENCY NOISE ON THE ORIENTATION OF LOGGERHEAD HATCHLINGS**
Thomas Magyar and Klaus Riede
- 88. HAWKSBILL TURTLES IN BRAZIL: PROJETO TAMAR-IBAMA, PRELIMINARY GENETIC AND TELEMTRY STUDIES**
Maria A. Marcovaldi, João C. Thomé, Gustavo G. Lopez, and Luciano S. Soares
- 89. HIGH-USE PELAGIC ZONES: THE OVERLAP OF LOGGERHEAD (*CARETTA CARETTA*) FORAGING AREAS AND LONGLINE FISHERIES BYCATCH IN THE NORTH ATLANTIC OCEAN**
Abigail L. McCarthy, Francois Royer, Thomas Dellinger, Selina S. Heppell, Molly E. Lutcavage, and Scott S. Heppell

- 90. PATTERN AND VARIATION IN THE USE OF NERITIC HABITATS BY JUVENILE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)**
Catherine M. McClellan and Andrew J. Read
- 91. MOVEMENT PATTERNS OF LOGGERHEAD TURTLES (*CARETTA CARETTA*) IN CUBAN WATERS INFERRED FROM FLIPPER TAG RECAPTURES.**
Félix Moncada, F. Alberto Abreu-Grobois, Arturo Muhlia-Melo, Llewellyn Ehrhart, Dean Bagley, Barbara Schroeder, Julio Zurita, Karen A. Bjorndal, Alan Bolten, Juan A. Camiñas, Gonzalo Nodarse, and Georgina Espinosa
- 92. TRANSATLANTIC MIGRATION OF JUVENILE LOGGERHEAD TURTLES (*CARETTA CARETTA*): MAGNETIC LATITUDINAL INFLUENCE**
Catalina Monzón-Argüello, Adolfo Marco, Ciro Rico, Carlos Carreras, Pacual Calabuig, and Luis F. López-Jurado
- 93. THE MARINE TURTLE RESCUE CENTER OF LINOSA: SEA TURTLES RECAPTURE DATA**
Stefano Nannarelli, Alberto Dominici, and Alessandra De Lucia
- 94. FINE-SCALE DIVING BEHAVIOUR OF MIGRATING TURTLES REVEALED BY AUTO RELEASING LOGGER SYSTEM**
Tomoko Narazaki, Katsufumi Sato, and Nobuyuki Miyazaki
- 95. BEHAVIOR AND FEEDING ADAPTATION OF HEAD-STARTED HAWKSBILL TURTLES, *ERETMOCHELYS IMBRICATA***
Junichi Okuyama, Tomohito Shimizu, Osamu Abe, Kenzo Yoseda, and Nobuaki Arai
- 96. POST-NESTING MIGRATIONS OF GREEK TURTLES INTO THE AEGEAN SEA, MONITORED THROUGH SATELLITE TELEMETRY**
Alan F. Rees and Dimitris Margaritoulis
- 97. SWIMMING BEHAVIOUR OF LOGGERHEAD SEA TURTLES RECOVERING FROM SEVERE ILLNESS ASSESSED BY SATELLITE TELEMETRY**
Mónica Revelles, Luis Cardona, Gloria Fernández, and Alex Aguilar
- 98. DISTRIBUTION OF OCEANIC STAGE NORTH ATLANTIC LOGGERHEADS: ARE SEAMOUNTS IMPORTANT HOTSPOTS?**
Marco R. Santos, Alan B. Bolten, Helen R. Martins, Brian Riewald, Karen Bjorndal, Rogerio Ferreira, and João Gonçalves
- 99. MOVEMENT AND BEHAVIOR OF FLORIDA NESTING LEATHERBACKS**
Christopher R. Sasso, Chris Johnson, Kelly Stewart, and Sheryan P. Epperly
- 100. PRELIMINARY DOCUMENTATION OF LOGGERHEAD SOLITARY AND SOCIAL BEHAVIOUR IN THE MARITIME BREEDING AREA OF LAGANAS BAY, ZAKYNTHOS, GREECE**
Gail Schofield, Kostas A. Katselidis, John D. Pantis, Panayotis Dimopoulos, and Graeme C. Hays
- 101. MOVEMENTS OF IMMATURE AND POST-NESTING KEMP'S RIDLEY SEA TURTLES IN THE NORTHWESTERN GULF OF MEXICO**
Erin E. Seney, Andre M. Landry, Jr., Benjamin M. Higgins, Joseph P. Flanagan, and Shanna L. Kethan
- 102. POST-NESTING DIVING BEHAVIOR, MOVEMENTS, AND DISTRIBUTION OF PACIFIC LEATHERBACK SEA TURTLES TAGGED AT PLAYA GRANDE, PARQUE NACIONAL LAS BAULAS, COSTA RICA FROM 2003-2004**
George Shillinger, Michael Castleton, James Ganong, Bryan Wallace, Jim Spotila, Frank Paladino, Scott Eckert, and Barbara Block

- 103. RESPONSES OF LOGGERHEAD AND GREEN TURTLE HATCHLINGS TO FLOTSAM DURING THE FRENZY AND POSTFRENZY PERIOD**
Morgan M. Smith and Michael Salmon
- 104. NESTING SITE FIDELITY IN FLORIDA LEATHERBACKS DETERMINED USING GPS TAGS.**
Kelly Stewart, Chris Johnson, and Scott Eckert
- 105. SATELLITE TRACKING OF THREE ADULT LOGGERHEAD TURTLES (*CARETTA CARETTA*) IN THE MEDITERRANEAN SEA**
Carola Vallini , R. Mencacci, Paolo Lambardi, S. Benvenuti, L. Funes, E. Anfuso, S. Zabini, S. Rubini, L. Bianchi, S. Montanari, and Paolo Luschi
- 106. SEA TURTLE RESERVE AND SATELLITE TRACKING IN CHINA**
Yamin Wang
- 107. LOGGERHEAD TURTLES FORAGING IN THE GULF OF ARGOSTOLI, KEFALONIA, GREECE (2000-2004): REJECTION OF AN OVERWINTERING HYPOTHESIS**
Michael White
- 108. USING HYDROACOUSTICS TO PREDICT HABITAT USE OF FORAGING JUVENILE LOGGERHEAD TURTLES IN BAJA CALIFORNIA SUR, MEXICO**
Dana K. Wingfield, S. Hoyt Peckham, Donald A. Croll, Wallace J. Nichols, Kelly Newton, and Egle Flores
- 109. BASKING BEHAVIOR OF GREEN TURTLES IN THE GALAPAGOS ISLANDS**
Patricia M. Zárate, Sigita S. Cahoon, María C. D. Contato, Peter H. Dutton, and Jeffrey A. Seminoff

Conservation, Management and Policy

- 110. SUCCESS OF DELAYED TRANSLOCATION OF LOGGERHEAD TURTLE NESTS: IMPLICATIONS IN MANAGEMENT PROGRAMS**
Elena Abella, Adolfo Marco, and Luis F. López-Jurado
- 111. GOLDEN JACKAL PREDATION ON MARINE TURTLES IN GOKSU DELTA, TURKEY**
S. Can Akcinar, Ozgur Guclu, Ertan Taskavak, and Oguz Turkozan
- 112. THE STATUS OF MARINE TURTLES IN ATLANTIC MOROCCO**
Mustapha Aksissou, Manjula Tiwari, Wafae Benhardouze, and Matthew H. Godfrey
- 113. LEGISLATION THAT PROTECTS SEA TURTLES IN GUATEMALA**
Luis Eduardo Girón Arana
- 114. MARINE TURTLE CONSERVATION IN THAILAND: A POST TSUNAMI RECOVERY**
Monica Aureggi and Kanjana Adulyanukosol
- 115. BYCATCH POLICY ALL AT SEA?**
Sali Jayne Bache
- 116. FUNDRAISING FOR ANIMAL REHABILITATION: A STRATEGIC APPROACH FOR TURTLE-FOCUSED WORK**
Thanos N. Belalidis and Alexander T. Deliyannis

- 117. DIFFERING TRENDS AND RESPONSE TO CONSERVATION EFFORTS BY TWO PROTECTED MEXICAN MARINE TURTLE ROOKERIES INDICATES NEED FOR CHANGES IN STRATEGIES**
Raquel Briseño-Dueñas, Juan Madrid-Vera, Daniel Rios-Olmeda, and Jose A. Trejo-Robles
- 118. POACHING AND PROTECTED NESTS RATE TRENDS OF SEA TURTLES IN CHALACATEPEC AND MISMALOYA BEACHES, TOMATLÁN, JALISCO, MEXICO, 1995-2004**
Rodrigo Castellanos, Cecilia Martínez-Tovar, Francisco Jiménez-Márquez, Eloy Flores-Millán, and Marcos Becerra-Delgado
- 119. POACHERS, KILLERS AND SKINNERS OF SEA TURTLES IN PLAYÓN DE MISMALOYA, TOMATLÁN & CABO CORRIENTES, JALISCO, MEXICO**
Rodrigo Castellanos, Eloy Flores-Millan, Ruth Hazlewood, Susana Salmerón, Fredi Gastellum, Daniel Patman, and Javier Jacobo
- 120. CO-MANAGEMENT MODEL: GANDOCA BEACH CASE**
Didiher Chacón and Claudio Quesada
- 121. CANCELLED**
- 122. THE NATIONAL MARINE PARK OF ZAKYNTHOS: THE FIRST MANAGEMENT AGENCY OF PROTECTED AREAS IN GREECE**
Christos Chryssomalis
- 123. RESULTS OF THE ANALYSIS OF THE NESTS PROTECTION OF MARINE TURTLE *LEPIDOCHELYS OLIVACEA* IN CEUTA BEACH, SINALOA, MEXICO (1994-2004)**
Ingmar Sosa Cornejo, Fernando Enciso Saracho, Marcos Bucio Pacheco, Aline Mejia Saldaña, Marco Antonio Barraza Ortega, and Jose Luis Alvarado Yahuaca
- 124. MARINE TURTLE PRODUCTS IN MAPUTO CITY MARKET**
Alice Costa and Helena Motta
- 125. ASSESSMENT, MONITORING AND REPORTING OF CONSERVATION STATUS – HOW DOES THE APPROACH OF THE EUROPEAN UNION FIT TO SEA TURTLES?**
Gerald Dick and Paolo Casale
- 126. AN ENVIRONMENTAL EDUCATION KIT AS A COMPLEMENTARY TOOL FOR THE MANAGEMENT OF THE NATIONAL MARINE PARK OF ZAKYNTHOS**
Dimitrios I. Dimopoulos and John D. Pantis
- 127. LOCAL COMMISSIONS, A SAMPLE OF IMPLEMENTATION IN CONSERVATION OF SEA TURTLES IN TURKEY**
Irfan Ekmekci and Sukran Yalcin-Ozdilek
- 128. SEA TURTLE STRANDING PATTERNS IN CALIFORNIA: 1982-2004**
Christina C. Fahy
- 129. THREE YEARS OF MEETINGS ON RESEARCH AND CONSERVATION OF SEA TURTLES IN THE SOUTHWEST ATLANTIC OCEAN (ASO)**
Alejandro Fallabrino, Martin Laporta, Laura Prosdocimi, and Gilberto Sales
- 130. DECREASING LOGGERHEAD NESTING AT FETHIYE BEACH, TURKEY: POTENTIAL TOURISM IMPACT**
Christine Fellhofer and Michael Stachowitsch

- 131. I INTERNATIONAL MEETING ON SEA TURTLES OF SAO TOME E PRINCIPE**
Rogerio N. Lopes Ferreira
- 132. EFFECTS OF TRANSLOCATION TIME ON HATCHING SUCCESS RATE FOR *LEPIDOCHELYS OLIVACEA* IN PROTECTED HATCHERIES, MAJAHUAS SOUTH BEACH, TOMATLÁN, JALISCO, MEXICO**
Eloy Flores-Millán, Rodrigo Castellanos, Ruth Hazlewood, Salvador Velásquez-Magaña, Marcos Becerra-Delgado, and Idelfonso Enciso-Padilla
- 133. HUMAN IMPACT ON SEA TURTLE NESTING AT A BEACH IN GUANACASTE, COSTA RICA**
Gabriel Francia
- 134. MARINE TURTLES OF ERITREA**
Mahta Goitom, Simon Weldeyohannes, Tekle Mengstu, and Yohannes Teclerariam
- 135. A COMPARISON OF TWO METHODS TO PRODUCE LEATHERBACK HATCHLINGS (*DERMOCHELYS CORIACEA*) EX SITU: GREENHOUSE AND INCUBATION CHAMBER**
Elizabeth Gonzalez, Volker Koch, Adriana L. Sarti, Juan R. Guzmán, and Rene Pinal
- 136. ANTHROPOGENIC IMPACT ON NESTING BEACHES OF THE OLIVE RIDLEY SEA TURTLE *LEPIDOCHELYS OLIVACEA* IN SOUTHERN BAJA CALIFORNIA PENINSULA**
Victor M. Gómez-Muñoz, Yazmín Monroy-García, Lucio Godínez-Orta, and Graciela Tiburcio-Pintos
- 137. GREEN TURTLE HUNTING IN TORRES STRAIT: COMPLEXITIES OF LOCAL MANAGEMENT FOR AN INTERNATIONALLY ROAMING TURTLE**
Mark Hamann, Jillian Grayson, and Helene Marsh
- 138. MARINE TURTLE CONSERVATION AT THREE NESTING SITES IN SIRTE, LIBYA**
Abdulmaula A. Hamza, Hisham Elghmati, Esam M. Buras, Mohamed A. Algumezi, Murad S. Sola, Wahid Hamed, Daw A. Hadoud, Mohamed A. Alshwaihedi, Mohamed E. Alsharif, Usama M. Shalouf, and Atef Ouerghi
- 139. THE DONATION SYSTEM OF GUATEMALA**
Scott Handy, Colum Muccio, Rob Nunny, and Francesca Barker
- 140. UPDATE ON POPULATION STATUS AND DEVELOPMENT OF MULTI-STAKEHOLDER MANAGEMENT OF LEATHERBACKS IN PAPUA, INDONESIA**
Creusa Hitipeuw, Frans Moga, Peter Dutton, Scott Benson, Manjula Tiwari, Ricardo Tapilatu, and Heidi Gjertsen
- 141. MARINE TURTLE CONSERVATION, MANAGEMENT AND POLICY DEVELOPMENTS IN THE INDIAN OCEAN - SOUTH-EAST ASIA REGION**
Douglas Hykle
- 142. DEFORESTATION: RISK OF SEX RATIO DISTORTION IN HAWKSBILL SEA TURTLES**
Stephanie J. Kamel and N. Mrosovsky
- 143. THE ROLE OF NGOS IN SEA TURTLE CONSERVATION ON ZAKYNTHOS, GREECE**
Demetres Karavellas, Gail Schofield, Giorgos Catsadorakis, Theodota Nantsou, and Charikleia Minotou
- 144. PILOT SAND DUNE RESTORATION AT KOTYCHI-STROFYLIA LOGGERHEAD NESTING BEACH, NORTHWESTERN PELOPONNESUS, GREECE**
Andreas Koutsodendris, Stavroula Papadopoulou, Niki Kardakari, and Dimitris Margaritoulis

- 145. CIRALI: AN EXAMPLE FOR COMMUNITY-BASED CONSERVATION OF MARINE TURTLES**
Bayram Kutle, Emine Kuzuturk, Habib Altinkaya, İbrahim Sahin, Mehmet Demir, Hidayet İtaatli, Mustafa Ilgaz, Saban Ilgaz, Ramazan Yörükoglu, Mehmet Sahin, and Husamettin Koyluoglu
- 146. CANCELLED**
- 147. CUSTOMARY VERSUS LEGAL GOVERNANCE: INTEGRATED APPROACH IN ADDRESSING TRADITIONAL HUNTING PRACTICES ON LEATHERBACK TURTLES IN KEI ISLANDS, MALUKU-INDONESIA**
Julius Lawalata, Nilam Ratnawati, Daniel Utra Kikilaitety, Creusa Hitipeuw, and Wallace J. Nichols
- 148. LEATHERBACK NEST ECOLOGY IN THE GAMBA COMPLEX, GABON: IMPROVING HATCHERY OUTPUT**
Suzanne R. Livingstone and Sebastiaan B. Verhage
- 149. A SUCCESSFUL CO-MANAGEMENT OF MARINE TURTLE CONSERVATION IN MNAZI BAY- RUVUMA ESTUARY MARINE PARK, TANZANIA**
Jairos Mahenge
- 150. DO TURTLES MOVE WITH THE BEACH? BEACH PROFILING AND POSSIBLE EFFECTS OF DEVELOPMENT ON A LEATHERBACK (*DERMOCHELYS CORIACEA*) NESTING BEACH IN GRENADA**
Kimberly Maison
- 151. BASTIMENTOS ISLAND NATIONAL MARINE PARK AND PLAYA CHIRIQUI: PROTECTED AREAS VITAL TO THE RECOVERY OF THE HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) IN CARIBBEAN PANAMA**
Anne B. Meylan, Inocencio Castillo, Natalia Decastro, Cristina Ordoñez, Sebastian Troëng, Argelis Ruiz, and Peter A. Meylan
- 152. A MODEL MANAGEMENT PLAN FOR SEKANIA, THE MOST IMPORTANT MEDITERRANEAN SEA TURTLE NESTING BEACH**
Charikleia Minotou and Gail Schofield
- 153. TOWARDS THE IDENTIFICATION OF KEY AREAS FOR SEA TURTLE CONSERVATION IN THE GULF OF VENEZUELA**
M. Gabriela Montiel-Villalobos, H. Barrios-Garrido, K. Rodriguez-Clark, and R. Lazo
- 154. NOURISHED BEACH BIOLOGY AND DYNAMICS**
Mario J. Mota and Ray Carthy
- 155. OLIVE RIDLEY POPULATION TRENDS ON THE PACIFIC COAST OF GUATEMALA – CRAWL COUNTS AS MANAGEMENT TOOL**
Colum Muccio, Scott Handy, and Rob Nunny
- 156. RESULTS OF THE 2005 NESTING SEASON OF THE SEA TURTLE RESEARCH AND CONSERVATION PROJECT IN THE PARIA PENINSULA, SUCRE STATE, VENEZUELA**
María de los Angeles Rondón Médicci, Hedelvy J. Guada, Ohiana Revuelta, and Alfredo Montilla
- 157. CANCELLED**
- 158. EFFECTS OF BEACH DRIVING ON LOGGERHEAD SEA TURTLE NESTING**
Lindsay Nester and Nat B. Frazer
- 159. GRAFT, DRUGS AND STEAL: THE ELEPHANT IN THE CORNER OF MARINE CONSERVATION**
Wallace J. Nichols

- 160. METHODOLOGY FOR THE OBSERVATION AND THE CONSERVATION OF THE MARINE TURTLES IN CAYO LARGO, CUBA**
Gonzalo Nodarse, Félix Moncada, and Rubén Blanco
- 161. PROGRESS IN IMPLEMENTING THE WESTERN INDIAN OCEAN (WIO) REGION MARINE TURTLE STRATEGY: THE CASE OF KENYA**
Simmons K. Nzuki
- 162. PARTICIPATORY HABITAT CHARACTERIZATION AND GIS DATABASE DEVELOPMENT FOR THE CONSERVATION AND MANAGEMENT OF SEA TURTLES IN SOUTH COAST KENYA**
Simmons K. Nzuki and John K. Muasa
- 163. THE ACTION PLAN FOR THE CONSERVATION OF THE MEDITERRANEAN MARINE TURTLES ADOPTED WITHIN THE FRAMEWORK OF MEDITERRANEAN ACTION PLAN (MAP)**
Atef Ouerghi
- 164. VOLUNTEERS & SEA TURTLE CONSERVATION: WHY TIME EQUALS MONEY FOR AN ENVIRONMENTAL NGO**
Aliko Panagopoulou and Kostandina Soulantika
- 165. NATIONAL MARINE PARK OF ZAKYNTHOS: A SCALE-DEPENDENT GOVERNANCE PROCEDURE**
John D. Pantis
- 166. IMPLEMENTATION OF GIS IN SEA TURTLE STRANDINGS ALONG THE GREEK COASTLINE: A MODERN MANAGEMENT TOOL**
Stavroula Papadopoulou, Andreas Koutsodendris, and Dimitris Margaritoulis
- 167. EVALUATION OF INCUBATION TEMPERATURE AS A METHOD FOR ESTIMATING HATCHLING SEX RATIOS IN THE KEMP'S RIDLEY RECOVERY PROGRAM**
Amber Park, Thane Wibbels, Hector J. Martinez-O., Lila Vega-M., Diana J. Lira-R., Marco Antonio-P., Jaime Pena-V., Patrick M. Burchfield, and Barbara Schroeder
- 168. THE FORGOTTEN SPECIES FROM OSTIONAL BEACH, COSTA RICA: WHAT ABOUT THE LEATHERBACKS AND GREENS?**
Wagner M. Quirós Pereira, Didiher Chacón Chaverri, Luis Corea Baltodano, Ben Sacks, Rolando Parra Reyes, and Noldan Avilés Avilés
- 169. MICROBIOTA ISOLATED FROM SEA TURTLE NESTS AND ASSOCIATED HEALTH RISKS FOR TURTLE RESEARCHERS**
Andrea D. Phillott and Billy Sinclair
- 170. MARINE TURTLE CONSERVATION ACTIVITIES IN SOUTHEASTERN COASTAL ECOLOGICALLY CRITICAL AREAS OF BANGLADESH**
S. M. A. Rashid
- 171. LONG-TERM COMMUNITY INCENTIVE AGREEMENTS AS A NOVEL APPROACH TO CONSERVING SEA TURTLE NESTING BEACHES**
Richard Rice
- 172. THE PLIGHT OF SEA TURTLES AND THEIR HUNTERS IN ANGOLA**
Tamar Ron

- 173. COMMUNITY-BASED CONSERVATION OF THE LEATHERBACK SEA TURTLE IN THE MEXICAN PACIFIC**
Marina Ruiz, Ana R. Barragán, Débora García, Marcela Romero, and Laura Sarti
- 174. DEVELOPMENT OF A SPANISH MEDITERRANEAN LOGGERHEAD CONSERVATION PLAN**
Ricardo J. Sagarminaga, Jose C. Baez, Lucia Rueda, Juan A. Caminas, Scott A. Eckert, and Christofer Boggs
- 175. PROGRAM OF CONSERVATION OF THE OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*), IN CEUTA BEACH, SINALOA, MEXICO: SEASON 2005**
Fernando Enciso Saracho, Marco Antonio Barraza Ortega, Angélica Maria González Barraza, Marcos Bucio Pacheco, and Ingmar Sosa Cornejo
- 176. HISTORICAL ASPECTS OF THE MARINE TURTLES IN THE MEXICAN PACIFIC**
Fernando Enciso Saracho, Aline Mejia Saldaña, and Ingmar Sosa Cornejo
- 177. PROGRAM OF CONSERVATION OF THE OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*), ON BEACH CAIMANERO, SINALOA, MEXICO: SEASON 2005**
Fernando Enciso Saracho and Héctor Contreras Aguilar
- 178. SPATIAL AND TEMPORAL ANALYSIS OF INCIDENTAL SEA TURTLE TAKES BY DREDGES IN THE WESTERN GULF OF MEXICO, USA**
Gary W. Sundin, Sara H. Schweitzer, Dena D. Dickerson, Craig T. Theriot, Monica S. Wolters, James T. Peterson, and Virginia Dickerson
- 179. WHAT WE ALL SHOULD KNOW...! REVIEW ON A 1904 DUTCH FISHERY SURVEY IN THE CARIBBEAN REGION**
Jeroen L. Swinkels
- 180. THE FILMING OF "TROY" AND NESTING SEA TURTLES – HOW THEY COEXISTED?**
Graciela Tiburcio-Pintos, F. Calderon-Campuzano, A. Gomez-Quiroga, and Peter Novak
- 181. TO MANAGE OR NOT TO MANAGE: LESSONS FROM ST. CROIX FOR A LEATHERBACK NESTING BEACH IN JAMURSBA-MEDI, INDONESIA**
Manjula Tiwari and Peter H. Dutton
- 182. MANAGEMENT OF *CARETTA CARETTA* IN PRACTICE: THE IMPORTANCE OF ENVIRONMENTAL INSTITUTIONS**
Anatoli Togridou and John D. Pantis
- 183. SPATIAL PATTERN OF LOGGERHEAD SEA TURTLE NESTS AS A TOOL TO REGULATE TOURIST ACTIVITIES ON NESTING BEACHES**
Anatoli Togridou, Dimitris Margaritoulis, John Halley, and John D. Pantis
- 184. CANCELLED**
- 185. LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) NESTING ON A GEORGIA BARRIER ISLAND: EFFECTS OF NEST RELOCATION**
Jacob A. Tuttle and David C. Rostal
- 186. INTEGRATING SEA TURTLE CONSERVATION IN THE ENVIRONMENTAL POLICY OF A TOURIST BUSINESS**
Maria Valerga and Aliko Panagopoulou
- 187. THE WHITE GHOSTS OF KAZANLI: SEA TURTLE CONSERVATION IN TURKEY**
Lily Venizelos and Max Kasparek

- 188. STRATEGIC COASTAL PLANNING OF A FLATBACK TURTLE (*NATATOR DEPRESSUS*) NESTING BEACH IN PORT HEDLAND, WESTERN AUSTRALIA**
David A. Waayers
- 189. THE LOGGERHEAD'S HOT SPOT ON THE WEST COAST OF ARUBA**
Edith S. van der Wal and Richard W. van der Wal
- 190. A TRI-NATIONAL PARTNERSHIP TO SAVE THE WESTERN PACIFIC LEATHERBACK TURTLE IN THE BISMARCK SOLOMON SEAS ECOREGION**
Lisette Wilson, M. Philip, J. Pita, C. Hitipeuw, and L. McLellan
- 191. SEA TURTLE CONSERVATION IN CHINA**
Yamin Wang

Ecological Roles of Marine Turtles

- 192. SUSTAINABLE FISHERIES POLICIES FROM AN ECOSYSTEM PERSPECTIVE: FAO'S WORK, WITH SPECIAL EMPHASIS ON REDUCING INTERACTIONS BETWEEN SEA TURTLES AND FISHERIES**
Gabriella Bianchi
- 193. MODELING THE ROLES OF SEA TURTLES IN MARINE ECOSYSTEMS**
Karen A. Bjorndal and Alan B. Bolten
- 194. THE ROLE OF MARINE TURTLES IN HUMAN ECOLOGY: RELATIVE MERITS OF FLAGSHIPS AND KEYSTONES**
J. Frazier
- 195. CERRO VERDE: A TEMPERATE DEVELOPMENTAL HABITAT FOR JUVENILE GREEN TURTLES ALONG THE EASTERN COAST OF URUGUAY**
Milagros López-Mendilaharsu
- 196. USING STABLE ISOTOPES TO DESCRIBE THE ECOLOGICAL ROLES OF SEA TURTLES: THE NICHE MOSAIC CONCEPT REVISITED**
Jeffrey A. Seminoff, Bryan P. Wallace, Robert L. Pitman, Patricia Zarate, and Peter H. Dutton
- 197. EVALUATION OF REMIGRATION INTERVALS AS INDICATORS FOR HOW WELL SEA TURTLE POPULATIONS FULFILL THEIR ECOLOGICAL ROLES**
Sebastian Troëng and Milani Chaloupka
- 198. ECOPATH WITH ECOSIM (EWE) AND THE ECOLOGICAL ROLE OF *CHELONIA MYDAS* IN THE CARIBBEAN**
Colette Wabnitz, Karen Bjorndal, Alan Bolten, and Daniel Pauly
- 199. LEATHERBACK TURTLES AS OCEANOGRAPHIC INDICATORS: STABLE ISOTOPE ANALYSES REVEAL A TROPHIC DICHOTOMY BETWEEN OCEAN BASINS**
Bryan Wallace, Jeffrey Seminoff, Susan Kilham, James Spotila, and Peter Dutton

Ecology and Evolutionary Biology

200. NEW MTDNA DLOOP PRIMERS WHICH WORK FOR A VARIETY OF MARINE TURTLE SPECIES MAY INCREASE THE RESOLUTION OF MIXED STOCK ANALYSES

Alberto Abreu-Grobois, Julia Horrocks, Angela Formia, Peter Dutton, Robin LeRoux, Ximena Vélez-Zuazo, Luciano Soares, and Peter Meylan

201. HAWKSBILL TURTLES FORAGING AROUND BARBADOS, WEST INDIES, ORIGINATE FROM ROOKERIES BOTH WITHIN AND OUTSIDE OF THE WIDER CARIBBEAN

Alberto Abreu-Grobois, Julia A. Horrocks, Barry Krueger, Angela Formia, and Jennifer Beggs

202. GREEN TURTLE POPULATION HAPLOTYPING USING SSCP

Aliya S. Alansari, Hafsa Al-Shamsi, Ibrahim Mahmoud, Abdul Aziz Al-Kindi, Joshua Reece, Sultan Al-Siyabi, Fatma M. Al-Hanai, and Shoaib A. Al-Zadjali

203. WEATHER INFLUENCES IN *CARETTA CARETTA* AND *DERMOCHELYS CORIACEA* REPRODUCTIVE ACTIVITIES IN COMBOIO'S BIOLOGIC RESERVE, LINHARES, ESPIRITO SANTO, BRAZIL

Mateus A. Baronio and Demetrio L. Guadagnin

204. GUT CONTENTS OF LOGGERHEADS STRANDED ALONG THE NORTHWESTERN MOROCCO COAST

Wafae Benhardouze, Mustapha Aksissou, and Younes Saoud

205. CHARACTERIZATION OF CRITICAL FORAGING HABITAT FOR LEATHERBACK TURTLES OFF CALIFORNIA, USA

Scott R. Benson, Karin A. Forney, Peter H. Dutton, and Erin LaCasella

206. THE ECOLOGY OF *CARETTA CARETTA* AND *CHELONIA MYDAS* POST-HATCHLING'S FROM EAST AUSTRALIAN POPULATIONS

Michelle M. Boyle and Colin J. Limpus

207. COMPLEX POPULATION STRUCTURE OF THE ENDANGERED LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) IN THE MEDITERRANEAN SEA REVEALED BY NUCLEAR AND MITOCHONDRIAL DNA MARKERS

Carlos Carreras, Marta Pascual, Luis Cardona, Alex Aguilar, Dimitris Margaritoulis, Alan Rees, Oguz Turkozan, Yaniv Levy, Avital Gasith, Monica Aureggi, and Mona Khalil

208. GENETIC STRUCTURING OF IMMATURE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN THE MEDITERRANEAN SEA AND THE ADJOINING ATLANTIC REFLECTS WATER CIRCULATION PATTERNS

Carlos Carreras, Sara Pont, Fulvio Maffucci, Juan Jesús Bellido, Marta Pascual, Anna Barcelo, Adolfo Marco, Flegra Bentivegna, Luis Cardona, Ferran Alegre, Ciro Rico, Alex Aguilar, Severine Roques, Manuel SanFelix, Gloria Fernandez, Jesus Tomás, and Juan Antonio Raga

209. SPORADIC NESTING IN THE WESTERN MEDITERRANEAN AS LONG DISTANCE DISPERSAL EVENTS

Carlos Carreras, Adolfo Marco, Juan Jesús Martín, José Luis Mons, Fulvio Maffucci, Flegra Bentivegna, Ciro Rico, and Severine Roques

210. DEGREE OF ISOLATION OF THE MEDITERRANEAN NESTING POPULATIONS OF THE LOGGERHEAD SEA TURTLE USING NUCLEAR MARKERS

Carlos Carreras, Luis Cardona, Adolfo Marco, Marta Pascual, Alex Aguilar, Dimitris Margaritoulis, Alan Rees, Juan Jose Castillo, Jesús Tomás, Juan Antonio Raga, Gloria Fernández, Manu SanFelix, Oguz Turkozan, Yaniv Levy, Avital Gasith, Monica Aureggi, Mona Khalil, Ciro Rico, and Severine Roques

- 211. PHYSICAL AND CHEMICAL PARAMETERS OF THE SANDY SUBSTRATE OF CEUTA BEACH AND ITS EFFECT IN THE HATCHING PERCENTAGE OF THE MARINE TURTLE *LEPIDOCHELYS OLIVACEA***
Ingmar Sosa Cornejo, Ramón Enrique Moran Angulo, Fernando Enciso Saracho, Rogelio Sosa Pérez, Marcos Bucio Pacheco, and José del Carmen Espericueta Viera
- 212. DESCRIPTION OF ORGANIC MATTER AND PH OF THE BEACH SAND CEUTA LIKE REFERRING FOR THE NESTING OF THE MARINE TURTLE *LEPIDOCHELYS OLIVACEA*.**
Ingmar Sosa Cornejo, Ramón Enrique Morán Angulo, Fernando Enciso Saracho, Rogelio Sosa Pérez, and Marcos Bucio Pacheco
- 213. CONFIRMATION OF MARINE TURTLE HYBRIDS IN NORTHWEST ATLANTIC WATERS**
Kara L. Dodge, Robin A. LeRoux, Amy Frey, and Peter H. Dutton
- 214. GEOGRAPHIC VARIATION IN FORAGING STRATEGIES OF LEATHERBACK POPULATIONS: A HEDGE AGAINST CATASTROPHY?**
Peter H. Dutton
- 215. CHARACTERIZATION OF MTDNA VARIATION AMONG KEMP'S RIDELYS NESTING ON PADRE ISLAND WITH REFERENCE TO RANCHO NUEVO GENETIC STOCK**
Peter H. Dutton, Victoria Pease, and Donna Shaver
- 216. A PREDICTIVE HABITAT MODEL FOR LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN THE ALBORAN SEA USING SATELLITE TELEMETRY AND GEOSPATIAL ANALYSIS**
Scott A. Eckert, Ricardo Sagarminaga van Buiten, Daniel Dunn, and Karen L. Eckert
- 217. TEMPERATURE COMPARISON OF LOGGERHEAD SEA TURTLE NESTING BEACHES THROUGHOUT FLORIDA**
Jennifer Estes, T. Wibbels, J. Wyneken, T. Tucker, L. Ehrhart, R. Carthy, R. Scarpino, E.R. Martin, M. Bresett, C. Johnson, B. Ball, J. Schmid, J. Vaughn, S. Condran, J. Grimes, and P. Clark
- 218. SOME REPRODUCTIVE ASPECTS OF THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) IN QUEREPARE BEACH, PENINSULA DE PARIÁ, SUCRE STATE, VENEZUELA, DURING THE 2004 NESTING SEASON**
Eneida Fajardo, Jim Hernandez, and Hedelvy J. Guada
- 219. SPATIO-TEMPORAL ANALYSIS OF LOGGERHEAD SEATURTLE INTERACTIONS WITH PELAGIC FISHERIES**
Beth Gardner, Patrick J. Sullivan, Stephen J. Morreale, and Sheryan Epperly
- 220. FORAGING ECOLOGY OF LEATHERBACKS IN THE CALIFORNIA CURRENT**
Jim Harvey, Scott Benson, and Tanya Graham
- 221. JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) FORAGING ON A HIGH-ENERGY, SHALLOW REEF ON THE EAST COAST OF FLORIDA, USA**
Karen G. Holloway-Adkins
- 222. A BEHAVIOURAL POLYMORPHISM IN THE HAWKSBILL SEA TURTLE? EVIDENCE FROM A MULTI-YEAR STUDY ON MATERNAL NEST-SITE CHOICE**
Stephanie J. Kamel and N. Mrosovsky
- 223. COLOUR VARIATIONS OF THE EAST PACIFIC GREEN TURTLE: AKA THE BLACK TURTLE**
Richard Lawson, Elaine Massie, Todd T. Jones, and Jeffrey Seminoff
- 224. DIET COMPOSITION OF LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN THE ADRIATIC SEA**
Bojan Lazar, Romana Gracan, Dusan Zavodnik, Jelena Katic, Moira Bursic, and Nikola Tvrtkovic

- 225. FACTORS INFLUENCING INSECT INFESTATION OF LOGGERHEAD (*CARETTA CARETTA*) SEA TURTLE NESTS ON ZAKYNTHOS, GREECE**
Angela P. Lazou and Alan F. Rees
- 226. EVALUATION OF PREDATION OF KEMP'S RIDLEY *IN SITU* NESTS AT RANCHO NUEVO, MEXICO**
Anne M. LeBlanc, Thane Wibbels, Hector J. Martinez-O., Lila Vega-M., Diana J. Lira-R., Marco Antonio-P., Jaime Pena-V., Patrick M. Burchfield, and Barbara Schroeder
- 227. NEW RECORD OF A NUDIBRANCHIA, *FIONNA PINNATA*, LIVING ON JUVENILE LOGGERHEADS IN THE CANARY ISLANDS**
Ana Liria Loza, Pascual Calabuig Miranda, and Luis F. Lopez Jurado
- 228. THE PANMIXIA PARADIGM OF EASTERN PACIFIC OLIVE RIDLEY TURTLES REVISED: EVIDENCE OF GENETIC STRUCTURE**
Melania C. López-Castro, Axayácatl Rocha-Olivares, and Raquel Briseño-Dueñas
- 229. PHYLOGEOGRAPHY OF EASTERN PACIFIC OLIVE RIDLEY TURTLES BASED ON MITOCHONDRIAL DNA**
Melania C. López-Castro, Axayácatl Rocha-Olivares, and Raquel Briseño-Dueñas
- 230. ESTIMATION OF OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*) HATCHLING PREDATION BY THE BLACK VULTURE (*CORAGYPS ATRATUS*) IN OSTIONAL NATIONAL WILDLIFE REFUGE (ONWR), COSTA RICA**
Dario Mantovani and Gerardo Chaves
- 231. ANALYZING THE PROFILES OF NEST SITE SELECTION OF LOGGERHEAD SEA TURTLES: A CASE STUDY OF THE ISLAND OF ZAKYNTHOS, WESTERN GREECE**
Antonios D. Mazaris and Yiannis Matsinos
- 232. CONNECTIVITY AND STRUCTURE OF ATLANTIC GREEN SEA TURTLES (*CHELONIA MYDAS*)**
Eugenia Naro-Maciel, J.H. Becker, E.H.S.M. Lima, M.A. Marcovaldi, and R. DeSalle
- 233. THE INFLUENCE OF HIGH TEMPERATURE AND TWO HURRICANES ON THE SUCCESS OF LATE SEASON LOGGERHEAD NESTS IN BROWARD COUNTY, FLORIDA, IN 2005**
Stefanie Ouellette and Curtis Burney
- 234. EVALUATION OF SQUID MEAL IN DIETS OF JUVENILE HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*)**
Elda Pelegrín, Iliana Fraga, José Galindo, and Susana Álvarez
- 235. ONTOGENETIC SHIFTS IN JUVENILE GREEN TURTLES FROM OCEANIC TO NERITIC HABITATS: EVIDENCE FROM STABLE ISOTOPES**
Kimberly J. Reich, Karen A. Bjorndal, and Alan B. Bolten
- 236. IS THE GIBRALTAR STRAIT A BARRIER FOR THE DISPERSAL OF MEDITERRANEAN LOGGERHEAD SEA TURTLES?**
Mónica Revelles, Carlos Carreras, Luis Cardona, Adolfo Marco, Flegra Bentivegna, Juan José Castillo, Giovanni de Martino, Michel B. Smith, Ciro Rico, Severine Roques, Marta Pascual, and Alex Aguilar
- 237. POPULATION GENETICS OF GREEN TURTLE ROOKERIES IN THE WEST CUBAN ARCHIPELAGO USING A MTDNA MARKER**
Ariel Ruiz-Urquiola, Julia Azanza-Ricardo, Maribel González-Pumariega, Rogelio Díaz-Fernández, María Elena Ibarra-Martín, and Georgina Espinosa-López

- 238. INFLUENCE OF THE SEASIDE VEGETATION ON THE NESTING OF MARINE TURTLES IN TOGO**
Gabriel Hoinsoude Segniagbeto, Joseph Esso Bowessidjaou, Jacques Fretey, and Koffi Akpagana
- 239. MATING SYSTEM IN FLATBACK TURTLES - A MICROSATELLITE ANALYSES**
Kathrin Theissinger, Nancy N. FitzSimmons, and Alfred Seitz
- 240. PRELIMINARY OBSERVATIONS ON DIETARY HABITS OF LEATHERBACK TURTLES FOUND IN THE MID-SOUTHERN TYRRHENIAN SEA (ITALY)**
Andrea Travaglini, Gianluca Treglia, Giovanni De Martino, and Flegra Bentivegna
- 241. A STUDY ON THE ECOLOGY AND CONSERVATION OF OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) AT THE RUSHIKULYA ROOKERY OF ORISSA COAST, INDIA**
Basudev Tripathy
- 242. A HURDLES RACE WITH THE CARIBBEAN HAWKSILLS: WHEN OBSTACLES ANALYZING MTDNA DATA BECOME HIGHER AND HIGHER**
Ximena Velez-Zuazo, Willy D. Ramos, Carlos E. Diez, Robert P. van Dam, Xaymara Serrano, Aida T. Miro, Stephan M. Funk, and W. Owen McMillan
- 243. REPRODUCTIVE STRATEGIES OF HAWKSBILL SEA TURTLES INFERRED WITH MICROSATELLITES ANALYSIS**
Ximena Velez-Zuazo, Aida T. Miro, Willy D. Ramos, Carlos E. Diez, Robert P. van Dam, Xaymara Serrano, Stephan M. Funk, and W. Owen McMillan
- 244. GENETIC COMPOSITION OF SEA TURTLES BYCATCH FROM PERUVIAN FISHERIES INFERRED THROUGH MTDNA ANALYSIS**
Ximena Velez-Zuazo, Shaleyla Kelez Sara, and Camelia Manrique Bravo
- 245. LIFE HISTORY VARIATION IN HABITAT USE BY LOGGERHEAD SEA TURTLES, NERITIC OR OCEANIC: A RESULT OF POPULATION SUBDIVISION?**
Kunihiko K. Watanabe, Hideo Hatase, Kazuyoshi Omuta, Jun Aoyama, and Katsumi Tsukamoto
- 246. SEA TURTLES OF THE EPI-PELAGIC SARGASSUM DRIFT COMMUNITY**
Blair Witherington and Shigetomo Hiram
- 247. MULTIPLE PATERNITY IN MEDITERRANEAN LOGGERHEAD SEA TURTLES**
Judith A. Zbinden, Carlo Largiadèr, Fabio Leippert, Dimitris Margaritoulis, and Raphaël Arlettaz

Education, Outreach and Advocacy

- 248. ADRIA-WATCH: AN OBSERVATORY FOR SEA TURTLES AND OTHER GREAT VERTEBRATES OF THE NORTHERN ADRIATIC SEA**
Marco Affronte and Dino Scaravelli
- 249. ECOTOURISM AND NATURAL RESOURCES (CASE STUDY OF SEA TURTLES IN CAMPO-MA'AN NATIONAL PARK IN CAMEROON)**
Isidore Ayissi, Hyacinthe Angoni, Amougou Akoa, and Jacques Fretey
- 250. KELONIA: THE MARINE TURTLES OBSERVATORY**
Stephane Ciccione

- 251. FATE OF LIVE STRANDED TURTLES IN NORTH CAROLINA, USA, AND THEIR ROLE IN CONSERVATION**
Wendy M. Cluse and Matthew H. Godfrey
- 252. MWOAKILLOA COMMUNITY-BASED MARINE TURTLE PROJECT RAISING AWARENESS AND MANAGEMENT**
Donald David, Dave Mathias, and Christina Caros
- 253. SEA TURTLES DAY IN BENIN: AN INITIATIVE TO PROMOTE**
Josea S. Dossou-Bodjrenou and Patrice Sagbo
- 254. SEA TURTLE CSI: A TEACHING MODULE IN SEA TURTLE GENETICS**
Jennifer Estes, Thane Wibbels, Alyssa G. Myers, Marilyn Niemann, and J. Micheal Wyss
- 255. A PROPOSED MODEL FOR IMPLEMENTING THE TCOT PROJECT RECOMMENDATIONS ON MARINE TURTLE EDUCATION IN THE TURKS & CAICOS ISLANDS**
Michelle Fulford-Gardiner and James Luxon
- 256. MARINE TURTLE EDUCATIONAL PROGRAMMING AT THE LOGGERHEAD MARINELIFE CENTER OF JUNO BEACH, FLORIDA, USA**
Kristine Halager, Leslie Figg, and Larry Wood
- 257. EVALUATION OF NEW TURTLE-TOUR VISITATION SYSTEM AT TORTUGUERO, COSTA RICA**
Andrea de Haro, Sebastian Troëng, Emma Harrison, Roxana Silman, Daynier Rodríguez, and Enrique Obando
- 258. THE TURTLE GUIDE: DEFINING THE POSSIBLE?**
Chris D. J. Jackson and Colin R. Scott
- 259. TWENTY YEARS OF CREATING EDUCATIONAL MATERIAL FOR SEA TURTLES IN GREECE**
Anna Kremezi-Margaritouli
- 260. PUERTO ADOLFO LÓPEZ MATEOS BAJA CALIFORNIA SUR, MEXICO: A LESSON IN OWNERSHIP OF NATURAL RESOURCES THROUGH PRIDE.**
Johath Laudino, Hoyt Peckham, Nichols J. Wallace, Ruth Ochoa, Egle Flores, Natalia Rossi, David Maldonado, Rodrigo Donadi, Vladimir De la Toba, Edgar Caballero, and Bertha Montaña
- 261. GROWING SEA TURTLE BIOLOGISTS: THE RESULTS OF A SEA TURTLE SEMINAR FOR HIGH SCHOOL STUDENTS ON ST. CROIX, USVI**
Kemit-Amon Lewis
- 262. A MOBILE EXHIBITION FOR EXTENDING THE RANGE OF PUBLIC AWARENESS IN SEA TURTLE CONSERVATION PROJECTS**
Jason D. Margaritoulis
- 263. THE STATE OF THE WORLD'S SEA TURTLES (SWOT): COLLABORATING FOR CONSERVATION - THE LEATHERBACK NESTING BEACHES OF THE WORLD**
Roderic B. Mast, Brian J. Hutchinson, and Lisa M. Bailey
- 264. STATUS AND CONSERVATION OF MARINE TURTLES IN MALTA**
Carmen R. Mifsud, Alfred E. Baldacchino, Darrin T. Stevens, and Anthony Gruppetta
- 265. SEATURTLE CONSERVATION THROUGH CAPACITY BUILDING IN NORTH WEST PACIFIC COAST OF NICARAGUA**
Mechteld Muurmans, Paul Rubio, Andrew Farmer, and Natasha Calderwood

- 266. STUDENT-SCIENTIST PARTNERSHIPS INVEST GALÁPAGOS RESIDENTS IN CONSERVATION**
Julie G. Osborn, Scott B. Pankratz, and Monica Lopez Conlon
- 267. EDUCATION, OUTREACH, AND ADVOCACY: A CASE STUDY COMPARISON OF COMMUNICATION STRATEGIES FOR SEA TURTLE CONSERVATION**
Jennifer L. Palmer and Wallace J. Nichols
- 268. EDUCATIONAL STRATEGIES AT THE CRAM FOUNDATION DIRECTED TOWARDS THE CONSERVATION OF SEA TURTLES**
Maria Parga, Manel Gazo, Sara Pont, Luisa García, Alex Bartolí, Carla Álvarez, and Ferran Alegre
- 269. NEW HAMPSHIRE SEA TURTLE FOUNDATION - BETWEEN TRADITION AND INNOVATION**
Jill R. Rolph
- 270. THE CESENATICO RESEARCH UNIT ON MARINE CHELONIAN**
D. Scaravelli, M. L. Fioravanti , and M. Trentini
- 271. MARINE CHELONIAN ILLUSTRATION PART FOUR: CARETTA, EXPLORATION AND THE ADVENT OF MODERN SCIENCE**
Chuck Schaffer and Rick Schaffer
- 272. “LA COMUNIDAD” - TORTUGUERO, COSTA RICA**
David Smith, Kelly Matheson, Ian Kellett, and Sebastian Troëng
- 273. TEACHING THE LOCAL COMMUNITY TO COLLECT SEA TURTLE DATA AT JAMURSBA MEDI BEACH, PAPUA, INDONESIA**
Ricardo F. Tapilatu, Creusa Hitipeuw, and Manjula Tiwari
- 274. MEETING OF THE YOUTH OF THE CALIFORNIAS FOR THE CONSERVATION OF MARINE TURTLES (BAJA CALIFORNIA SUR, MEXICO)**
G. Tiburcio-Pintos, A. Cruz-Morelos, S. García-Rojas, Dean Kama, Y. García-Monroy, and M. Bañagas-Ojeda
- 275. CREATING A NETWORK FOR THE PROTECTION OF SEA TURTLES IN THE TOURIST CORRIDOR OF THE MUNICIPAL OF LOS CABOS, BAJA CALIFORNIA SUR, MEXICO**
G. Tiburcio-Pintos, D. García-García, R. Briseño-Dueñas, P. Marquez-Almanza, V. Castillo-Leggs, E. Acevedo-Ruiz, S. Burgoín-Marron, and Y. Monroy-García
- 276. “HELP OUT OR SEA TURTLES MISS OUT”: A SEA TURTLE EDUCATION AND OUTREACH PROGRAM FOR THE NETHERLANDS ANTILLES**
Dominique Vissenberg and Emma Harrison
- 277. LOCAL COMMUNITY, GLOBAL VOLUNTEERS, AND SEA TURTLES – DELIVERING SUSTAINABLE DEVELOPMENT ON KEFALONIA ISLAND, GREECE**
Katerina Xenopoulou, Sarah Maynard, and Manuel Coleman

Fisheries

- 278. AN ASSESSMENT OF THE RATE OF INCIDENTAL CAPTURE OF MARINE TURTLES IN FISHING ACTIVITIES OFF THE COAST OF MICHOACÁN, MEXICO**
Javier Acevedo, Javier Vasconcelos, Arturo García, and Marina Ruiz Slater

- 279. STUDY ON THE LONG-TERM EFFECT OF HOOKS LOGGED IN THE MID-OESOPHAGUS OF SEA TURTLES**
Ferran Alegre, Maria Parga, Carlos del Castillo, and Sara Pont
- 280. CANCELLED**
- 281. MODELING THE RELATIONSHIP BETWEEN FISH LANDINGS, FISHING EFFORT AND STOCK ABUNDANCE**
Rhema Bjorkland, Michelle Sims, Tara Cox, Andrew Read , Daniel Dunn, Larry B. Crowder, Pat Halpin, Rebecca Lewison, Wallace J. Nichols, Carl Safina, Bryan Wallace, and Ramunas Zydelis
- 282. SEA TURTLES AND LONGLINE FISHERIES – WHAT NEXT?**
Alan B. Bolten, Karen A. Bjorndal, Marco Santos, Rogerio Ferreira, Helen R. Martins, and Joao Goncalves
- 283. IMPACT OF THE COMMON DOLPHIN FISH LONGLINE FISHERY ON SEA TURTLES ALONG THE PERUVIAN COAST BETWEEN 2003 AND 2005**
Camelia Manrique Bravo, Shaleyra Kelez Sara, and Ximena Velez-Zuazo
- 284. ANALYSIS OF LOGGERHEAD SUMMER CAPTURE PATTERNS IN THE SPANISH MEDITERRANEAN SURFACE DRIFTING LONGLINE FISHERY**
José C. Báez, Juan A. Camiñas, Ricardo Sagarminaga, and Raimundo Real
- 285. ANALYSIS OF LOGGERHEAD (*CARETTA CARETTA*, LINNAEUS, 1758) AND SWORDFISH (*XIPHIAS GLADIUS*, LINNAEUS, 1758) CAPTURE DISTRIBUTION WITHIN SETS IN THE SPANISH MEDITERRANEAN SURFACE DRIFTING LONGLINE FISHERY.**
Juan A. Camiñas, J.C. Báez, R. Real, R. Sagarminaga, and X. Valeiras
- 286. CO-MANAGEMENT POTENTIAL FOR MARINE TURTLE FISHERIES IN ANGUILLA, BRITISH VIRGIN ISLANDS, MONTSERRAT, AND TURKS AND CAICOS ISLANDS**
Lisa M. Campbell, Annette Broderick, Brendan Godley, Sue Ranger, Peter Richardson, Karim V.D. Hodge, Carlos Sasso, Shannon Gore, Andy McGowan, Jon Jeffers, Corrine Martin, Tatum Fisher, Amber Thomas, and Jennifer Silver
- 287. TURTLE BY-CATCH AROUND LAMPEDUSA ISLAND, CENTRAL MEDITERRANEAN**
Lorenzo Cattarino, Paolo Casale, Daniela Freggi, Massimiliano Rocco, and Roberto Argano
- 288. STUDY OF THE STRANDED AND BIOMETRY OF LOGGERHEAD SEA TURTLE, *CARETTA CARETTA*, IN SICILIAN COASTS**
Andrea Contina and Gianni Insacco
- 289. TRANSLATING EXPERIMENTAL RESULTS INTO FLEET OPERATIONS; LESSONS IN MITIGATING THE BYCATCH OF SEA TURTLES, SEABIRDS, AND MARINE MAMMALS**
Larry Crowder, Tara Cox, Rebecca Lewison, Bryan Wallace, Ramunas Zydelis, Wallace J. Nichols, Carl Safina, and Andy Read
- 290. VERTICAL DISTRIBUTION OF LOGGERHEADS CAUGHT BY LONGLINE IN THE IONIAN SEA**
Michele Deflorio, Aida Aprea, Aldo Corriero, Nicoletta Santamaria, and Gregorio De Metrio
- 291. INCIDENTAL CAPTURE OF MARINE TURTLES BY COMMERCIAL FISHERIES IN THE WATERS OF THE ARCHIPELAGO OF GUADELOUPE**
Eric Delcroix and Johan Chevalier
- 292. DISTRIBUTION AND STOCK ORIGIN OF SEA TURTLES CAUGHT INCIDENTALLY IN THE CHILEAN LONGLINE FISHERY FOR SWORDFISH, 2001-2004**
Miguel Donoso and Peter H. Dutton

- 293. TRANS-ATLANTIC LEATHERBACK CONSERVATION – BUILDING SOLUTIONS THROUGH INTERNATIONAL COOPERATION**
Carlos Drews
- 294. INTERACTION OF MARINE TURTLES WITH LONGLINE FISHERIES IN THE REGION OF ZARZIS (GULF OF GABES, TUNISIA)**
Khaled Echwikhi, Imed Jribi, Mohamed Nejmeddine Bradai, and Abderrahmen Bouain
- 295. POPUP ARCHIVAL TRANSMITTING (PAT) TAGS AND THEIR APPLICATION TO LOGGERHEAD SEA TURTLE SURVIVAL STUDIES**
Sheryan Epperly, Christopher Sasso, Eric Prince, and Carlos Rivero
- 296. UNDERSTANDING THE THREAT: LOGGERHEAD (*CARETTA CARETTA*) SEA TURTLE INTERACTIONS WITH VIRGINIA (USA) WHELK POT FISHERY GEAR**
Meredith A. Fagan, John A. Musick, and Richard Brill
- 297. A CALL TO ARMS AGAINST THE CONSERVATION POLICE: A BRIEF HISTORY ON THE BATTLE TO EVALUATE HATCHLING “FITNESS” IN THE SOUTHEASTERN UNITED STATES**
Michael G. Frick
- 298. BYCATCH MORTALITY OF LEATHERBACK TURTLES IN TRINIDAD’S ARTISANAL GILLNET FISHERY**
Jordan Gass
- 299. INVESTIGATING THE EVIDENCE FOR INJURIOUS IN-WATER INTERACTIONS BETWEEN SCALLOP DREDGES AND SEA TURTLES**
Heather L. Haas, Jeff Gearhart, Brett Hayward, Ellen Keane, Henry Milliken, and Wendy Teas
- 300. STAVNIK AS A VALUABLE FISHING MEANS FOR THE PROTECTION OF MARINE ORGANISMS**
Idriz Haxhiu and Merita Rumano
- 301. RELATIVE IMPACT ASSESSMENT FOR LOGGERHEAD BYCATCH IN NORTHERN ADRIATIC FISHERIES**
Selina S. Heppell and Bojan Lazar
- 302. PRELIMINARY ASSESSMENT OF SEA TURTLE INTERACTIONS WITH INDONESIAN FISHERIES**
Creusa Hitipeuw, Imam Mustofa, and Lida Pet Soede
- 303. SEA TURTLE BY-CATCH IN THE GREEK DRIFTING LONG LINE FISHERY**
Argyris Kapantagakis and Lambros Lioudakis
- 304. THE MARINE TURTLE STRANDING NETWORK: PRELIMINARY DATA IN THE GULF OF GABES (TUNISIA)**
Sami Karaa, Mohamed Nejmeddine Bradai, Imed Jribi, and Abderrahmen Bouain
- 305. FISHERMEN’S ATTITUDES TOWARDS SEA TURTLES ON CRETE: AN ANALYSIS**
Olga Karadaki, Aliko Panagopoulou, and Dimitris Margaritoulis
- 306. STRANDED SEA TURTLES ALONG THE GREEK COASTLINE: AN INDICATOR OF FISHING INDUCED MORTALITY?**
Alexandra Kavvadia, Alan Rees, Isidora Katara, John Haralabous, Argyris Kapantagakis, Vasilis D. Valavanis, and Dimitris Margaritoulis

- 307. INTERACTIONS OF GILLNET FISHERY WITH LOGGERHEAD SEA TURTLES *CARETTA CARETTA* IN THE NORTHERN ADRIATIC SEA**
Bojan Lazar, Valter Ziza, and Nikola Tvrtkovic
- 308. GENETIC STOCK DETERMINATION OF MARINE TURTLE BY-CATCH FROM THE CALIFORNIA-BASED PELAGIC LONGLINE FISHERY AND CALIFORNIA/OREGON DRIFT GILLNET FISHERY**
Robin A. LeRoux and Peter H. Dutton
- 309. CONSIDERING THE RELATIVE IMPACT OF FISHERIES INTERACTIONS IN THE ATLANTIC AND THE PACIFIC: ACCOUNTING FOR DIVERGENT POPULATION TRENDS**
Rebecca Lewison, Ramunas Zydalis, Bryan Wallace, Selina Heppell, Abigail McCarthy, Molly Lutcavage, and Yonat Swimmer
- 310. TRINIDAD'S LEATHERBACKS: THE NET COST?**
Suzanne R. Livingstone and J. Roger Downie
- 311. ANALYSIS OF STRANDED LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN NORTH AND SOUTH CAROLINA USING MITOCHONDRIAL DNA AND STRANDING RECORDS**
Kristen T. Mazzarella, Al Segars, Sally R. Murphy, Joseph M. Quattro, and Thomas W. Greig
- 312. BYCATCH ASSESSMENT OF SEA TURTLES BY A COASTAL BOTTOM TRAWL FISHERY ON THE RIO DE LA PLATA ESTUARY, URUGUAY**
Philip Miller, Martin Laporta, Andres Domingo, Cecilia Lezama, and Mariana Rios
- 313. STRANDINGS AND SEA TURTLE FISHERIES INTERACTIONS ALONG THE COAST OF RIO GRANDE DO SUL STATE, BRAZIL**
Danielle Monteiro, Leandro Bugoni, and Sergio Estima
- 314. THE MARINE TURTLE RESCUE CENTER OF LINOSA: 11 YEARS OF ACTIVITIES**
Stefano Nannarelli, Alberto Dominici, and Alessandra De Lucia
- 315. REGULATION OF SEA TURTLE BYCATCH IN HAWAIIAN SWORDFISH LONGLINE FISHERY**
Jeffrey O'Hara and Theodore Groves
- 316. IMMATURE LEATHERBACK MORTALITY IN COASTAL GILLNET FISHERIES OFF SAN ANDRES, SOUTHERN PERU**
Nelly de Paz, Julio C. Reyes, Milagros Ormeño, Helbert A. Anchante, and Ali J. Altamirano
- 317. HOOK, LINE AND BYCATCH WORKSHOP SETTING THE AGENDA FOR MITIGATION OF BYCATCH IN LONGLINE FISHERIES**
Nicolas J. Pilcher, Amanda Nickson, Liz McClellan, and Ian Cartwright
- 318. BOTTOM TRAWLING IS A THREAT FOR THE CONSERVATION OF LOGGERHEAD SEA TURTLES OFF NORTH-EASTERN SPAIN**
Irene Álvarez de Quevedo, Andrea de Haro, Eva Pubill, Lluís Cardona, and Alex Aguilar
- 319. SEPARATING SEA TURTLES FROM FISHERIES: OCEANOGRAPHIC HABITAT MODELS OF SEA TURTLES ENCOUNTERED IN THE EASTERN TROPICAL PACIFIC TUNA FISHERY**
Jason J. Roberts, Michael S. Coyne, Patrick N. Halpin, and Martin A. Hall

- 320. TESTING MACKEREL BAIT AS A POSSIBLE BYCATCH MITIGATION MEASURE FOR THE SPANISH MEDITERRANEAN SWORDFISH LONGLINING FLEET**
Lucia Rueda, Ricardo J. Sagarminaga, Jose C. Baez, Juan A. Caminas, Scott A. Eckert, and Christofer Boggs
- 321. SHARK LONGLINE FISHERY AND SEA TURTLES IN PERUVIAN WATERS**
Shaleyra Kelez Sara, Camelia Manrique Bravo, and Ximena Velez-Zuazo
- 322. ANALYSIS OF THE CLANDESTINE CAPTURE OF TURTLES BY FISHERMEN OF LA REFORMA, ANGOSTURA, MEXICO**
Fernando Enciso Saracho, Ingmar Sosa Cornejo, Marco Antonio Barraza Ortega, Héctor Rafael Contreras Aguilar, and Marcos Bucio Pacheco
- 323. LOGGERHEADS AND SHRIMP TRAWLERS: NEW MANAGEMENT IDEAS FOR AN OLD PROBLEM.**
Jason A. Scott, Steven B. Castleberry, and Mark G. Dodd
- 324. AN OVERVIEW OF THE INTRODUCTION OF TURTLE EXCLUDER DEVICES IN SHRIMP TRAWL NETS IN NIGERIA**
B.B. Solarin, S.C. Opurum, F. Aniebona, and E.E. Ambrose
- 325. REFINING POST-RELEASE MORTALITY ESTIMATES FOR SEA TURTLES CAUGHT IN FISHING GEAR: AN ASSESSMENT OF THE IMPACTS OF ENTANGLEMENT ON PHYSIOLOGY AND BEHAVIOR**
Amanda Southwood and Yonat Swimmer
- 326. MORPHOMETRIC PARAMETERS AND ONTOGENY OF THE ORAL CAVITY IN LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)**
Lesley Stokes, Sheryan Epperly, Lisa Belskis, and Dominy Hataway
- 327. EVALUATION OF INJURY POTENTIAL IN INCIDENTALLY CAPTURED LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) RELATING TO HOOK SIZE AND BAITING TECHNIQUE**
Lesley Stokes, Dominy Hataway, Sheryan Epperly, Lisa Belskis, Charles Bergmann, John Watson, and Ben Higgins
- 328. SEA TURTLES AND LONGLINE FISHERIES INTERACTIONS IN BRAZIL - AN UPDATE ON FIELD TRIALS AND POST-RELEASE MORTALITY AND MOVEMENTS**
Yonat Swimmer, Gilberto Sales, Bruno Guffoni, and Joao Carlos Thome
- 329. DEVELOPING A COMMUNITY-BASED "SOLUTIONS MODEL" FOR MITIGATING MARINE TURTLE BYCATCH MORTALITY IN VIETNAM'S GILLNET FISHERIES**
Keith Symington, Chu Tien Vinh, and Pham Hong Dung
- 330. GETTING HOOKED: THREATS ON SEA TURTLES IN THE VALENCIAN COMMUNITY WATERS (SPANISH MEDITERRANEAN)**
Jesus Tomas, Patricia Gozalbes, Francisco J. Badillo, and Juan A. Raga
- 331. RESEARCH FINDINGS FROM A SEA TURTLE BYCATCH RELEASE PROGRAMME IN KENYA**
Steve Trott, Kahindi Changawa, and Richard Zanre
- 332. FIRST YEAR RESULTS OF THE HOOK SUBSTITUTION EXPERIMENT TO REDUCE SEA TURTLE BYCATCH IN PERU**
Michael Valqui, Amado Cruz, Joanna Alfaro Shigueto, Shaleyra Kelez Sara, Mariela Pajuelo, Jeffrey Mangel, and Paola Melly

333. EVALUATION OF FEEDING AREAS AND THE FISHERIES IN THE AGGREGATIONS OF SEA TURTLES PRESENT IN THE ARCHIPIELAGO LOS TESTIGOS, SOUTH CARIBBEAN, VENEZUELA
Pedro P. Vernet and Angela Arias-Ortiz

334. LIGHT STICKS USED IN LONGLINE FISHERIES ATTRACT JUVENILE LOGGERHEAD SEA TURTLES: POTENTIAL MITIGATION STRATEGIES
John H. Wang, Justin McAlister, Matthew Fuxjager, Ben Higgins, and Kenneth J. Lohmann

Freshwater & Terrestrial Turtles

335. AN ENERGETIC APPROACH TO UNDERSTANDING EGG SIZE VARIATION IN AN OVIPAROUS REPTILE
Phil Allman

336. REPRODUCTIVE PARAMETERS VARY WITH AGE IN THE PAINTED TURTLE
Rachel M. Bowden and Fredric J. Janzen

337. THE 'GREY' TURTLE (*TRIONYX TRIUNGUIS*): A CHALLENGE TO THE DEFINITION "SEA TURTLE"?
Ian Bride

338. THE EFFECTS OF BEACH NOURISHMENT ON THE NESTING AND REPRODUCTIVE SUCCESS OF THE NILE SOFT-SHELL TURTLE (*TRIONYX TRIUNGUIS*); A CASE STUDY AROUND THERMAL LAKE KUKURTLU, MUGLA-TURKEY
Muge Gidis, Ersin Pacali, and Yakup Kaska

339. ECOLOGY OF A RARE AND ELUSIVE NORTH AMERICAN TORTOISE: THE IMPORTANCE OF GENETICS ANALYSES
Bridgette E. Hagerty and C. Richard Tracy

340. INTEGRATING ECOLOGY AND GENETICS TO DEFINE POPULATION EXTENT FOR A CONTINUOUSLY-DISTRIBUTED SPECIES, THE DIAMONDBACK TERRAPIN (*MALACLEMYS TERRAPIN*)
Kristen M. Hart, Larry B. Crowder, Carole C. McIvor, and Tim L. King

341. POPULATION SIZE AND REPRODUCTIVE ECOLOGY OF THE NILE SOFT-SHELL TURTLE (*TRIONYX TRIUNGUIS*) IN TURKEY
Yakup Kaska and Muge Gidis

342. PHYLOGEOGRAPHY AND POPULATION GENETICS OF THE AEGEAN *MAUREMYS RIVULATA* (TESTUDINES; GEOEMYDIDAE)
Georgia Mantziou, Kevin de Queiroz, Nikos Poulakakis, and Moysis Mylonas

343. ONTOGENY OF STEROID RECEPTOR DEVELOPMENT IN THE BRAIN AND GONADS OF THE RED-EARED SLIDER (*TRACHEMYS SCRIPTA*)
Ryan T. Paitz and Rachel M. Bowden

344. REASSESSMENT OF THE TURTLE COMMUNITY IN THE NORTH FORK OF WHITE RIVER, OZARK COUNTY, MISSOURI, USA
Amber L. Pitt and Max A. Nickerson

345. WHERE IT ALL BEGAN: EARLY IMAGES FROM THE ART OF CHELONIAN SCIENCE
Chuck Schaffer and Rick Schaffer

346. TESTUDO TERRAPIN (SCHOEPF): A BRIEF HISTORY OF ITS ILLUSTRATION

Chuck Schaffer

347. TURTLES AS ENVIRONMENTAL INDICATORS: USING THE DIAMONDBACK TERRAPIN (*MALACLEMYS TERRAPIN*) TO MONITOR ESTUARINE MERCURY CONTAMINATION

Jeffrey A. Schwenter, Gaëlle Blanvillain, Russell D. Day, Steven J. Christopher, and David Wm. Owens

348. RECENT STATUS OF THE EUPHRATES SOFT-SHELLED TURTLE, *RAFETUS EUPHRATICUS*, IN THE EUPHRATES AND TIGRIS RIVERS, TURKEY

Ertan Taskavak and Tag N. Engstrom

349. TESTUDO TRADE IN TURKEY

Oguz Turkozan and Ferhat Kiremit

350. REPRODUCTIVE ECOLOGY AND STATUS OF *TRIONYX TRIUNGUIS* IN DALYAN, TURKEY

Oguz Turkozan, Can Yilmaz, and Ertan Taskavak

351. *TRIONYX TRIUNGUIS*: THE BRACKISH WATER TURTLE THAT ALSO LIVES IN THE MEDITERRANEAN SEA

Lily Venizelos and Max Kasparek

Peter Lutz Scientific Tribute

352. WHAT IT TAKES TO BE A GOOD SCIENTIST IN A CRISIS DISCIPLINE

Selina S. Heppell

353. FROM WAVES TO GEOMAGNETISM: AN INTEGRATIVE APPROACH TO SEA TURTLE NAVIGATION

Kenneth Lohmann

354. A LUTZ-IAN APPROACH TO THE LEATHERBACK: INTEGRATION OF ORGANISM AND OCEANOGRAPHY

Molly E. Lutcavage

355. SKELETAL GROWTH IN TURTLES: PATTERNS OF FORM AND FUNCTION

Anders G.J. Rhodin

356. BIOLOGICAL IMPLICATIONS OF TEMPERATURE-DEPENDENT SEX DETERMINATION IN SEA TURTLES

Thane Wibbels

Population Biology and Monitoring

357. FIVE YEARS OF MARINE TURTLE CONSERVATION EFFORT IN LEBANON: MONITORING AND AWARENESS.

Monica Aureggi, Mona Khalil, Helen Cross, Max Kasparek, Charbel Rizk, and Lily Venizelos

358. GENETIC STOCK ORIGIN OF HAWKSBILL TURTLE STRANDINGS ON THE TEXAS COAST BASED ON MTDNA

Michelle Averbeck, Donna Shaver, Robin A. LeRoux, and Peter H. Dutton

359. CANCELLED

360. FIRST RECORD OF NESTING ACTIVITIES OF THE SEA TURTLE IN THE GULF OF VENEZUELA: NOT JUST FOR FOOD

Hector Barrios-Garrido and Ma. Gabriela Montiel-Villalobos

- 361. RECRUITMENT OF POST-PELAGIC GREEN TURTLES (*CHELONIA MYDAS*) TO NEARSHORE REEFS ON FLORIDA'S EAST COAST**
Michael Bresette, Dave Singewald, and Edward De Maye
- 362. CARIBBEAN LEATHERBACKS: RESULTS OF NESTING SEASONS FROM 1984 TO 2005, CULEBRA ISLAND, PUERTO RICO**
Jessica H. Castro, Carlos E. Diez, Rolando Soler, and Carlos T. Carrion
- 363. PATTERNS IN NUMBERS OF NESTING LOGGERHEADS (*CARETTA CARETTA*) DERIVED FROM A 41-YEAR TIMELINE OF REPLICATE SEASONAL SURVEYS (1964-2005), LITTLE CUMBERLAND ISLAND, GEORGIA, USA**
Jocelyn A. Coulter, Rebecca Bell, Patricia Kusmierski, James Richardson, and Thelma Richardson
- 364. SEX-RATIO OF JUVENILE PELAGIC LOGGERHEADS, *CARETTA CARETTA*, OFF MADEIRA ISLAND (PORTUGAL), NE ATLANTIC, USING HISTOLOGIC ASSIGNMENT**
Cláudia Delgado and Thomas Dellinger
- 365. ANALYSIS OF ARRIBADA IN 1947 HERRERA FILM AT RANCHO NUEVO, MEXICO**
Virginia L. Dickerson and Dena D. Dickerson
- 366. *IN-SITU* NEST INCUBATION TEMPERATURE STUDY IN A SEA TURTLE NEST WITH INTERNET-BASED DATA ACQUISITION TECHNOLOGY: POTENTIAL FOR CONCURRENT ANALYSIS OF GLOBALLY COORDINATED RESEARCH ACROSS MULTIPLE SITES BY MULTIPLE RESEARCHERS**
Cheong-Hoong Diong, James Anak Bali, and Oswald Braken Tisen
- 367. ESTIMATING JUVENILE SURVIVAL RATES AND AGE AT FIRST NESTING OF LEATHERBACK TURTLES AT ST. CROIX, US VIRGIN ISLANDS**
Tomoharu Eguchi, Peter H. Dutton, Steven A. Garner, and Jeanne Alexander-Garner
- 368. NESTING ACTIVITY OF THE MARINE TURTLES (*CHELONIA MYDAS* AND *CARETTA CARETTA*) DURING 2005 IN ALATA, MERSİN-TURKEY**
Serap Ergene, Cemil Aymak, and Aşkın H. Uçar
- 369. THE SPATIAL DISTRIBUTION OF LOGGERHEAD SEA TURTLE NESTS AND THEIR TEMPERATURE AND SEX RATIO VARIATIONS ON DALAMAN BEACH, TURKEY**
Tarik Erzin, Akin Kirac, and Yakup Kaska
- 370. HATCHLING SEX RATIOS OF HAWAIIAN GREEN SEA TURTLES**
Jennifer Estes, George Balazs, and Thane Wibbels
- 371. SEA TURTLE SURVEY IN PRAIA GRANDE, SÃO TOMÉ E PRÍNCIPE**
Rogério Nuno Lopes Ferreira
- 372. CONFIRMATION OF HAWKSBILL NESTING IN GABON**
Jacques Fretey, Bas Verhage, Alexis Billes, and Alain Gibudi
- 373. AN UNUSUAL NEST ACTIVITY ALONG SOUTHERN SICILIAN COASTS: AN HOPE FOR SEA TURTLE SURVIVAL?**
Francesco Galia, Daniela Freggi, Stefania d'Angelo, and Mario lo Valvo
- 374. TWO DECADES OF STRANDING DATA FROM BERMUDA, AN ISLAND IN THE SARGASSO SEA**
Jennifer Gray, Anne Meylan, and B. Outerbridge

- 375. NESTING SEA TURTLES ON THE AUSTRALIAN CONTINENTAL SHELF EDGE ISLANDS: ASHMORE REEF, CARTIER ISLAND AND SCOTT REEFS, EASTERN INDIAN OCEAN**
Michael L. Guinea, Scott D. Whiting, and Andrea U. Koch
- 376. AN ESTIMATION OF DEMOGRAPHIC PARAMETERS FOR THE LOGGERHEAD SEA TURTLE, *CARETTA CARETTA*, ON BALD HEAD ISLAND, NC USA**
Melissa E. Hedges and Jim Berkson
- 377. WHERE HAVE ALL THE RIDLEYS GONE: THE DECLINE OF THE ARRIBADA AT PLAYA NANCITE COSTA RICA**
Shaya Honarvar, Pamela Plotkin, and James R. Spotila
- 378. MONITORING OF THE GREEN TURTLE POPULATION IN THE CAMPO-MA'AN AREA SOUTH CAMEROON, CENTRAL AFRICA REGION**
Angoni Hyacinthe, Jacques Fretey, and Amougou Akoa
- 379. NEST TEMPERATURES AND SEX RATIO VARIATIONS AMONG THE HATCHLINGS AND EMBRYOS OF LOGGERHEAD TURTLES ALONG THE MEDITERRANEAN COAST OF TURKEY**
Yakup Kaska, Pinar Ili, Arzu Kaska, Monica Aureggi, Muge Gidis, Rasit Urhan, Eyup Baskale, and Yusuf Katilmis
- 380. A FIVE YEAR SUMMARY OF SEA TURTLE TAGGING DATA FROM AN IN-WATER STUDY IN THE MARYLAND PORTION OF THE CHESAPEAKE BAY: POSSIBLE EVIDENCE OF SITE FIDELITY**
Tricia L. Kimmel, Cindy P. Driscoll, and Julianna R. Brush
- 381. PAPUA NEW GUINEA LEATHERBACKS: SETTING THE PACE**
Karol M. Kisokau, Levi Ambio, Colin Naru, Peter Dutton, Scott Benson, Tomo Eguchi, Nicolas Pilcher, and Vagi Rei
- 382. MAXIMIZING POPULATION INFORMATION FROM VARIOUS BEACH CENSUS REGIMES**
Andrea U. Koch, Milani Chaloupka, Michael L. Guinea, Colin J. Limpus, Nicholas Pilcher, Scott D. Whiting, and Lamri Ali
- 383. SURVIVAL PROBABILITIES FOR IMMATURE HAWKBILL TURTLES, *ERETMOCHELYS IMBRICATA*, ALONG THE WEST COAST OF BARBADOS**
Barry H. Krueger, Milani Chaloupka, and Jen A. Beggs
- 384. SEASONAL FECUNDITY AND ITEROPARITY IN THE LOGGERHEAD (*CARETTA CARETTA*) DERIVED FROM A 43-YEAR TIMELINE OF REPLICATE SEASONAL SURVEYS (1964-2005), LITTLE CUMBERLAND ISLAND, GEORGIA, USA**
Patty Kusmierski, Rebecca Bell, Jocelyn Coulter, James I. Richardson, and Thelma H. Richardson
- 385. GENETIC STOCK COMPOSITION OF LOGGERHEADS (*CARETTA CARETTA*) ENCOUNTERED IN THE ATLANTIC NORTHEAST DISTANT (NED) LONGLINE FISHERY USING ADDITIONAL MTDNA ANALYSIS**
Erin L. LaCasella, Peter H. Dutton, and Sheryan P. Epperly
- 386. POTENTIAL SOURCE OF MALES IN LOGGERHEAD TURTLE (*CARETTA CARETTA*) POPULATION IN THE SOUTHERN COAST OF ISRAEL**
Yaniv Levy, Yariv Malichi, and Avital Gasith
- 387. PASTA: THE PACIFIC-ATLANTIC SEA TURTLE ASSESSMENT PROJECT**
Molly Lutcavage, Selina S. Heppell, and Abigail McCarthy

- 388. NORTHWEST ATLANTIC LOGGERHEADS: ADDRESSING DATA GAPS IN SUB-ADULT ABUNDANCE ESTIMATES**
Katherine L. Mansfield and John A. Musick
- 389. G.I.S. APPLIED IN SEA TURTLE CONSERVATION**
Alvaro Manzano and Monica López Conlon
- 390. VARIATION IN CLUTCH SIZE AND EGG SIZE IN THE LOGGERHEAD TURTLE NESTING POPULATION AT MINABE, JAPAN**
Yoshimasa Matsuzawa, Takeharu Bando, and Kiyoshi Goto
- 391. SEA TURTLE NESTING IN FLORIDA, USA: ASSESSMENTS OF ABUNDANCE AND TRENDS FOR REGIONALLY SIGNIFICANT POPULATIONS OF *CARETTA*, *CHELONIA*, AND *DERMOCHELYS***
Anne B. Meylan, Blair E. Witherington, Beth Brost, Rosanna Rivero, and Paul S. Kubilis
- 392. DISTRIBUTION AND RELATIVE ABUNDANCE OF SEA TURTLE NESTING IN THE UNITED ARAB EMIRATES**
Jeff Miller and Ron Loughland
- 393. LOGGERHEAD TURTLE, *CARETTA CARETTA*, IN ITALY: A REAPPRAISAL OF NESTING ACTIVITY WITHIN THE NATIONAL SCENARIO**
T. Mingozi, G. Cambié, F. Crispino, N. Micò, and S. Urso
- 394. CANCELLED**
- 395. PRELIMINARY SURVEY OF MARINE TURTLES OF THE EGYPTIAN MEDITERRANEAN COASTAL WATERS**
Hesham M. Mostafa and A.H. Nasser
- 396. NESTING ACTIVITY OF THE LOGGERHEAD SEA TURTLE *CARETTA CARETTA* ON THE POCKET BEACH OF LINOSA ISLAND (SOUTH OF ITALY): RECENT DATA (2004-2005)**
Stefano Nannarelli, Alessandra De Lucia, Alberto Dominici, and Susanna Piovano
- 397. TURTLE MONITORING IN SOUTH AFRICA: 42 YEARS WORTH OF DATA**
Ronel Nel
- 398. INTERNESTING SEASON PRESENCE OF LEATHERBACK TURTLES IN NEAR-COASTAL WATERS OFF GABON**
Solange Nguesso, Tim Collins, and Richard Parnell
- 399. AN OVERVIEW OF THE STATUS OF GREEN TURTLES (*CHELONIA MYDAS*) IN KENYA**
Gladys M. Okemwa and Andrew Wamukota
- 400. A REVIEW OF FEEDING, BREEDING AND WINTERING SITES OF MARINE TURTLES IN TURKEY**
Ayse Oruc
- 401. THE QUÉBEC SEA TURTLE PROJECT: TOWARDS A CONSERVATION STRATEGY IN THE ESTUARY AND GULF OF ST. LAWRENCE, CANADA**
Martin Ouellet, Christian Fortin, Patrick Galois, and Patricia Nash
- 402. AREAS OF FEEDING OF MARINE TURTLES IN THE NATIONAL PARK ARCHIPELAGO THE ROQUES, SOUTH CARIBBEAN, VENEZUELA**
Pedro P. Vernet and Angela Arias-Ortiz

- 403. LEATHERBACK TURTLE NESTING MONITORING IN LA PLAYONA, ACANDÍ, CHOCÓ, ATLANTIC NORTHWEST OF COLOMBIA**
Juan Patiño-Martínez, Ana Suárez, Adriana Restrepo, Liliana Quiñones, Vivian Páez, and Adolfo Marco
- 404. AERIAL PHOTOGRAMMETRY OF LEATHERBACK TURTLES: A NOVEL METHOD FOR NON-INVASIVE MEASUREMENT**
Victoria L. Pease, Wayne Perryman, Jeffrey Seminoff, Morgan Lynn, Jim Gilpatrick, and Peter H. Dutton
- 405. POPULATION LEVEL IMPACTS OF SMALL-SCALE FISHERIES BYCATCH ON HIGHLY-MIGRATORY MEGAVERTEBRATES: A CASE STUDY OF LOGGERHEAD TURTLE MORTALITY AT BAJA CALIFORNIA SUR, MEXICO**
Hoyt Peckham, Wallace J. Nichols, David Maldonado, Victor de la Toba, Andreas Walli, Natalia Rossi, and Edgar Caballero-Aspe
- 406. TRIALS AND TRIBULATIONS OF TRACKING SEA TURTLES IN MOSQUITO LAGOON- TRENDS IN ABUNDANCE AND RESULTS FROM THE PASSIVE ACOUSTIC MONITORING NETWORK**
Jane A. Provancha, Russell Lowers, Mario Mota, Karen Holloway-Adkins, Eric Reyier, and Doug Scheidt
- 407. NEST COUNTS AND BEACH CHOICES FOR MARINE TURTLES (LEATHERBACK, *DERMOCHELYS CORIACEA*; GREEN, *CHELONIA MYDAS*; OLIVE RIDLEY, *LEPIDOCHELYS OLIVACEA*; AND HAWKSBILL, *ERETMOCHELYS IMBRICATA*) ON THE SOUTHERN BEACHES OF BIKO ISLAND (GULF OF GUINEA, AFRICA) ACROSS FIVE NESTING SEASONS (2000/2001 THROUGH 2004/2005)**
Heidi A. Rader, Miguel Angel Ela Mba, Wayne Morra, Gail Hearn, and Jennifer Bradsby
- 408. AMVRAKIKOS BAY: AN IMPORTANT FORAGING AREA FOR LOGGERHEAD TURTLES IN GREECE**
ALan F. Rees and Dimitris Margaritoulis
- 409. IMPLEMENTATION OF GIS SYSTEMS IN *CHELONIA MYDAS* NESTING AREAS IN THE WESTERN REGION OF CUBA**
Julia Azanza Ricardo, Ernesto Águila Fonseca, María Elena Ibarra Martín, Rogelio Díaz Fernández, César Y. Luis Castellanos, and Duniesky Ríos Tamayo
- 410. REPRODUCTIVE SUCCESS OF *CHELONIA MYDAS* IN NESTING AREAS OF GUANAHACABIBES PENINSULA, CUBA**
Julia Azanza Ricardo, María Elena Ibarra Martín, Rogelio Díaz Fernández, Ariel Ruiz Urquiola, Yeleine Ruisanchez Carrasco, César Y. Luis Castellanos, and Duniesky Ríos Tamayo
- 411. COMPARATIVE MODELING OF SEA TURTLE POPULATION DYNAMICS**
Paul M. Richards
- 412. SINGLE NUCLEOTIDE POLYMORPHISM (SNP) MARKER DISCOVERY IN *CHELONIA MYDAS***
Suzanne E. Roden, Phillip A. Morin, and Peter H. Dutton
- 413. MARINE TURTLE NESTING SURVEY, SYRIA 2005**
Adib Saad, Abdellatif Ali, and Akram Darwish
- 414. CANCELLED**
- 415. LOGGERHEAD TURTLE DENSITY AND ABUNDANCE ALONG THE PACIFIC COAST OF THE BAJA CALIFORNIA PENINSULA, MEXICO DETERMINED THROUGH AERIAL SURVEYS: A PRELIMINARY ASSESSMENT**
Jeffrey A. Seminoff, S. Hoyt Peckham, Tomoharu Eguchi, Adriana Laura Sarti-Martinez, Rodrigo Rangel, Karin Forney, Wallace J. Nichols, Enrique Ocampo Olvera, and Peter H. Dutton

- 416. NESTING ACTIVITY OF *CHELONIA MYDAS* AND *CARETTA CARETTA* ON KARPAS PENINSULA, NORTH CYPRUS**
Asaf Senol and Hasibe Kusetogullari
- 417. EVALUATION OF HATCHING LOGGERHEAD SEX RATIOS FROM THE SOUTHEASTERN U.S. USING GONADAL HISTOLOGY**
David Shulman, Meghann Jones, Keval Patel, Tejas Patel, Jeanette Wyneken, and Thane Wibbels
- 418. DEVELOPMENT AND VALIDATION OF A TECHNIQUE FOR USING SKELETAL GROWTH MARKS TO BACK-CALCULATE LENGTH IN LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)**
Melissa L. Snover, Larisa Avens, and Aleta A. Hohn
- 419. APPLICATION OF THE DENNIS-HOLMES POPULATION VIABILITY ASSESSMENT MODEL TO MARINE TURTLE CONSERVATION**
Melissa L. Snover, Selina S. Heppell, and Tomoharu Eguchi
- 420. INSIGHTS INTO THE NESTING POPULATION OF MARINE TURTLES IN THE CAYMAN ISLANDS**
Joni L. Solomon, Janice Blumenthal, Timothy J. Austin, Gina Ebanks-Petrie, Annette C. Broderick, and Brendan J. Godley
- 421. OCCURRENCE OF LEATHERBACK SEA TURTLES OFF THE PACIFIC COAST OF CANADA**
Lisa D. Spaven and John K. B. Ford
- 422. SEA TURTLES OF PALMYRA ATOLL, LINE ISLANDS**
Eleanor Sterling and Eugenia Naro-Maciel
- 423. EGGS WELLDONE: NEST SUCCESS OF FLATBACK SEA TURTLES, BARE SAND ISLAND, NORTHERN TERRITORY, AUSTRALIA**
April Stevens, Scott Whiting, and Michael Guinea
- 424. A QUANTITATIVE LOOK AT LONG-TERM SEA TURTLE NESTING CYCLES IN GUYANA; WHAT ROLE HAS CONSERVATION PLAYED?**
Kelly Stewart, Peter C.H. Pritchard, Romeo de Freitas, and Audley James
- 425. ST. KITTS SEA TURTLE MONITORING NETWORK: IMPLEMENTATION OF A LONG-STANDING SEA TURTLE PROTECTION PROGRAM**
Kimberly M. Stewart, Marc R. McDanel, and Nick J. Reed
- 426. EVALUATION OF SPATIAL CHANGES AND CARDINAL BEACH DIRECTIONAL EFFECTS ON LOGGERHEAD SEA TURTLE NESTS ON BALD HEAD ISLAND, NORTH CAROLINA**
Karen E. Sullam and Melissa E. Hedges
- 427. A REVIEW OF 2005 MARINE TURTLE NESTING SEASON ON FIVE BEACHES (DALYAN, FETHIYE, PATARA, BELEK, GOKSU DELTA) IN TURKEY**
Ertan Taskavak, Oguz Turkozan, Ferhat Kiremit, Onur Turkecan, Ozgur Guclu, Can Akcinar, Can Yilmaz, and Dogan Tuncay
- 428. IMPLICATIONS OF HATCHING SUCCESS ANALYSIS ON THE REPRODUCTIVE SUCCESS OF THE LEATHERBACK TURTLES THAT NEST AT PARQUE NACIONAL MARINO LAS BAULAS, COSTA RICA**
Pilar Santidrian Tomillo, Bryan P. Wallace, Richard D. Reina, Frank V. Paladino, and James R. Spotila

- 429. GRUPO ECOLOGICO DE LA COSTA VERDE SAN FRANCISCO, NAYARIT - MEXICO 1994-2004: 10 YEARS OF CONSERVATION EFFORTS**
Paul C. Tsaros and Frank D. Smith
- 430. TRENDS AT THE MAJOR LOGGERHEAD ROOKERY IN THE EASTERN GULF OF MEXICO: 1980-2005, SARASOTA COUNTY, FLORIDA**
Tony Tucker, Jim Grimes, Sarah Condran, Jerris Foote, Mario Mota, Paula Clark, Alli Hays, Wilma Katz, Zoe Bass, Kenya Leonard, Howard Berna, and George Tatge
- 431. PRELIMINARY RESULTS FOR THE POPULATION TRENDS OF TWO INDEX BEACHES, FETHIYE AND DALYAN, TURKEY**
Oguz Turkozan
- 432. LENGTH AND WEIGHT RELATIONSHIPS OF HATCHLING AND ADULT LOGGERHEAD TURTLES IN BELEK, TURKEY**
Onur Türkecan, Sedat V. Yerli, and Ertan Taskavak
- 433. RESULTS OF SEA TURTLE NESTING ON AVES ISLAND, VENEZUELA: 2005 SEASON**
Vicente Vera and Alfredo Montilla
- 434. THREE YEARS OF MARINE TURTLE MONITORING IN THE GAMBA COMPLEX OF PROTECTED AREAS, GABON**
Bas Verhage and Hans Gwladis Magaya
- 435. HAS THE INCUBATION PERIOD OF LEATHERBACK NESTS ON ARUBA CHANGED?**
Richard W. van der Wal and Edith S. van der Wal
- 436. PHOTO-RECOGNITION: A TECHNIQUE USED TO IDENTIFY INDIVIDUAL LOGGERHEAD TURTLES IN THE MARINE ENVIRONMENT**
Michael White
- 437. SEA TURTLES IN ALBANIA: RESULTS OF A RAPID ASSESSMENT OF POSSIBLE FORAGING AND OVER-WINTERING HABITATS (OCTOBER-NOVEMBER 2005)**
Michael White, Vassilis Kouroutos, Adonis Plytas, Arian Gace, Andrian Vaso, Sajmir Beqiraj, and Idriz Haxhiu
- 438. THE REMOTE COCOS (KEELING) ISLANDS, INDIAN OCEAN: A HAVEN FOR RESIDENT SEA TURTLES AND A POSSIBLE INDICATOR SITE FOR THE HEALTH OF EAST INDIAN OCEAN HAWKSBILL AND GREEN TURTLE POPULATIONS**
Scott D. Whiting, Wendy Murray, Ismail Macrae, and Robert Thorn
- 439. REPRODUCTIVE HISTORIES OF REMIGRANT LOGGERHEAD TURTLES FROM WASSAW NATIONAL WILDLIFE REFUGE, GEORGIA, USA**
Kristina L. Williams, Michael G. Frick, and Edward A. Standora
- 440. A PRELIMINARY ASSESSMENT OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN PALM BEACH COUNTY WATERS**
Lawrence D. Wood
- 441. THE IMPORTANCE OF ANNUAL VARIATION IN UNDERSTANDING SEA TURTLE SEX RATIOS**
Jeanette Wyneken, Sheryan Epperly, Selina Heppell, and Larry Crowder
- 442. NESTING BEACH MONITORING OF GREEN TURTLES IN THE GALAPAGOS ISLANDS: A 4-YEAR EVALUATION**
Patricia M. Zárate, Sigita S. Cahoon, María C. D. Contato, Peter H. Dutton, and Jeffrey A. Seminoff

- 443. FIRST RECORD OF FLY LARVA DEPREDATION ON GREEN TURTLE DEVELOPING EGGS AND HATCHLINGS IN THE GALAPAGOS ISLANDS**
Patricia M. Zárate, Henri W. Herrera, María C. D. Contato, Italo E. Bravo, Peter H. Dutton, and Jeffrey A. Seminoff

Social Science Research

- 444. ORIGIN AND PROGRESS IN RESEARCH AND CONSERVATION OF MEDITERRANEAN MARINE TURTLES AT THE NAPLES “STAZIONE ZOOLOGICA”**
Flegra Bentivegna
- 445. INCIDENTAL CATCH OF SEA TURTLE IN ARTISANAL GEARS IN ANDALUSIA AND MURCIA (SE SPAIN): RESULTS FROM INTERVIEWS**
Jose C. Báez, Juan A. Camiñas, and Ricardo Sagarminaga
- 446. ENGAGING WITH INDIGENOUS TRADITIONAL OWNERS IN THE PLANNING AND MANAGEMENT OF DUGONG AND MARINE TURTLE TOURISM IN AUSTRALIA**
Kirstin Dobbs, Alastair Birtles, Dermot Smyth, Helene Marsh, Col Limpus, Peter Valentine, William Hyams, and Matt Curnock
- 447. TOWARDS SUSTAINABLE MANAGEMENT OF VESSEL AND IN-WATER TURTLE TOURISM IN AUSTRALIA**
Kirstin Dobbs, Alastair Birtles, Matt Curnock, Andy Dunstan, Peter Arnold, Peter Valentine, Helene Marsh, Col Limpus, Dermot Smyth, Arnold Mangott, and Dean Miller
- 448. MARINE TURTLE CONSERVATION AND LIVELIHOODS OF COASTAL COMMUNITIES - TOWARD A CONCEPT AND INDICATORS TO UNDERSTAND AND ENHANCE OUR SOCIOECONOMIC IMPACT**
Carlos Drews, Sandra Andraka, and Sebastian Troëng
- 449. TURTLES AND TOURISTS: VALUING CARIBBEAN BEACHES FOR INTEGRATED COASTAL MANAGEMENT**
Marianne R. Fish, Andrew P. Jones, Julia A. Horrocks, Isabelle M. Côté, and Andrew R. Watkinson
- 450. THE ENIGMA OF THE LEATHERBACKS IN PAINTINGS OF RENÉ MAGRITTE**
Jacques Fretey
- 451. THE AEGINETAN STATERS OR CHELONOMORPHS ON THE FIRST COINS OF HUMANITY**
Jacques Fretey, Dimitris Margaritoulis, and Patrice De La Perriere
- 452. COMMUNITY-BASED CONSERVATION STRATEGIES: AN ANALYSIS OF EFFORTS EMPLOYED IN BAJA CALIFORNIA, MEXICO AND NICARAGUA**
Katy Garland, Ray Carthy, Wallace J. Nichols, Cynthia Lagueux, and Cathi Campbell
- 453. COGNITIVE STRUCTURE OF TRADITIONAL FISHERMAN AND COMMERCIAL FISHERMAN WAYUU: AN ETHNOGRAPHIC STUDY**
Magaly Andreina Castellano Gil and Hector Barrios-Garrido
- 454. USING SOCIOECONOMIC SURVEYS TO DESIGN COMMUNITY INCENTIVES FOR CONSERVATION**
Heidi Gjertsen and Creusa Hitipeuw
- 455. MARINE TURTLE CULTURE IN THE BRITISH VIRGIN ISLANDS**
Shannon Gore, Arlington Pickering, Gaverson Frett, and Bertrand Lettsome

- 456. COMMUNITY-BASED CATCH-MONITORING OF A TRADITIONAL FISHERY FOR MARINE TURTLES IN THE KAIWALAGAL TRADITIONAL SEA COUNTRY OF TORRES STRAIT**
Jillian E. Grayson, Mark Hamann, and Helene Marsh
- 457. PRELIMINARY RESULTS OF VILLAGE-LEVEL TURTLE CONSERVATION FROM MAINLAND TANZANIA, EAST AFRICA**
Catharine Muir, Freya St John, and Omari Abdallah
- 458. JUST SAY NO! AN ASSESSMENT OF THE ESTABLISHMENT, IMPLEMENTATION AND UTILITY OF THE 25-YEAR MORATORIUM ON TURTLE EXPLOITATION ON THE ISLAND OF ANGUILLA, BWI**
Susan Ranger, Lisa M. Campbell, Brendan J. Godley, James Gumbs, Karim V.D. Hodge, Peter B. Richardson, and Carlos Sasso
- 459. OHUIRA WAS SILENCIO JOROBADO**
Fernando Enciso Saracho
- 460. THE SEA TURTLES ON THE GUINEAN COASTLINE**
M'mah Soumah and Béatrice de Gaulejac
- 461. COMMUNITY PARTICIPATION IN THE CONSERVATION AND MANAGEMENT OF SEA TURTLES IN KENYA**
Andrew W. Wamukota, Simmons Nzuki, and John Muasa

Turtles and Climate Change

- 462. THE IMPACT OF CLIMATE CHANGE ON HAWKSBILL TURTLES – A WAY FORWARD TOWARD ADAPTATION STRATEGIES**
Carlos Drews, Michael Case, and Lara Hansen
- 463. BEACH TEMPERATURES AND THE POTENTIAL IMPACT OF GLOBAL WARMING ON MARINE TURTLE NESTING IN THE UNITED ARAB EMIRATES**
Ron Loughland and Jeff Miller
- 464. TEMPORAL SHIFTS IN HAWKSBILL NESTING: MECHANISMS AND CONSEQUENCES**
Peri A. Mason and James I. Richardson
- 465. THE IMPACTS CAUSED BY CLIMATIC GLOBAL CHANGES ADD TO THE THREATS OF THE BREEDING POPULATION (*DERMOCHELYS CORIACEA*) IN THE MARGARITA ISLAND, SOUTH CARIBBEAN, VENEZUELA**
Pedro P. Vernet and Angela Arias-Ortiz
- 466. THE EFFECT OF DECREASING RAINFALL AS CLIMATIC CHANGE ON SUBSTRATE CONDUCTIVITY, EMBRYO MORTALITY AND FUNGAL INVASION OF SEA TURTLE NESTS**
Andrea D. Phillott and C. John Parmenter
- 467. ENSO DETERMINES THE REPRODUCTIVE FREQUENCY OF EASTERN PACIFIC LEATHERBACKS**
Vincent S. Saba, Pilar Santidrian-Tomillo, Richard D. Reina, James R. Spotila, Frank V. Paladino, John A. Musick, and David A. Evans
- 468. ENSO GOVERNED PRODUCTIVITY TRANSITIONS AT POTENTIAL LEATHERBACK FORAGING AREAS IN THE EQUATORIAL AND SOUTHEASTERN PACIFIC**
Vincent S. Saba, James R. Spotila, and John A. Musick

469. NESTING PHENOLOGY OF LOGGERHEADS IN SOUTHWEST FLORIDA: IS AN EARLIER NESTING SEASON TIED TO SST OR SIMPLY A REFLECTION OF SURVEY EFFORT?

Tony Tucker

470. LEATHERBACK TURTLES, JELLYFISH AND CLIMATE CHANGE IN THE NORTHWEST ATLANTIC: CURRENT SITUATION AND POSSIBLE FUTURE SCENARIOS

Matthew J. Witt, Brendan J. Godley, Annette C. Broderick, Rod Penrose, and Corrine S. Martin

Video

471. ANCIENT NAVIGATORS

Milagros López-Mendilaharsu, Virginia Boix, Horacio Gomez, Lorenzo Paradell, Andrés Estrades, and Alejandro Fallabrino

472. SEA TURTLES SEEN FROM THE SKY

Serge Montagnan, Thierry Portafaix, and Stéphane Ciccione

473. GLORIEUSES... GENETIC

Serge Montagnan, Emmanuel Pons, and Thierry Portafaix

474. SEA TURTLE: WAYUU TREASURE

Ysidro Sore, Pablo Barboza, Marielvy D'apollo, Dalia Sanchez, Hector Barrios-Garrido, and Ma. Gabriela Montiel-Villalobos

475. "UNA ENTRE MIL" (ONE IN A THOUSAND), A LOOK AT THE SEA TURTLES OF MEXICO. ENVIRONMENTAL

EDUCATION PROGRAM IN LOS CABOS, BAJA CALIFORNIA SUR, MEXICO

G. Tiburcio-Pintos, E. Garcia Juan, and Villarías Leoncio

476. PICCOLO

Michael White

Order: 1 Abstract ID: 1426 Type: Poster Subject: Anatomy, Physiology and Health

WHY ARE EGG FERTILIZATION RATES NOT CORRELATED WITH HATCHING SUCCESS IN SEA TURTLES?

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The relative number of developing eggs is directly affected by fertilization rate, and unfertile eggs may indirectly negatively affect development of viable eggs within the nest. Thus, the number of viable eggs at laying should influence hatching success. We have studied both parameters in a nesting population of loggerhead turtles from Boavista Island (Republic of Cabo Verde). Fertility was estimated based on eggs excavated from nests within the first 96 hours after deposition. Our results confirm a high egg fertilization rate for the species, which exceeded an average of 94% fertility (95% confidence limits: 91.9 and 96.2%, N=43 nests). The minimum was 75%, and 100% fertility was observed in 11.5% of the clutches. We did not detect a temporal variation within the season ($F(2,40)=0.583$, $P=0.563$) or spatial variation when comparing nests from different beaches ($F(2,40)=0.532$, $P=0.592$). Female body size ($r=0.054$, $P=0.760$) and clutch size ($r=-0.094$, $P=0.549$) did not influence our estimation of egg fertilization rate. Mean hatch rate of 50 clutches incubated in a hatchery was 52.37 % and ranged from 0 to 94.57%. When we compared the number of live embryos at deposition with the hatching success (in the 29 clutches where both parameters were measured), we did not detect a significant correlation ($r=0.097$, $t=0.504$, $P=0.618$, $N=29$). This lack of correlation could be caused by the high fertilization rates and high variability of hatching success. Unfertilized eggs in the nest may experience decomposition and fungus growth but they do not seem to have a negative impact on the development of contiguous viable eggs within the nest.

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POTENTIAL HUMAN HEALTH RISKS ASSOCIATED WITH THE CONSUMPTION OF SEA TURTLE MEAT AND EGGS: A GLOBAL PERSPECTIVE

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Despite current international regulations, sea turtle products (e.g., meat, adipose tissue, organs, blood and eggs) remain common food items for many communities worldwide. The consumption of sea turtles, however, may have adverse human health effects due to the presence of bacteria, parasites, biotoxins and environmental contaminants. Reported health effects of consuming sea turtles or their eggs infected with zoonotic infectious agents include diarrhea, vomiting, and extreme dehydration, which in several occasions has resulted in hospitalization and death. Documented cases in the literature include an outbreak of gastroenteritis caused by *Salmonella* Chester affecting a coastal Aboriginal community lasting one week in Australia affecting 37 people. In Costa Rica, individuals have been hospitalized after the consumption of raw turtle eggs contaminated with *Vibrio mimicus*. Other zoonotic agents found in sea turtles which may also represent a risk to human health include *Escherichia coli* and *Cryptosporidium* sp. Human fatalities and illnesses induced by poisoning from eating marine turtles have been reported throughout the Indo-Pacific region. Not every turtle is poisonous but when a toxic turtle occurs in the diet of a village it usually impacts groups of people including entire families with alarming effects. How individual turtles become toxic is not clear. It is generally believed that the toxin(s) originates in the invertebrate or algal food species of turtles. Similarly, the tissues within the turtle where the toxins accumulate have yet to be identified. To the best of our knowledge no studies have been performed correlating sea turtle organic contaminant or heavy metal levels, consumption of meat or eggs and risks to human health. Levels of cadmium in livers from stranded green turtles in Australia were up to three times higher than the levels reported in other sea turtles, fish, and crustaceans. The liver cadmium levels were found to be sufficiently high to warrant health concerns for indigenous people consuming green turtles in that part of the world. Both published data and anecdotal information suggest that the consumption of sea turtles can have negative effects on human health. Women and children in particular are most at risk of suffering from any adverse effects associated with sea turtle consumption. Although contaminant levels vary according to sea turtle species and location, recent research suggests that turtles in Baja California may have elevated contaminant levels, and their consumption is cause for concern. The health data presented in this review provide a compelling argument for the reduction of human consumption of sea turtles. Dissemination of this information may improve public health and simultaneously result in enhanced conservation of these endangered species.

DETERMINATION OF THE HEMATOLOGIC VALUES IN FOUR SPECIES OF SEA TURTLES IN THE ORIENTAL VENEZUELAN CARIBBEAN

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Grupo de Trabajo en Tortugas Marinas del Estado Nueva Esparta, Fundación Científica Los Roques. Isla de Margarita, Estado Nueva Esparta, Venezuela

We determined the hematological values of free-ranging and captive *Chelonia mydas*, *Eretmochelys imbricata*, *Caretta caretta* and *Lepidochelys olivacea* inside the feeding areas near Margarita Island and the Archipelago Los Testigos. The samples were taken between March-December 2004. The animals were obtained through confiscation, direct capture and captivity. Thirty-one individuals were measured and marked, and blood was collected for clinical and hematological examinations. Six cell types were identified for the total count of white blood cells and platelets with the hemocytometer and the indirect method, Unopette 5855. Total red blood cells counts, hematocrit, hemoglobin, index erythrocytes, percentages and absolute counts of the differential leukocytes were quantified. We calculated the average, deviation, standard error and range using the statistical program Statographics Plus 4.0. We applied the Kruskal Wallis test and an analysis of variance to compare the values between captive and free-ranging turtles. Significant differences were found for the percentage and absolute values of lymphocytes for captive turtles (19.2% (3.95) and $1.15(0.28) \times 10^3$ cells/ μ l) and for free-ranging turtles (7.9% (1.54) and $0.55(0.09) \times 10^3$ cells/ μ l), with higher values in captive turtles since they had been exposed to infectious agents within their habitat. Other variables were not significantly different between groups, but were different from previous reports found in the literature. These differences are likely attributed to geographical location, stress, capture technique and size of the specimen differences. These results are relevant in the diagnosis and treatment for the presence of possible diseases.

THE FIRST RECORD OF DIGENEAN PARASITES (*PLATYHELMINTHES*) IN HAWKSBILLS (*ERETMOCHELYS IMBRICATA*) IN VENEZUELA

Angela Arias-Ortiz and Pedro P. Vernet

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The present study participated in the project of Medicine of the Conservation in Margarita's Island for the Grupo de Trabajo de Tortugas Marinas del Estado Nueva Esparta (GTTM-NE) (Sea Turtles Working Group) to determine the presence/absence of parasites in sea turtles. This is the first report from Venezuela of digenean parasites found in an adult hawksbill female turtle. The turtle was captured in the sea northeast of the island by fishermen of El Tirano for the purpose of commercial utilization, an illegal activity in our country. This was one of six necropsies performed between May-September 2004: two hawksbills, one *Caretta caretta*, one *Chelonia mydas* and one *Lepidochelys olivacea*, all supported in captivity. We preformed external examinations, took morphometric measurements, recorded a detailed review of internal organs to raise relevant information about possible anomalies, and preserved parasites and epibiota. Twelve helminths were collected from the digestive tract, specifically from the esophagus and stomach, which were fixed and preserved in 70% ethanol. Specimens were dehydrated and tinted with acetocarmin of Semichon for identification. The parasites belong to *Tiaschistorchis* and family *Pronocephalidae* with a prevalence of 16.66%. This species has been found in *C. caretta*, *C. mydas* and *E.*

imbricata in other localities of the world, causing serious disorders in digestive tracts, compromising the health of these species. We deduced that the lifecycles of these parasites are similar to the parasites described in salt-water fishes. More studies are needed to generate effective treatments for recovery.

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**ECOTOXICOLOGY OF THE CYANOBACTERIUM *LYNGBYA MAJUSCULA*
AND THE POTENTIAL EXPOSURE OF GREEN TURTLES, *CHELONIA MYDAS*,
TO TUMOUR PROMOTING COMPOUNDS**

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Lyngbya majuscula, a benthic filamentous cyanobacterium found throughout tropical and subtropical oceans, has been shown to contain the tumour promoting compounds lyngbyatoxin A (LA) and debromoaplysiatoxin (DAT). It grows epiphytically on seagrass and macroalgae, which also form the basis of the diet of the herbivorous green turtle (*Chelonia mydas*). The toxic cyanobacterium has been observed growing in regions where turtles suffer from fibropapilloma (FP), a potentially fatal neoplastic disease. This study aimed to understand whether green turtles consume *L. majuscula* and whether turtles in Queensland, Australia and the Hawaiian Islands, USA were exposed to the tumour promoting compounds produced by the cyanobacteria. Green turtles were found to consume only a small amount of *L. majuscula* even when *L. majuscula* was in bloom, suggesting they try to avoid the cyanobacterium when feeding. Toxin concentrations in *L. majuscula* varied greatly both temporally and spatially. However, when all sites were considered, *L. majuscula* was found to produce more LA and DAT at sites where FP was prevalent in the turtle population. In addition, tissue samples collected from stranded turtles in Moreton Bay, Australia were found to contain LA. As such, this study has demonstrated that green turtles are exposed to, and assimilate, tumour promoting compounds produced by the cyanobacterium, providing potential for these compounds to be involved in FP.

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YOU ARE WHAT YOU EAT, UNLESS YOU ARE WHAT YOUR MOTHER ATE

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This study examined ontogenetic life history changes in green turtles (*Chelonia mydas*) with the use of stable isotope analysis. Stable isotope analysis provides a powerful tool in understanding long-term resource acquisition in animals. Green turtles are endangered, long-lived marine reptiles that display an ontogenetic shift during development. As young, post-hatchlings they display a cryptic life history stage spending years in the open pelagic ocean where they feed omnivorously on planktonic material found in the oceanic gyres. These animals then recruit to an inshore foraging habitat where they become primarily herbivorous. Through the determination of carbon and nitrogen stable isotope compositions ($\Delta^{13}\text{C}$ and $\Delta^{15}\text{N}$), it was possible to distinguish the isotopic signature of green turtle epidermal tissue for both their omnivorous and herbivorous life history stages. The results also provide information on the lag time involved in the isotopic signature change of epidermal tissue after switching from an omnivorous diet to an herbivorous one. In addition, we were also able to show that the isotopic signature of hatchlings is similar to that of adult turtles, demonstrating an energy transfer during reproduction. From this study of green turtles in the Southwest Pacific, we were able to close the life cycle of green turtles in terms of resource acquisition and support previous dietary studies that have described an ontogenetic shift in these marine reptiles.

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ABNORMAL AND ALBINO MARINE TURTLE (*CHELONIA MYDAS*) HATCHLINGS IN MERSİN, TURKEY

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During our studies of the nesting biology of green and loggerhead turtles (*Caretta caretta* and *Chelonia mydas*) on Alata beach Turkey in 2002-2003, live albino hatchlings were encountered. The contents and various features of the nests that produced albino hatchlings are described. Some of the abnormalities (bicephalus, mouth and arm variation etc.) of *Chelonia mydas* also were found in the 2002-2003 nesting season.

RESCUE, REHABILITATION AND LIBERATION OF A LOGGERHEAD TURTLE (*CARETTA CARETTA*) CAPTURED WITH LONGLINE FISHERY IN THE GULF OF VENEZUELA

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Sea turtles are affected by human pressures on nesting beaches and at their feeding areas, where they develop and reach sexual maturity. One of the main pressures is the interaction with fisheries, and the Gulf of Venezuela does not escape this reality. The Red de Aviso Oportuno-Zulia (RAO-Zulia) was activated on March 12, 2005 by the capture of a loggerhead turtle (*Caretta caretta*) on Zapara Island, by longline fishermen. The Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV) and a group of veterinarians examined the turtle to verify the health of the animal, to mobilize it, and to practice surgically extracting the hook from the esophagus. The animal measured 68 cm CCL and weighed 28 kg. They used Ketamina to immobilize the turtle and an X-ray to locate the hook. During rehabilitation, the turtle was under permanent observation for 3 days in a provisional pool with homemade physiological serum, and daily measurements of the physiological levels of hydration were taken. The animal was released in the company of the inhabitants of Zapara Island, who were educated on sea turtle biology as well as on the social responsibility for the preservation of this species.

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ENDOSCOPIC EVALUATION OF THE COELOMIC CAVITY IN SEA TURTLES WITH GASTROINTESTINAL FOREIGN BODIES

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The ingestion of fishing hooks, fishing lines or floating waste is often the cause of occlusions and serious lesions of the gastrointestinal wall of sea turtles. Radiographic examinations allow the localization of fishing hooks but not the diagnosis of perforations in the gastrointestinal wall or other lesions caused by these foreign bodies. The fishing lines and plastic debris cannot be detected by radiography, but they often cause edema, congestion, occlusions leading to necrosis, and perforation of the intestinal wall. In this study we observed 12 loggerhead sea turtles, weighing between 6.8 and 42.5 kg: three turtles were treated at the WWF Sea Turtles Rescue Centre of Lampedusa (Ag) and nine at the Division of Veterinary Surgery (Faculty of Veterinary Medicine of Bari), two of

which were referred from the WWF Oasis Policoro Herakleia, Policoro (Mt). Radiographic examinations revealed that two turtles each had a fishhook located in the stomach and four turtles each had a fishhook located in the small intestine. The other six turtles had fishing line emerging from the ramphotheca and/or from the cloaca, but there was no evidence of a fishing hook in the gastrointestinal tract in the radiographs. Each turtle was premedicated with medetomidine (80 µg/kg IM) and ketamine (10 to 15 mg/kg IM). Afterwards, the turtle was intubated with an orotracheal tube and anesthesia was maintained with a mixture of sevoflurane and pure oxygen. The endoscopic evaluation was performed via an inguinal approach. A 30° laparoscope (10 mm diameter in large turtles and 4 mm diameter in small turtles) was inserted through a little incision in the soft tissues. Endoscopic evaluation of the coelomic cavity, applied to the described cases, allowed identification of lacerations and adhesions of the stomach and intestinal wall in two cases, penetration of fishing hooks into other intracoelomic organs in one case, and, most importantly, the extent of intestinal tract damage by fishing hooks and lines in four cases. The intestinal wall was not damaged by foreign bodies in the other five turtles. In the described cases, visualization of lesions through the endoscopic examination of the coelomic cavity helped to formulate a more correct prognosis and to choose the most appropriate approach and surgical procedure to remove foreign bodies successfully.

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LEVELS OF HEAVY METALS AND ANTIOXIDANT ENZYMES IN THE GREEN TURTLE (*CHELONIA MYDAS*) IN THE ARABIAN SEA, SULTANATE OF OMAN

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The objective of this paper was to study the levels of several metals (Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb and V) in the population of *Chelonia mydas* in the Sultanate of Oman (Arabian Sea). Concentrations of these metals were measured in the eggs of nesting turtles and in the livers of individuals that stranded on the beaches of the nature reserve Ras Al Hadd. In addition, the activity of antioxidant enzymes (GPX, Se-GPX, e SOD) and the levels of lipid peroxidation in individuals were measured. Antioxidant enzymes are important in the physiology of these animals which are often exposed to several situations that can cause oxidative stress, like diving or exposure to pollution. Results indicate that Cd, Cu and Mn were present in higher concentrations in the liver and Cu was present in high concentrations in the eggs. The concentrations of metals in the liver in this study were higher than values found in studies at other locations worldwide. For instance, concentrations of metals in the livers were 1408.15 ± 813.630 ppm wet weight for Cd and 534.61 ± 255.269 ppm wet weight for Cu, and in the eggs were 31.781 ± 8.019 ppm wet weight for Cu and 7.404 ± 5.681 for V ppm wet weight. These results indicate that this population is highly exposed to metals due to the high level of contamination in the Arabian Sea. The values of antioxidant enzyme activity were higher when compared with values found in other species with similar lifestyles. However, the level of lipid peroxidation was much lower than that found for other species. SOD was 19.281 ± 2.47 (U/g Hb), Se-GPx was 63.181 ± 10.891 µmol/min/g Hb and GPx was 186.942 ± 26.867 µmol/min/g Hb. Values of the TBA test were lower (0.025 ± 0.007 µmol/ml plasma) than those found in other species. This may explain the fact that these animals had such high levels of metals in the liver, indicating that this species has mechanisms of

adaptation that allow them to face situations of oxidative stress, including exposure to metals.

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PBDE AND ORGANOCHLORINE CONTAMINANTS IN JUVENILE *CARETTA CARETTA* BLOOD: PARTITIONING AMONG BLOOD COMPARTMENTS AND TEMPORAL AND SPATIAL TRENDS

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Caretta caretta is a threatened species that forages off the southeastern US coast, rendering individuals vulnerable to human impacts, including exposure to pollution and contaminants. Industrial and agricultural contaminants such as polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs), though largely banned in the 1970s, persist in the environment. Polybrominated diphenyl ethers (PBDEs), a class of brominated flame retardants (BFRs), can leach from the textiles and electronics in which they are used and contaminate the global environment. PBDE concentrations in wildlife increased exponentially during the last three decades, but are currently stabilizing as PBDE use decreases (Renner 2000); the European Union banned the use of most PBDEs in 2005 and California will follow in 2008. This study examines aspects of PCB, OCP, and PBDE contamination in *C. caretta*, including distribution among blood compartments, temporal and spatial trends. Such analysis of PBDEs is novel to this region and organism. Whole blood, plasma, and red blood cells (RBCs) from five juvenile *C. caretta* captured from coastal South Carolina in 2005 were analyzed by gas chromatography/mass spectrometry (GC/MS) for 24 PBDEs, 83 PCBs, and 20 OCPs. Tissue distributions of PCBs were similar to those observed by Keller *et al.* (2004) (85.5% of Σ predominant PCB in plasma, 15.5% in RBCs). Preferential distribution of PBDEs into plasma was not observed; however, many PBDE congeners were below the detection limit, limiting the usefulness of these data. Preliminary temporal trends were obtained using 41 samples collected from Florida to South Carolina in 2000, 2003, and 2005. With respect to year, mean concentrations (pg/g wet weight) were: 32, 127, and 28 for Σ predominant PBDE (5 congeners), 7840, 3041, and 2673 for Σ predominant PCB (18 congeners), and 771, 464, and 229 for 4,4'-DDE (a representative OCP). The decreasing trend in PCB and OCP concentrations was expected; the temporal pattern of PBDE concentrations may have resulted from recent shifts in use from PBDEs to other BFRs. Additional samples are needed to discern clear temporal trends. Additionally, geographical variability may have affected observed trends; for example, concentrations of PCB congeners found in the technical mixture Aroclor 1268 were higher in turtles captured near Brunswick, GA, a site heavily contaminated with the mixture. A future study employing design improvements will better characterize blood partitioning and temporal trends of BDEs. More sensitive GC/MS techniques that increase detection of PBDEs will be used to analyze plasma or whole blood samples obtained annually (1998-2005) from juveniles captured from a single location (Core Sound, NC), facilitating a more thorough temporal trend assessment.

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Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service for their assistance in funding this research and travel to the ISTS Symposium.

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COMPARATIVE MORPHOLOGY OF THE REPRODUCTIVE SYSTEM IN NEONATE SEA TURTLES

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We compared the morphology of the gonads, kidneys and reproductive ducts of hatchling and post-hatchling loggerhead, green and leatherback turtles to identify structural differences that may be useful in determining sex. *Caretta caretta* served as the baseline against which the other species were compared. Previous studies identified the value of using relative gonad size, shape, attachment and several paramesonephric duct characters to discriminate males and females. These same characters may be used in *Chelonia mydas* with some modifications. The *C. mydas* paramesonephric ducts are less mobile than in *C. caretta*. *Dermochelys coriacea* departs significantly in its reproductive anatomy from that of the cheloniid species we examined. Dermochelyid kidneys and adrenal glands are relative large and elongated while the gonads and ducts are not well developed. As with many other *D. coriacea* characteristics, the reproductive system itself shows a form of pedomorphosis so that the gonads and reproductive ducts are relatively underdeveloped relative to what we observe in cheloniids.

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FACTORS THAT INFLUENCE THE WATER POTENTIAL DURING THE GREEN SEA TURTLE EMBRYOGENESIS

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The environmental factors such as temperature, water availability (or water potential) and oxygen/carbon dioxide level are known to influence reptilian embryogenesis, especially species that have eggs with a fibrous shell membrane. They can influence gas exchange between the nest and the surrounding environment, the incubation period, embryonic developmental physiology, sex ratio, hatchling morphology and survivorship. In order to understand the factors that influence the water potential during in situ embryogenesis of green sea turtles (*Chelonia mydas*), 3 nests were buried in plastic buckets with the bottom cut-off and 4 were buried without buckets. Thus, water was only available in the vertical direction for nests with buckets. Water potential was measured by dry tensiometers (the instrument that measure the water potential), the nest temperature was measured by temperature loggers, the sand water content was measured by dielectric aquameters, and the air temperature and precipitation

were obtained from the Central Weather Bureau Office of ROC. The experiment was conducted in the summer of 2004 on a subtropical island: Lanyu Island, southeast of Taiwan. Results showed that the nest temperature is the main factor that influenced the water potential dynamics during embryogenesis in both bucketed and unbucketed nests. It also co-varied with sand water content and precipitation in some nests. The influence of sand water content increased with the development of the fetus. The influence of air temperature and precipitation was minor. Buckets only decreased the influence of nest temperature before the exponential growth of the fetus organs and after pipping, when the metabolic rate was low.

Order: 14 **Abstract ID:** 1760 **Type:** Oral **Subject:** Anatomy, Physiology and Health

MICROBIAL POPULATIONS ASSOCIATED WITH UNHATCHED LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) EGGS: A COMPARISON OF TRADITIONAL AND MOLECULAR IDENTIFICATION TECHNIQUES

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Hatch success rates for loggerhead sea turtle nests in Georgia are approximately 70%. Egg failure is most often a result of embryonic death during development. Little is known about the possible causes of embryonic death among sea turtle eggs. While many anecdotal reports place the blame on microbial contamination of the unhatched eggs, no current data exist to support these claims. In an effort to determine whether bacterial contamination does play a role in embryonic death, unhatched loggerhead eggs were collected from nests which had completed incubation on Jekyll Island, Georgia and swabbed for microbial contamination. A total of sixty-four unhatched eggs were collected from thirteen different nests during August and September 2004 and 2005. Microbial populations inside and outside the eggs were isolated using sterile techniques, followed by quadrant streaking onto Tryptic Soy Agar (TSA) and marine agar plates. Eggs were examined to determine the stage of embryonic development and the presence of any abnormalities. No fungi were observed or isolated during this investigation. Isolated bacteria were identified using the api 20 E and the api 20 NE Identification Systems and Bergy's Manual. Bacterial identifications were cross-referenced with genotypic microbial identification performed by Accugenix. Most of the isolated bacteria were identified to species with >89% confidence using traditional laboratory methods. Verification of a subset of identified bacteria using genetic analysis added more certainty to the project and will enable further investigation of potential pathogens. Preliminary results of this study indicate (1) the presence of Gram positive and Gram negative species on both the outside surface and the fluid inside the eggs, (2) the species of Gram negative bacteria (mainly *Pseudomonas* spp.) in the embryonic fluid were different than those isolated from outside the eggshell, and (3) common environmental species like *Alcaligenes*, along with a variety of potential pathogens including *Ochrobactrum*, *Serratia* and *Pseudomonas*. With preliminary data in place, the next step will be isolating microbes from the cloaca of nesting females and from full term eggs incubated under sterile conditions. This study contributes reliable data to a poorly documented pool of knowledge. Microbial contamination of sea turtle nests has long been suspected, and in fact bacterial contamination may contribute to embryonic death during incubation due to the presence of potential pathogens.

BLOOD BIOCHEMISTRY AND HEMATOLOGICAL VALUES FOR JUVENILE PELAGIC LOGGERHEADS, *CARETTA CARETTA*, OFF MADEIRA ISLAND, NORTH-EASTERN ATLANTIC

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Reference values for blood biochemistry and hematologic parameters have not been established for most free-ranging sea turtle populations, especially juvenile pelagic loggerheads *Caretta caretta*. Although sea turtle studies have been ongoing in Madeira Island waters since 1994, and turtles have been recovered in the last 5 years, little is known on physiologic reference values for this population. Assessment of physiologic values provides a sensitive and less-invasive tool for obtaining valuable information on the health status of these organisms, which is a priority for their conservation and management. Therefore, the objective of this project is to develop a baseline profile for physiological parameters in pelagic loggerhead turtles. The Marine Turtles Project at the University of Madeira started a health assessment study of these free-ranging animals. Twenty-three sea turtles were captured and brought into the laboratory between July and September 2005. Animals were visually checked for an external health assessment and standard biometry data were also collected. Blood samples were collected from the dorsal cervical sinus and the serum obtained was transferred into Eppendorfs and frozen immediately at -20°C for later analysis. Blood smears were provided for performing differential white blood cell counts. Gonad biopsies were collected using laparoscopy for histological sex assignment. Preliminary data (mean values, standard deviation, range and number of samples) on 18 plasma biochemicals and white blood cell counts are presented for each parameter: Uric acid Mean= 1.11± 0.76 mg/dl, range 0.3-2.5 mg/dl, n=16; Total Bilirubin Mean= 0.09± 0.01 mg/dl, range= 0.07-0.12 mg/dl, n=17; Total cholesterol Mean= 110.00 ± 61.82 mg/dl, range= 31-257 mg/dl, n= 17; Creatinine kinase Mean= 0.27± 0.09 mg/dl, range= 0.2-0.5 mg/dl, n= 16; Total Protein Mean= 28.82± 9.74 g/l, range= 5.0-49.0 g/l, n= 17; Urea nitrogen Mean= 180.07± 81.13 mg/dl, range= 47-352 mg/dl, n= 14; LDH Mean= 128.60, ± 79.74 UI/l, range= 30-300 UI/l, n= 15; SGOT Mean= 244.50±79.82 UI/l, range= 141-412 UI/l, n= 14; SGTP Mean= 4.00± 2.83 UI/l, range= 1-10 UI/l, n= 12; Gamma-glutamyl transferase Mean= 0.50± 0.84 U/L, range= 0-2 U/L, n= 6; Albumin Mean= 9.71±2.08 g/l, range= 7-14 g/l, n= 17; Alkaline phosphatase Mean= 27.33 ±9.53 U/L, range= 13-50 U/L, n= 15; CPK Mean= 1325.73±749.22 UI/l, range= 171-2491 UI/l, n= 15; Sodium Mean= 144.20±36.68 mEq/L, range= 12-160 mEq/L, n= 15; Potassium Mean= 4.21±1.33 mEq/L, range= 0.3-6.0 mEq/L, n= 15; Chloride Mean= 109.73±27.55 mEq/L, range= 11-126 mEq/L, n= 15; Calcium Mean= 43.29±11.18 mg/l, range= 27-70 mg/l, n=17; Phosphorus Mean= 9.05±2.89 mg/dl, range= 3.6-13.7 mg/dl, n= 14. The complete blood count yielded (Mean %, Standard Deviation, range and number of samples): Heterophils Mean= 86.96±5.76%, range= 73-96%, n=23; Lymphocytes Mean= 9.57±5.21%, range= 2-21%, n=23; Az Monocytes Mean= 1.57±1.88%, range= 0-6%, n=23), Monocytes Mean= 0.70±1.55%, range= 0-7%, n= 23; Eosinophils Mean= 1.65±1.72%, range= 0-6%, n= 23); Basophils Mean= 0.00±0.00%, range= 0, n= 22. No hemoparasites were found in any of the samples screened. The large variance in some of the biochemistry variables in this study can be associated with the stress level of the animals, namely caused by capture procedures. The sample size will be further increased and used for comparison in subsequent years to evaluate temporal trends and compare with previous established values for other populations, namely adult populations. This study is a first contribution to a better knowledge of this pelagic loggerhead population's health status. It is also a helpful tool for the recovery of sick/injured animals that are subsequently released back into the wild.

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CARAPACE WEIGHTING AS TREATMENT FOR LONG-TERM FLOATING DISORDER IN A LOGGERHEAD: A CASE STUDY

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Sophia, a sub-adult turtle (CCL 60cm) arrived at the ARCHELON's Rescue Centre in May 2000. It had a severe head injury and trauma to the plastron. Over a period of 3 years, it received treatment of various medications including; Baytril, Zingul, Neurobion and Flazyl. Sophia arrived at the Rescue Centre very weak and inactive, and remained a passive floater for 3 months making little effort to dive. Within three years its activity and energy levels improved so that the turtle was able to obtain food from the bottom of the tank. However, its body position was always bottom up during the dive and when it ceased efforts to remain submerged, it bobbed to the surface. At the beginning of 2004, weights (1.5% of its body weight) were attached to three steel bolts epoxied to the rear of its carapace. Sofia regained buoyancy control and was able to rest on the bottom of its tank. One and a half years after the weights were attached, its swimming, diving and feeding behaviors were normal. Subsequently, the weights were gradually removed over a period of 4 months. No loss of buoyancy control was observed without the weights and, after an observation period of a month, it was equipped with a satellite transmitter and successfully released after living for 5 years at the Centre. Sofia immediately headed south until it reached Crete and headed east along its coast. Soon, the turtle headed towards Africa to spend the winter cold months. Two months after the release, Sofia was off of Libya when the transmissions stopped. Either the battery life ended or the water was so cold, she wouldn't surface long enough to produce a location.

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CARAPACIAL SCUTE VARIATION IN LOGGERHEAD TURTLES AND GREEN TURTLES (*CARETTA CARETTA* AND *CHELONIA MYDAS*)

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The carapacial scutes of 1,536 specimens of hatchling and adult green and loggerhead turtles from Alata beach in Turkey were examined in 2002 and 2003. Scutes were examined with regard to variation within carapacial scute series and in carapacial scute patterns. The vertebral, costal and marginal series were the most variable and the supracaudal scutes were extremely stable for the hatchlings. The adult scute pattern of *Chelonia mydas* observed was 11 pairs of marginals, 4 pairs of costals, 2 supracaudals and a single nuchal.

EFFECTS OF TEMPERATURE ON THE GROWTH RATE AND FOOD CONSUMPTION OF POST-HATCHLING LOGGERHEAD TURTLES IN CAPTIVITY

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Water temperature is known to affect the growth rates of sea turtles, but the exact relationship is still not completely clear. Here we report individual growth rates and food intake of ten loggerhead turtle post-hatchlings which stranded along the southern Italian coasts and were subsequently reared at the Rescue Center of the Stazione Zoologica of Naples. The turtles were kept in individual tanks with natural sea water. Water temperatures ranged from 18°C to 26°C. Food (5% of body mass) was provided daily and the actual food intake registered to the nearest tenth of a gram. Seven morphological parameters were measured weekly to examine morphometric relationships, which were identical to previous results reported in the literature. Straight carapace length at the beginning (7.8-9.5 cm) of the rearing period was not correlated to that at the end (17.7-20.3 cm) ($r=0.491$, $p>0.05$) which implies considerable individual variability in growth rates. Water temperature was correlated to food intake ($r=0.707$, $p<0.001$) and, to a lesser extent, growth rates ($r=0.332$, $p<0.05$). Analysis of the growth curves revealed the existence of a temperature threshold between 20°C and 22°C above which growth rates accelerated abruptly. Turtles held above or below the threshold temperatures showed constant specific growth rates. These results indicate that variations in water temperature of 1 or 2°C around such critical thresholds produce significant changes in growth rates. This may help to explain differences in growth rates of wild loggerhead turtles which utilize areas with different temperature regimes.

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REVIEW OF CLINICAL CASES OF SEA TURTLES UNDER VETERINARY TREATMENT IN URUGUAY

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Since 2001, the "Sea Turtle Stranding Network" of Karumbé has been receiving reports of live stranded juvenile green turtles, *Chelonia mydas*, and loggerhead turtles, *Caretta caretta*, along the Uruguayan coast. During the years 2004 and 2005, we treated 18 green turtles (mean CCL = 39.1 cm) and 2 loggerhead turtles (mean CCL = 70 cm). The majority of these turtles appeared lethargic, dehydrated and underweight, due to either injuries (mutilations) produced by entanglement in fishing gear, floating syndrome (inability to submerge), cold stunning or generalized (systemic) bacterial infection. In this study, we highlight the results of the necropsies performed on 3 green turtles that died during the veterinary treatment, and the diagnosis and treatment of 2 green turtles and 1 loggerhead that were successfully recovered and released. Also, we have isolated *Proteus mirabilis* from a liver infection, which is the first report of this bacterium in sea turtles in Uruguay. No gastrointestinal parasites were found during the necropsies. These are the first cases in which paraclinic methods, such as bacteriological and radiological examinations, were employed on sea turtles in Uruguay. This work establishes the first step towards a long-term population health status assessment, aimed to analyze the main pathological agents which affect sea turtles in Uruguay.

CURRENT CONCEPTS IN THE HUSBANDRY AND MEDICAL MANAGEMENT OF SEA TURTLES IN AQUARIUMS

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Sea turtles are popular and effective exhibit animals in modern aquaria. They function as ambassadors to increase public interest in the conservation of marine animals. A 2002 survey of zoos and aquariums in the United States found 43 institutions to be housing sea turtles, with 40 institutions having sea turtles representing six species as part of public displays. A total of 165 turtles were residents of permanent collections and 255 turtles were in temporary exhibits. Coordinated teams of medical and husbandry professionals provide a program of support to ensure the welfare of sea turtles in aquariums throughout the United States. Animal care is provided by a team of professional life support specialists, aquarists, technicians, curators, and veterinarians responsible for water quality, nutrition, enrichment and health management. Sea turtle husbandry is divided into five areas: exhibit design, life support, nutrition, enrichment, and preventive medicine. Modern exhibits are spacious and populated with a variety of species. Realistic theming and diverse fish populations provide turtles with a naturalistic environment, while modern life support systems ensure water quality. Nutritional programs address the needs of various turtle species. For example; research is being done at the New England Aquarium to try and match the nutritional values of commercially available diets to foods turtles consume in the wild. The nutritional compositions of readily available vegetables were compared to *Thalassia* in an effort to develop feeding protocols that approximate the dietary intake of a wild turtle. Green and red peppers, peas, cucumbers, cabbage, shrimp, and a variety of lettuces were the items most closely correlated with *Thalassia*. Enrichment programs provide visual and tactile stimulation for sea turtles. Behavioral training sessions provide mental and physical stimulation and reinforce procedure-based behaviors that make sea turtle husbandry and medical care less stressful. Health care is pro-active. Turtles receive complete health checkups once or twice a year. Nutritional, reproductive, and health status is monitored using a variety of technologies such as radiography and ultrasonography. Regular ultrasonography of reproductively active sea turtles has proven useful in monitoring ovarian activity. It has allowed for medical intervention when necessary to prevent the turtles from becoming egg-bound. This pro-active approach to medical care provides baseline health information, increases our understanding of sea turtle physiology and helps prevent the development of health problems.

BODY MASS IN THE LEATHERBACK TURTLE *DERMOCHELYS CORIACEA*

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Body mass is a major life history trait and provides a scale for all living processes of organisms. Unfortunately body mass cannot be easily measured for many species, because of the logistical difficulty in actually catching and weighing them. This is particularly true for sea turtles which spend most of their life at sea and whose adult body mass frequently exceeds several hundred kilograms. Here we performed a general linear model of body mass in

49 leatherback turtles nesting in Awala Yalimapo Beach, French Guiana, South America, using 17 morphometric measurements as independent parameters. A stepwise backward analysis removing independent parameters with $P > 0.001$ indicated that standard curved carapace length (SCCL) and body circumference at half of SCCL explained 93% of the variance of body mass, and contributed to 28% and 72% of the model, respectively. A sensibility test showed that this simple model was robust, as changes in SCCL and/or body circumference (due to potential misreading during field work at night) of 1 or 2 cm resulted in slight changes in estimated body mass of 0.7 or 1.3%, and 0.9 or 1.7%, respectively. Leatherback turtles from French Guiana were larger and heavier than those reported from all other studied nesting sites, suggesting either that gravid leatherbacks feed during the nesting season in French Guiana, and/or that this species exhibits site-specific growth strategies. Further studies are required to test these hypotheses, including implementation of similar models for other nesting populations, in order to better understand the life history of this endangered species.

Order: 22 **Abstract ID:** 1727 **Type:** Poster **Subject:** Anatomy, Physiology and Health

CONSISTENCIES BETWEEN YEARS IN SEASONAL VARIATION OF HEMATOLOGY AND PLASMA BIOCHEMISTRY VALUES OF JUVENILE LOGGERHEAD TURTLES IN NORTH CAROLINA, USA

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Health status of juvenile loggerhead turtles passively captured in pound nets in Pamlico and Core Sounds, North Carolina, was monitored by hematology and plasma biochemistry in June – November of 2004 and 2005 (ongoing), August 2000 and November 1997. Previous comparison of 1997 and 2000 data revealed differences in analyte values suggesting physiological changes possibly associated with autumn migration from the sounds or with seasonal variation in feeding, water temperature or other factors. Two additional years of data collected throughout summer and autumn allowed us to compare seventeen analytes and to determine which values changed consistently by season. Summer and autumn seasons were defined as June – September and October – November, respectively. Repeat captures were excluded from analysis. Sample sizes were: autumn 1997 (40), summer 2000 (15), summer 2004 (52), autumn 2004 (48), summer 2005 (40) and autumn 2005 (25 thus far). Season/year combinations were compared using a Kruskal-Wallis test, followed by multiple comparisons and visual inspections of seasonal patterns. Hematocrit, glucose and AST levels were consistently lower in autumn, while total protein and phosphorus levels did not vary between seasons and years. Lower electrolyte (sodium, potassium, chloride) and calcium values and higher CK values of autumn 1997 were not consistently repeated in the autumns of 2004 and 2005. Lower Ca/P ratios and higher granulocyte/mononuclear cell ratios in autumns of 1997 and 2004 have not yet recurred in 2005. The variation observed is considered clinically minor on an individual turtle basis, but is still of interest as an indication of population level effects.

CLOACAL BACTERIAL ISOLATES AND ANTIMICROBIAL RESISTANCE PATTERNS IN JUVENILE LOGGERHEAD TURTLES IN NORTH CAROLINA, USA

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Cloacal bacterial flora and antimicrobial resistance were monitored in juvenile loggerhead turtles captured in Core and Pamlico Sounds, North Carolina, from June – November, 2004 and 2005. Sensitivity to 13 antimicrobials (amikacin, chloramphenicol, cephalothin, ciprofloxacin, cefotaxime, doxycycline, enrofloxacin, gentamicin, orbifloxacin, penicillin, piperacillin, tetracycline and trimethoprim-sulfa) was determined. Multiple antimicrobial resistance (MAR) index was calculated for each isolate (number of antimicrobials to which the isolate was resistant/number of antimicrobials tested). Summer and autumn seasons were defined as June – September and October – November, respectively. In 2004, 181 isolates of 26 bacterial species were cultured from 64 turtles; in 2005, 161 isolates of 18 bacterial species were cultured from 59 turtles. Of the six most abundant isolates (motile aeromonads *Aeromonas hydrophila/caviae* and *Aeromonas* spp. [56], *Escherichia coli* [38], *Pseudomonas aeruginosa* [14], *Proteus mirabilis* [31], *Serratia putrefaciens* [26], and gamma *Streptococcus* [51]), there was no variation in prevalence between years. *Pseudomonas aeruginosa* was less frequently isolated in autumn in both years and *E. coli* was less frequently isolated in autumn of 2005. MAR did not differ significantly between seasons and years except for motile aeromonads which had a higher MAR in 2004 (median 0.23) than in 2005 (median 0.15). Gamma *Streptococcus* and *P. aeruginosa* had the highest median MAR (0.42 and 0.38, respectively), and *S. putrefaciens* and *E. coli* had the lowest median MAR (0.15 each). Among gram negative rods, resistance was greatest for penicillin (53 – 100%) and cephalothin (35 – 100%), and least for amikacin and gentamicin (0%).

THE EXPOSURE OF SEA TURTLES TO PERSISTENT ORGANIC POLLUTANTS WITHIN MORETON BAY, QUEENSLAND

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Dioxins and furans are classified as persistent organic pollutants (POPs). These compounds are considered a serious health concern to humans, wildlife, and the environment, due to their toxicity and ability to accumulate in lipids

and biomagnify in the food chain. In addition, the worlds' oceans provide a sink environment for these compounds, placing long-lived and lipid-rich marine megafauna among the high risk groups. Recent research from Queensland has identified elevated concentrations of POPs in nearshore marine ecosystems, and has been shown to affect the herbivorous dugong (*Dugong dugong*). Worldwide, however, there is very limited data available on dioxin and furan exposure of sea turtles. In this study, concentrations and toxic equivalents (TEQs) of POPs are described in three species of sea turtle; green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*) turtles from Queensland, Australia. Total dioxin/furan concentrations were elevated in some animals and ranged from 47-213 pg/g lipid, 93-137 pg/g lipid and 151-319 pg/g lipid in green, hawksbill and loggerhead turtle blood samples, respectively. Trophic level has been identified to influence the bioaccumulation of certain POPs in these animals, and the highest TEQ levels are present in the carnivorous loggerhead turtles, followed by the hawksbill and green turtles. Incorporation of known life history information and contamination zones has shown no significant differences between mature and juvenile green sea turtles, however, a clear trend of increasing tissue concentrations and TEQs was observed with increasing habitat contamination zones. This data provides the framework for determining exposure and sensitivity of marine turtles to POPs in order to assess associated risks to these animals.

Order: 25 **Abstract ID:** 1500 **Type:** Poster **Subject:** Anatomy, Physiology and Health

COMPUTED TOMOGRAPHIC ANATOMY OF THE HEAD OF THE LOGGERHEAD SEA TURTLE (CARETTA CARETTA)

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Many veterinary surgeons are involved in sea turtle conservation in wildlife rehabilitation hospitals around the world, thereby contributing to the improvement of the reptile's medical management. The introduction of computed tomography (CT) has revolutionized the practice of diagnostic imaging. In turtles, CT has been used in the diagnostics of metabolic bone diseases (Raiti and Haramati, 1997), aural abscesses (McKlveen *et al.*, 2000), and a nodal mass in the chest (Garland *et al.*, 2002). The objective of this study was to describe the CT anatomy of the head of the normal loggerhead sea turtle (*Caretta caretta*), optimizing the diagnosis of head diseases. Computed tomographic (CT) images of three dead loggerhead sea turtles were obtained using soft-tissue window. Turtles were submitted from the Tafira Wildlife Rehabilitation Center (TWRC) to the Veterinary Faculty (ULPGC). After CT imaging, the heads were disarticulated at the level of the atlanto-occipital joint and were imaged immediately to minimize post-mortem changes. CT imaging was performed at the Radiodiagnostic Service of the Santa Catalina Clinic of Gran Canaria using third-generation CT equipment (a Toshiba 600 HQ). After CT exploration, the heads were sectioned and the gross sections were compared to CT images to assist in the accurate identification of the anatomic structures. Thus, the bones of the skull, mandible and hyoid were clearly observed by the high CT density in cortical bone and the intermediate CT density in their medullar cavities. Cartilage and articular sutures were clearly detected. Structures of the respiratory and digestive systems gave negligible CT tissue density. Muscles, salt glands, and eyes gave an intermediate CT density. Cerebral tissues were clearly appreciated in this modality CT window. The use of CT imaging in exotic animal medicine is currently limited because of its expense, availability, and the logistic problems of acquiring CT images in these animals. With developing technology in the wildlife rehabilitation centers, CT imaging may soon become more readily available for exotic animal imaging. CT provided excellent details of clinically relevant anatomy and correlated well with the corresponding gross specimens. In addition, it provides excellent discrimination of soft tissues and mineralized tissues of the head. The planimetric or sectional anatomy of the head allows a correct morphologic and topographic evaluation of the anatomic structures, which is a useful tool for the identification of the CT images. Sagittal images were used to evaluate the midline structures of the head. The anatomic relationships were appreciated most easily in the

transverse planes. In the same way, we consider it quite useful to be able to establish some reference on the head, in order to scan only these selected parts during clinical or experimental applications. The information presented should serve as an initial reference to evaluate CT images of the loggerhead sea turtle head and to assist in the interpretation of lesions of this region.

Order: 26 **Abstract ID:** 1501 **Type:** Poster **Subject:** Anatomy, Physiology and Health

MAGNETIC RESONANCE IMAGING ANATOMY OF THE HEAD OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*)

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An accurate interpretation of the planimetric magnetic resonance (MR) imaging normal anatomy is necessary for the evaluation of pathological tissues. The objective of the present study was to provide an overview of the normal cross-sectional anatomy of the head of the loggerhead sea turtle (*Caretta caretta*) using MR images. MR imaging of three dead turtles submitted from the Tafira Wildlife Rehabilitation Center (TWRC) to the Veterinary Faculty (ULPGC) was performed at the Radiodiagnostic Service of the Santa Catalina Clinic of Las Palmas de Gran Canaria using a superconducting magnet operating at a field strength of 0.5 Teslas and a human head coil. T1-weighted MR images were acquired with fast spin-echo sequences. Different clinically relevant anatomical structures were identified and labeled, according to higher or lower signal intensity. The bones of the skull (prefrontal, frontal, parietal, postorbital, supraoccipital, squamosal, quadratojugal, jugal and maxilla), hyoid bones and mandibles could be visualized indirectly because of fat in the bone marrow, as well as by observing the area of negligible signal corresponding to the cortical margins of those bones. Cartilage and articular sutures gave an intermediate MR signal intensity. Cerebral tissues (spinal cord, myelencephalon, cerebellum, optic lobe and cerebrum) were easily identifiable because of their high signal intensity compared to respiratory structures (nasal cavity, glottis and trachea), the oral cavity and the esophagus. Muscles, salt glands, eyes and associated structures had an intermediate MRI signal intensity. Blood vessels were evaluated by their low signal intensity. Clinical diagnosis by imaging techniques is based on different physical principles that allow visualization of the internal structures, the composition, and even the function of the live organism. MR is based on the properties of certain elements, mainly hydrogen, to send a radiofrequency signal when it is under a magnetic field of certain intensity and stimulated by radiowaves of appropriate frequency. Advantages of MRI include multiplanar imaging, superior contrast resolution and the absence of ionizing radiation. Spin-echo T1-weighted MR images of the loggerhead sea turtle (*Caretta caretta*) head have provided details of clinically relevant anatomy and discrimination of both soft and mineralized tissues. A thorough understanding of normal anatomy on MR images is essential to optimize the diagnosis of lesions of the head. The anatomic relationships of the deep cerebral structures are appreciated most easily in the transverse plane. The use of magnetic resonance imaging in veterinary medicine is currently limited because of its expense, availability, and the logistic problems of acquiring MR images. Imaging live turtles in MR is difficult because of the low availability of a suitable unit and a non-magnetic anaesthetic unit. With developing technology, including new developments in open magnet design, MR imaging may soon become more readily available for imaging. The information presented in this paper should serve as an initial reference to evaluate MR images of the loggerhead sea turtle head, and these images should provide useful reference material for clinical studies of turtles' heads.

IDENTIFICATION OF SEX IN HATCHLING GREEN TURTLES (*CHELONIA MYDAS*) BY MORPHOMETRIC HISTOLOGICAL MEASUREMENTS

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A new histological method was developed to distinguish the sexual characteristics of hatchling *Chelonia mydas*. The diameter of the paramesonephric duct, height of the nuclei of ductal lining cells and gonadal ridge width were measured in 117 hatchlings from over a thousand specimens collected by Ibrahim (Unpublished data) in Peninsular Malaysia (Laboratory Incubation study: 1996-1998). Each individual had 10 images taken of the Müllerian duct lumen, the height of the duct cell nuclei and the gonadal ridge at different levels. For digital image measurements, Image J Program (NIH, Company) was used. Differences were observed between the two sexes. Females had significantly larger paramesonephric duct diameters ($p < 0.005$, mean \pm SE; $2215.85 \pm 195 \mu\text{m}$), nuclear heights ($416.12 \pm 35 \mu\text{m}$) and gonadal ridge widths ($7693 \pm 288 \mu\text{m}$) in comparison to male (461.98 ± 72 ; 228.17 ± 19 and $3886.25 \pm 679 \mu\text{m}$, respectively) hatchlings. The sex of the hatchlings was validated by observations of the temperature of the nest (Mrosovski and Yntema, 1980) and by histological observations (Yntema and Mrosovsky, 1980; Larios, 1999). The method we used distinguishes the sex of hatchling sea turtles using morphometric measurements instead of observational methods and is important because the latter may be prone to bias. The method was then used to study a small number (46 out of 1000 in total) of hatchlings that demonstrate characteristics of both sexes in some or all of the above measurements. In particular, this number of hatchlings possesses un-differentiated gonads. We speculate that “inter-sex” or an indifferent sex may exist in embryo *Chelonia mydas* early in their lives and may persist in hatchlings exposed to environmental toxicants (e.g. pesticides). We speculate that these hatchlings may not survive or reach reproductive maturity, consequently leading to a percentage of non-reproductive individual *Chelonia mydas* within a population.

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ALLOMETRY OF REPRODUCTIVE ORGANS AND IMMATURE MEMBRANE OF LOGGERHEAD TURTLES, *CARETTA CARETTA*

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We conducted a survey on the reproductive organs of loggerhead turtles caught around Cape Muroto. Fifteen dead females found in pond nets were used for the study. The average straight carapace length (SCL) was 752 ± 55 mm (range=698-919 mm). In order to examine the allometry, SCL and cloacae length were taken as the standard dimension (x) against each character (y) of the reproductive organs compared using a logarithmic scale. The relationship of y to x was expressed by the power function $y = b x^a$ estimated by the least squares method. One of three alphabetical characters was assigned to each allometric growth where P indicates positive growth ($a > 1.2$), I indicates isometric growth ($1.2 > a > 0.8$), and N indicates negative growth ($0.8 > a$). P was assigned to; oviduct length ($a = 9.66$, $p < 0.0001$), oviduct diameter ($a = 6.67$, $p < 0.01$), cloacae length ($a = 1.93$, $p < 0.05$), papillary process length ($a = 2.89$, $p < 0.00001$), papillary process width ($a = 2.29$, $p < 0.0001$), and length between urinary bladder and papillary process ($a = 1.21$, $p < 0.05$). I was assigned to the length between urinary bladder and clitoris ($a = 1.08$, $p < 0.0001$), and N was assigned to clitoris length ($a = 0.639$, $p < 0.001$). The data suggests that the oviduct, cloacae and papillary process show prominent development relative to SCL growth, but the clitoris was an exception to this trend. In addition, orifices of the papillary process were covered with a white membrane in immature female turtles. The membrane is nonexistent in mature females that have eggs in their oviducts. This comparison suggests that the membrane disappears during either the maturation process or copulation, and that the loss is associated with sperm entry to oviduct.

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ORGANIC CONTAMINANT CONCENTRATIONS ARE HIGHER IN DEBILITATED LOGGERHEAD TURTLES COMPARED TO APPARENTLY HEALTHY TURTLES

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The number of debilitated (emaciated, lethargic, barnacles on skin) loggerhead turtles stranded along the southeastern U.S. has increased during the last decade. Although the primary cause of this syndrome is unknown, previous health findings indicate a wide range of secondary bacterial and parasitic infections. A standardized protocol was developed in 2004 to collect samples from debilitated turtles during necropsies or rehabilitation to measure health parameters and contaminants. Blood from living turtles, and liver and fat from dead turtles were collected for organohalogen contaminant (OC) analysis during 2004-2005. We measured the concentrations of polychlorinated biphenyls (PCBs), pesticides, and polybrominated diphenylethers (PBDEs) in 19 fat samples using gas chromatography/mass spectrometry. Respective mean PCB 153, Σ PCB, 4,4'-DDE, and Σ PBDE concentrations were 20.3, 78.1, 15.3, and 1.00 ng/g wet mass; and 4030, 13800, 2610, and 167 ng/g lipid. Concentrations were generally highest in North Carolina (NC) turtles followed by South Carolina (SC), Georgia and Florida, suggesting that turtles inhabiting northern latitudes are more exposed to OCs. For example, mean Σ PCB concentrations were 22100 (n=4), 14500 (n=10), 6860 (n=4), and 3903 (n=1) ng/g lipid, respective of location. PCB 153 and 4,4'-DDE concentrations on a wet-mass basis were lower in the sick turtles than mean concentrations measured in fat biopsies collected from 44 apparently healthy turtles from NC in 2000-2001 (81.0 and 65.0 ng/g wet mass, respectively). However, the lipid-normalized PCB 153 and 4,4'-DDE values were seven times higher in the sick turtles compared to the healthy turtles (571 and 372 ng/g lipid, respectively). Geographical differences are not likely the reason, because healthy NC turtles are expected to have higher concentrations than southern turtles. Because OCs are lipophilic, lipid content and lipid mobilization may explain the differences observed between sick and healthy turtles. In other words, non-foraging debilitated turtles rely more on fat stores, and as fat is used, fat-soluble contaminants may be dumped into the blood. Mean lipid content in the fat of debilitated and healthy turtles was 0.745% and 27.9%, respectively, indicating that sick turtles do substantially mobilize their fat stores. Preliminary data indicate that contaminants are mobilized into the blood of debilitated turtles. Blood contaminant concentrations (ng/g wet mass) were ~15 times higher in 7 debilitated turtles (mean Σ PCB=70.9) than in 107 healthy turtles (4.50). These higher levels, circulating to target tissues, may contribute to the progression of this illness. Conversely, as turtles recover and replenish fat stores, contaminants may be re-sequestered into fat. Analysis of blood sampled at several time points during rehabilitation will help assess changes in blood contaminant concentrations during recovery.

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A SURVEY OF HEAVY METAL ACCUMULATION IN THE FORAGING HABITATS OF GREEN SEA TURTLES (*CHELONIA MYDAS*) AROUND ST. CROIX, UNITED STATES VIRGIN ISLANDS

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Sea grass meadows serve as important foraging habitats for the endangered green sea turtle (*Chelonia mydas*) around St. Croix, United States Virgin Islands (USVI). Those meadows, restricted to shallow coastal waters, are susceptible to both direct and indirect anthropogenic impacts from land. On St. Croix, USVI, there are a number of sites that may degrade sea grass meadows and overall water quality along the southwestern coast of the Caribbean island. In addition to possible impacts from an oil refinery, an aluminum plant, and a landfill, the direct discharge of sewage and the waste products from a rum distillery into the ocean may have some negative effects on the marine environment. Globally, near-shore habitats adjacent to large human populations and industrial regions, as well as habitats with low water turnover rates, are all areas where diagnosis of green turtle fibropapillomatosis (GTFP) has been prevalent. GTFP is an epizootic disease primarily affecting green sea turtles. The primary purpose of this study is to quantify the levels of metal accumulation in various sea grass meadows around St. Croix, comparing industrially impacted and non-impacted sites. The levels of metals in the sediment from these sea grass meadows are currently being analyzed using total digestion and inserted into an Inductively Coupled Plasma Optical Emissions Spectrometer (ICP-OES). The loading of metals into these meadows is an issue of concern; some implications to management may be needed to enforce or amend current regulations.

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INTERACTION BETWEEN THE GREEN SEA TURTLE (*CHELONIA MYDAS*) AND AN ALIEN GASTROPOD (*RAPANA VENOSA*) IN URUGUAY

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Immature green turtles utilize insular and coastal waters of the Rio de la Plata estuary and the Atlantic coast of Uruguay as developmental and foraging habitats. A new kind of interaction, never recorded before, between *Chelonia mydas* and an alien gastropod, rapa whelk (*Rapana venosa*) was first observed on November 2004 in “Bajos del Solis” (Canelones), a foraging area for *C. mydas* located within the coastal waters of the estuary. This large mollusk, native from Japanese seas, was first recorded in South America in 1998 in the Rio de la Plata estuary and was previously introduced to the Black Sea, Adriatic Sea, Aegean Sea and more recently in Chesapeake Bay in North America. It is thought that the transoceanic range expansion of this carnivorous species is probably attributable to larval transport via ship traffic have been favoured by ship traffic. During May 2005, 12 green sea turtles were found either stranded or entangled in gillnets with rapa whelks attached to their carapace at the “Bajos del Solis” area. Three of them were already drowned at the time they were found while the other nine were still alive. After removing the alien gastropod, the individuals were released back to the sea. The number of rapa whelks attached to host turtles’ carapaces varied from 2 to 49 individuals, with an

average shell length (SL) of 70.6 mm \pm 6.0 (range= 49-85 mm; n= 94). The size of the green turtles found interacting with rapa whelk ranged between 37 and 63.5 cm over the curve carapace length. To our knowledge, this is the first report on the interaction between *C. mydas* and *R. venosa*, and the first documentation of this kind among green turtles and gastropods. We consider that this is a negative interaction that constitutes a real threat to green turtles - particularly because this snail affects a turtle's swimming hydrodynamics via increased drag as well as buoyancy due to the extra weight that host turtles must carry. Also, these voracious gastropods can cause severe injuries to host turtles via feeding.

Order: 32 **Abstract ID:** 1440 **Type:** Poster **Subject:** Anatomy, Physiology and Health

ULTRASTRUCTURAL CHANGES OF EGGSHELLS BEFORE AND AFTER HATCHING IN THE GREEN TURTLE, *CHELONIA MYDAS*, AT RAS AL-HADD

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A detailed study has been conducted on the ultrastructural changes of eggshells immediately after oviposition and post-hatching. The eggshells were cut into small pieces and then air-dried. They were placed on a conductive carbon layer or stubs placed at different orientations. Some eggshells were examined under low vacuum conditions (untreated) and viewed with a back scattered electron detector (BSE) at 20kV and 20Pa vacuum pressure using JEOL JSM-5600LV SEM. Others were examined under high vacuum conditions after being gold-coated (Bio-Rad SEM Sputter coater) and viewed with a secondary electron detector (SE) at 5kV. The outer layer of eggshell consists mainly of tightly compacted crystals in radiating forms while other crystals connected loosely with each other at different angles and also within the inside shell layer. There are numerous pores in the outer and the inner shells, which continue into the inner shell membrane. Apparently, these pores are for gas exchange during incubation. After hatching, the eggshells showed that there are large areas of the outer shells that are completely lost during the process of incubation leaving bare spots and exposing the inside layer directly to sand. This may be caused by the expansion of the eggshell with the absorption of moisture or from friction between the outside layer due to the movement of embryo during incubation. There were no significant changes in the inner layer. However, the inner shell membrane showed a significant increase of fibers compared to the freshly laid eggs. The significance of these changes will be discussed.

Order: 33 **Abstract ID:** 1430 **Type:** Oral **Subject:** Anatomy, Physiology and Health

FIELD AND EXPERIMENTAL EVIDENCE ABOUT THE INFLUENCE OF THE SUBSTRATE WATER CONTENT ON HATCHING SUCCESS OF LEATHERBACK TURTLE EGGS

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Substrate water content strongly varies spatially on marine turtle nesting beaches and can decisively influence nest hatching success. We have studied the relationship in the field between water content of the incubation substrate and hatching success of 12 leatherback turtle nests from La Playona, Chocó, Colombia. Moreover, we have experimentally incubated eggs of this species at different realistic levels of water content, varying from 1% to 12%, inside closed plastic containers that were located in the nesting beach at the depth where nests are often found. In

both field and experimental studies there was a strong correlation between substrate water content and hatching success (experiment: $r = -0.840$, $F_{1,19} = 45.595$, $P < 0.0001$; field study: $r = -0.851$, $F_{1,8} = 21.105$, $P = 0.0017$). Nests that were farther from the shoreline had lower substrate water content and higher success rates. Hatching rate varied from 0 % in the wetter nests to 64 % in the drier nests (1% water content). Hatching success found in the driest tested conditions was higher than that of natural protected nests or nests relocated to the hatchery. Embryo mortality in wet substrates occurred mainly in the earlier developmental stages. Water uptake from the nest during incubation does not seem to be necessary in order to improve hatching success or embryonic growth. Eggs incubated in the driest tested substrates lost mass, but there were no effects on hatchling mass, hatchling length, or running speed compared to those eggs that gained water during incubation.

Order: 34 **Abstract ID:** 1441 **Type:** Poster **Subject:** Anatomy, Physiology and Health

NATURAL COLONIZATION OF LOGGERHEAD TURTLE EGGS BY THE PATHOGENIC FUNGUS *FUSARIUM OXYSPORUM*

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Sea turtle nests are exposed to different environmental risks that may affect their hatching success. Human exploitation, predation by wild or domestic animals, nest flooding or severe beach erosion or accretion are common causes of egg mortality. However, there is very little information about the impact of microorganisms on turtle eggs. We analyzed loggerhead turtle eggs from Boavista Island (Republic of Cabo Verde) which were incubated under different environmental conditions in order to evaluate the presence and impact of fungus. We have isolated *Fusarium oxysporum* from dead and live eggs after three days of incubation. This fungal species is a very well known plant pathogen that attacks a great variety of species including important commercial crops. The fungus grows imbedded within the eggshell and can colonize the yolk and the embryo. It is usually spherical and can present bright yellow, blue or orange colorations. Many fungus-colonized eggs die within a short period of time. We have also found the fungus in shells of hatched eggs. Hatchlings from infected eggs may suffer several physiological problems such as bronchopneumonia. We only detected fungus in eggs that were incubated in natural substrates. Freshly laid eggs isolated directly from the female cloacae did not show fungus development. Similar results were found when those eggs were incubated in sterilized sand. Fungus spores may be common in nesting beaches and represent a potential risk for the species conservation. Any activity that favours the presence of this fungus in the nesting beaches should be avoided.

CONTRIBUTION ON LIFE-HISTORY PARAMETERS IN OLIVE RIDLEY SEA TURTLES (*LEPIDOCHELYS OLIVACEA*) IN TOMATLÁN, JALISCO, MEXICO

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The 69 km stretch of beach known as ‘Playón de Mismaloya’, Tomatlán, Jalisco State, Mexico, in the Eastern Pacific, is one of the most important beaches for nesting sea turtles. The extensive legal and illegal exploitation of the last 40 years has had critical consequences on this species and their numbers have diminished dramatically. Although papers report data on other populations of olive ridley sea turtles, life history data for this population is lacking. Reproductive data was collected on two beaches of Jalisco, Mexico: on Mismaloya from October-November 2003 (28 km, 20°05’N-105°32’W) (n=81) and on Majahuas South in November-December 2003 (9km, 19°50’N-105°22’W) (n=28). Female morphometric measurements, clutch size and weight of 10 eggs per nest were recorded for every nesting turtle. We discovered differences in clutch size ($F(1, 108)=10.266, p=0.002$) and mass of eggs ($F(1, 108)=6.424, p=0.013$) between these two beaches. We did not find any significant differences among female morphometrics (CCL: $F(1, 108)=0.005, p=0.945$; SCL: $F(1, 108)=0.319, p=0.573$), or individual egg weight ($F(1, 108)=0.337, p=0.563$). However, we found strong relationships between SCL and individual egg weight ($r=0.415, p=0.000$), mass of eggs ($r=0.385, p=0.000$), and clutch size ($r=0.228, p=0.017$). We also observed a negative relationship between number of eggs and individual egg weight ($r=-0.020, p=0.840$). The differences between the clutch sizes of the different locations are related to season and female body size. Our results were similar to data reported in other populations; however, adult female size, clutch size and egg mass was smaller than in other studies. We currently don’t have a definitive explanation for this, although we think this population or group of olive ridley females contains many young turtles and few large turtles. This may be due to high a depredation rate in the past and to the current protection program in this area. New females were incorporated into the nesting population, although in this study, minimum measurements aren’t like other data cited in papers. Clutch size is associated with female size: small turtles produce small clutches. This information can be useful for management plans.

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TREATMENT OF TRAUMA, FRACTURES, WOUNDS AND LESIONS IN INJURED SEA TURTLES

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Located in the Stazione Zoologica of Naples (Italy), a public research institute, the Rescue Centre has been working since 1983 towards the recovery of marine turtles, primarily loggerheads (*Caretta caretta*), the most common species of sea turtle in Italian waters. Most of the injuries of rescued loggerhead sea turtles are caused by

accidental capture in fishing gear and nets, violent impacts with boats, and unfavorable environmental conditions. All of these factors can cause not only internal damage but external, potentially severe, traumatic injuries involving the head, carapace, neck and flippers. In recent years, the number of turtles taken into the Rescue Centre with external injuries has increased greatly. We have concentrated our efforts on the treatments of traumatic injuries, preparing a specific methodology of medical intervention. Here we present cases concerning four loggerhead turtles that had carapace and head fractures, deep neck injuries or flipper lesions, indicating the treatments, therapies or prophylactic maintenance procedures carried out for each injury. The results, supported by photographic documentation of several temporal phases, demonstrate that complete recovery from these injuries requires a long time. Thus, it would be better for animals in recovery to be held in captivity to avoid any source of stress that can adversely affect the injured animal's rehabilitation.

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VETERINARY MEDICINE IN SEA TURTLES AT THE CENTRO MEXICANO DE LA TORTUGA, MAZUNTE, OAXACA, MEXICO

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The Centro Mexicano de la Tortuga (Mexican Turtle Center) has been working with sea turtles in captivity since 1993, among other activities. Some turtles were found to have developed pneumonia, liver cirrhosis, neoplasia and intestinal occlusions. Intestinal occlusions were caused by objects accidentally falling into tanks, either from visitors or from routine maintenance. This problem has been surgically treated by inguinal gastrotomy and enterotomy, using general anesthesia with Ketamina (10 mg/Kg), and local anesthesia with Xilocaine (1ml/cm of skin to be cut). Basically, the procedure opens the skin of the left inguinal region, stomach and intestinal wall to extract any foreign material. Turtles with pneumonia are treated with antibiotics such as Tylosin (0.05 ml/Kg) and a subcutaneous application of 20 ml Amino Lite of serum, 1.5 ml of B Complex and 1 ml of vitamins A, D, and E. Turtles with cirrhosis of the liver are treated with B Complex (1.5 ml/Kg). Animals have responded well to this treatment and have fed normally afterwards. A case of neoplasia from osteosarcoma was found in the right forelimb of an adult olive ridley female. In order to prevent dissemination of the neoplastic cells to other organs and tissues, we amputated the limb. Histopathological studies are underway, but the results are not available yet. However, in general, this individual seems to be in good health.

THE SUSPENSION VEST, A BREAKTHROUGH HOLDING TECHNIQUE FOR LEATHERBACK SEA TURTLE REHABILITATION

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One of the most challenging aspects of rehabilitating stranded leatherback sea turtles is preventing them from colliding with the walls of the tank. On 31 October 2005 a juvenile leatherback stranded in Dennis, Massachusetts. The animal's size (170 kilograms) and location after dark made a rescue impossible. A beach exam revealed an alert, responsive animal with no substantial wounds. The leatherback was released on-site, only to re-strand the next day. A second beach exam was performed including immediate plasma biochemical analysis. The animal was underweight and the plasma results revealed low glucose and calcium levels. Fluids and prophylactic treatments were administered prior to transport to the New England Aquarium. The animal was dry docked on large blocks of open cell foam for the first twenty-four hours during critical care. Concerns of muscle fatigue and pressure necrosis compelled us to create a system that would allow the turtle to float in the pool without contacting the walls. Support beams were installed over the rehabilitation tank and a custom suspension vest was created for the animal. Equipped with the vest, the turtle was tethered to the overhead structure to allow for in-water support. Tether lines were measured to allow mobility but prevent impact with the tank walls. Although this animal did not survive, the successful implementation of this innovative suspension system suggests that its use could be beneficial for longer term holding for sub-adult or adult leatherbacks in a rehabilitation setting. "Blue prints" for constructing this system will be presented.

DETECTION OF ORGANOCHLORINES IN MARINE TURTLES STRANDED IN THE CANARY ISLANDS: A PRELIMINARY REPORT

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Polychlorinated biphenyl compounds (PCBs) and organochlorine pesticides are well known as environmental contaminants due to three main facts: their stability, their strong bioaccumulative capacity and their global presence in different ecosystems. Therefore, it is essential to know these compound levels in the biological tissues to determine the potential impact that these accumulated substances have on the exposed organisms. This is the main goal of our study on marine turtles. The chemical analysis was performed on adipose and hepatic tissues from 15 juvenile loggerhead sea turtles (*Caretta caretta*) stranded in the Canary Islands between 2002 and 2004, and submitted from the Tafira Wildlife Rehabilitation Center to the Veterinary Faculty (ULPGC). The method of analysis is described by Tanabe *et al.* (1994). The application of this method in our work has been successfully tested by certified reference material, CARP-2 (National Research Council Canada). Among PCBs analyzed, the dominant congeners have 5-7 chlorine atoms, numbers 180,153,138 and 101 in accordance to previous observations in marine turtles by Lake *et al.* (1994), McKenzie *et al.* (1999) and Storrelli and Marcotrigiano (2000). These compounds are found in higher proportions in industrial CB formulations and are not susceptible to metabolic degradation as they have no vicinal H atoms, a requirement necessary to allow oxidative metabolism (Boon *et al.*

1994). The congener CB180 was the most frequently detected and most highly concentrated congener, at 199.72 ppb in the hepatic tissue of a turtle. The highest concentration for the congeners analyzed are CB153 = 89.83 ppb (liver); CB138 = 171.92 ppb (liver); CB209 = 171.27 ppb (liver); CB28,31 = 68.79 ppb (liver); CB101 = 74.29 ppb (liver); CB52 = 81.17 ppb (liver). Among the organochlorine pesticides analyzed, 2,4'-DDD was the most frequently detected and most highly concentrated, at 766.84 ppb in an hepatic sample. The highest concentration for DDT was 265.05 ppb in the adipose tissue of a turtle. It was remarkable to note the absence of 2,4'-DDE in the majority of the samples analyzed, as previously observed by Gardner *et al.* (2003). CB concentrations in adipose tissues ranged from 0 to 348.15 ppb w.w. and from 0 to 371.64 ppb w.w. in the liver. In the case of DDTs, concentrations ranged from 0 to 363.70 ppb w.w in adipose tissues and from 0 to 778.42 ppb w.w. in the liver. In our study, the organochlorine concentrations were higher in the liver than in the adipose tissue. This may be due to the state of the turtles. Emaciated animals which have mobilized their lipid stores may have an increased concentration of the higher chlorinated biphenyl compounds in the remaining tissues (Bernhoft and Skaare, 1994), which may make them more susceptible to toxic effects as a result of remobilization of the pollutants.

Order: 40 **Abstract ID:** 1746 **Type:** Poster **Subject:** Anatomy, Physiology and Health

MYCOBACTERIOSIS IN LOGGERHEAD SEA TURTLE, *CARETTA CARETTA*, STRANDED IN ITALY: A CASE REPORT

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In May 2005, a loggerhead sea turtle (*Caretta caretta*) stranded along the Adriatic coast near Ancona (Italy) and was housed in the Sea Turtle Hospital of Parco Oltremare, Riccione (RN). The sea turtle showed signs of depression, anorexia, lethargy and tachypnea. After two days, the subject died and was submitted for postmortem, parasitological and bacteriological examination. Samples from internal organs were fixed in neutral buffered 10% formalin and subjected to histological exam. At postmortem examination, abundant ascitic fluid and pericardial effusion were observed. Multiple whitish nodules ranging from 1-2 mm to 7 cm were scattered in lungs; pleural effusion was also detected. Several yellowish miliary nodules were evident in the liver showing normal dimensions and regular edges. A low number of miliary nodules were also observed in the stomach and gut wall. Parasitological exam of the gut revealed the nematode *Sulcascaris sulcata* and the digenean *Pachypsolus irroratus*, while the other organs tested negative. At the microscopic exam, smears from liver and lungs stained with Ziehl-Neelsen (Z-N) tested positive for acid-fast rods. The cultural exam from lungs, liver and kidney using Löwenstein-Jensen and Middlebrook 7H10 isolated whitish colonies after 5 days at 30°C. These colonies were positive to Z-N stain and were consistent with *Mycobacterium* sp. The histological sections stained with H&E and Z-N showed granulomas at different developmental stages containing acid-fast bacteria. Phenotypical characterization and PCR-RFLP of the hsp65 Gene are in progress to identify the *Mycobacterium* sp. This report contributes to the knowledge of sea turtle mycobacteriosis.

INJURY ASSESSMENT OF SEA TURTLES UTILIZING THE NERITIC ZONE OF THE SOUTHEASTERN UNITED STATES

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Natural and anthropogenic factors within marine and terrestrial environments regulate the long-term survival of sea turtles. To gain insight into how such interactions may be influencing survival rates, as well as how non-lethal injuries may be affecting the ability of sea turtles to function throughout their lives, we studied sea turtles (n=3,290) captured at the St. Lucie Nuclear Power Plant (SLNPP), May 2000 through July 2005. These animals were utilizing the neritic zone of the southeastern United States and were subsequently entrained into the canal system at the SLNPP. Physical cues (injury types) left from past interactions between turtles and the abiotic/biotic factors within their environment were quantified and statistically compared, but before doing so it was first necessary to develop a standardized injury identification system that would aid in reducing observer error when categorizing injury types, causes and locations. Injury locations were recorded in order to identify regions of the body that may sustain significantly higher rates of injury. The focus of this project was limited to the following injuries: 1) shark bites, 2) social interactions between turtles, 3) barnacles, 4) fishing gear (hook, entanglement), 5) oil/tar, 6) boat propeller strikes, and 7) SLNPP intake pipes. The systematic Sea Turtle Injury Identification System (STIIS) developed in this project can be applied globally by researchers and volunteers across research and stranding projects assessing both live and dead turtles. Results from this study indicate statistically significant differences in the types, causes, and locations of injuries observed between sea turtle species, sex and size-class.

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HUMAN IMPACTS ON THE MORTALITY OF SEA TURTLES STRANDED IN THE CANARY ISLANDS, SPAIN (2003-2004)

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Between January 2003 and July 2004, 35 loggerhead turtles (*Caretta caretta*) and 1 green turtle (*Chelonia mydas*) that stranded on the coasts of the Canary Islands were submitted for necropsy to the Veterinary Faculty (ULPGC). Some of them had been previously submitted to the TWRC for health evaluation, medical management, and possible rehabilitation. Six turtles (16.6 %) died from spontaneous diseases including different types of pneumonia, hepatitis, septicemic processes and salt gland adenitis. However, 30 turtles (83.3 %) died from lesions associated with human activities such as boat strike injuries (19.4 %), entanglement in fishing nets (27.7 %), and ingestion of hooks and monofilament lines (36.1 %). Turtles with boat strike traumatic injuries had severe fractures of the carapace/plastron, and severe lesions mainly penetrating into the lungs and kidneys. Entanglement in fishing nets resulted in severe ulcerative dermatitis, necrotizing myositis, amputation of flippers, and septicemic processes. A

comparison of our survey and the data provided by the sea turtle stranding registry of the TWRC indicates that turtles with lesions induced by entanglement usually have a better prognosis for rehabilitation than those with traumatic lesions in the carapace or plastron. Affection of vital organs such as lungs and kidneys, because of the anatomical location, dorsally attached to the carapace, explain the generally poor prognosis for turtles with severe traumatic injuries in the carapace. Ingestion of hooks and monofilament lines resulted in ulcerative and fibrinous esophagitis, fibrinonecrotic gastritis, fibrinous and necrotizing enteritis, intestinal intussusception, severe celomitis, and septicemia.

Order: 43 **Abstract ID:** 1705 **Type:** Poster **Subject:** Anatomy, Physiology and Health

TURTLES AS PHYSIOLOGICAL MODELS FOR ENVIRONMENTAL STRESS: CAN THEY BE “USED” AND IS IT ETHICAL?

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Can turtles be used as sentinels for coastal and estuarine environmental stress? The ethical issue is “Can one use an animal in invasive physiological studies whose population status is insecure?” We think “yes” and for two primary reasons. First, based on 30 years of descriptive and experimental studies using ultrasonography, laparoscopy, tagging, manipulated stress, tissue sampling, and occasionally injection of compounds; we have had excellent results in terms of knowledge gained compared to minimal population impacts. We estimate less than 1% animal loss in prior research and we avoid choosing study subjects that are under population pressure. We also take advantage of captive bred, captive non-releasable and stranded animals. It is critical to choose species that are the best candidates for answering targeted questions. For example, the diminutive diamondback terrapin is proving very useful for current studies of mercury contamination when the loggerhead, while instructive, left us with many unanswered questions due to its migratory nature, large size precluding experimentation and complications of multiple environmental stressors (e.g. fisheries interactions). Finally, the second reason to support the use of these species in selected physiological research is that there are minimal studies on the sensitivity and effects of environmental stressors on sea turtles, turtles in general, or even reptiles. With each experiment (if carefully conceived), we learn more about the biology and adaptations of these poorly known species. With coastal development proceeding unchecked in most areas, these turtle species are exceptionally vulnerable. This research should be an investment in the turtle’s future.

HEAVY METAL ACCUMULATION IN THE LIVER OF HATCHLINGS AND EGG YOLK OF GREEN TURTLES, *CHELONIA MYDAS*

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The purpose of this study is to investigate the bioaccumulation of heavy metals in *Chelonia mydas* at Ras Al-Hadd turtle reserve area. A total of 14 heavy metals in 322 hatchling livers and 420 egg yolks was determined by using AAS and ICP analytical methods. Samples were collected randomly from different beaches at Ras Al-Hadd for a period of 3 years. The average metal contents varied from 0.08 (Ni) to 4.76 (Zn) $\mu\text{g/g}$ wet weight in livers and 0.04 (Cd) to 3.26 (Zn) $\mu\text{g/g}$ wet weight in egg yolks. Generally, the data for Zn and Cu were significantly high ($\geq 2.92 \mu\text{g/g}$), while the data for Ni, Cd and V were significantly low ($\leq 0.10 \mu\text{g/g}$). These results do not reflect the levels of metals found in sea water and sand samples collected at the Ras Al-Hadd reserve area. However, laboratory experiments with artificial contamination of these metals in both sea water and sand showed a significant accumulation ($p < 0.01$) of 11 out of 14 heavy metals studied compared with controls in both livers and egg yolks. The results of this study indicate that green turtles can accumulate most heavy metals. Studies on the toxicological effects of these metals on the population health of these most endangered species are urgently needed.

SKULL ALLOMETRY WITH RESPECT TO CARAPACE MEASUREMENTS OF EAST PACIFIC GREEN TURTLES *CHELONIA MYDAS AGASSIZII* FROM SECHURA BAY, PERU

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Skulls of East Pacific green turtles collected between 2002-2004 were measured following Kamezaki and Matsui (1995). Additionally, some skulls and carapaces from the same individuals were collected to obtain the curve carapace length (CCL) and curve carapace width (CCW) ratios. A total of 20 skull measurements and 2 carapace measurements were used for this analysis. Seventeen specimens with complete data sets (skull and carapace measurements) were divided into two groups according to the CCL of nesting females in 2001-2002 in Galapagos Islands ($< 60.7\text{cm}$ and $\geq 60.7\text{cm}$). These were analyzed with a regression test using CCL and CCW as dependent variables. Using CCL, proportionality was found among seven variables in the $\geq 60.7\text{cm}$ group, and there was only one allometric variable in $<60.7\text{cm}$ group. Using CCW, proportionality was found in four variables in the $\geq 60.7\text{cm}$ group and in one variable in the $<60.7\text{cm}$ group - the same as with the CCL analysis (height of nares). Our results suggest that East Pacific green turtles show variability after they have reached maturity according to variables observed in seven of twenty skulls and in four of twenty skulls with respect to CCL and CCW, respectively. This variability is mostly related to the morphology of non-rostral segments in the skull. Immature specimens show proportionality in one skull measurement for both carapace length and carapace width. We conclude that development in length of this animal is isometric only

in rostral bones at both immature and mature East Pacific green turtles; neural structure development is not allometric while animals are immature and it becomes allometric once individuals reach maturity.

Order: 46 **Abstract ID:** 1651 **Type:** Poster **Subject:** Anatomy, Physiology and Health

ENDOPARASITIC FAUNA OF *CARETTA CARETTA* FROM SPANISH AND ADRIATIC SEAS: FIRST COMPARISONS

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In this study, we compared helminths found in *Caretta caretta* from Spanish and Adriatic waters. Parasites were collected during necropsies and studied using classical methods and SEM. Fifty-four specimens were analyzed from Spanish waters and 18 were from Italian waters. Helminth species found in the Spanish sample were identified as *Enodiotrema megachondrus* [Prevalence: 96%, median (range): 74.5 (1–680)], *Calycodes anthos* [46%, 9 (1–86)], *Hemiuroidea* sp. [28%, 1 (1–4)], *Pachypsolus irroratus* [6%, 8 (1–15)] and *Rhytidodes gelatinosus* [6%, 1(1)]. The helminths from the northern Adriatic coast were identified as *Sulcascaaris sulcata* [16.7%, mean (range): 52.67 (3–152)], *R. gelatinosus* [11.1%, 2.5] *E. megachondrus* [5.6%, 17] *Orchidasma amphiorchis* [5.6%, 14] and *Pleurogonius trigonocephalus* [5.6%, 78]. The lower prevalence values (except for the nematode *S. sulcata*) observed in the Italian group may be related to the fewer subjects examined and to the scarce condition state of some carcasses. *E. megachondrus* and *R. gelatinosus* were present in both samples. In the Adriatic, *S. sulcata* stands out from other species. The presence of helminths was correlated with feeding data available from both areas, showing a greater presence in benthic prey species in the Adriatic and higher diversity in prey from the Spanish Mediterranean. A comparison of results previously reported in the literature on the parasites of *Caretta caretta* from the Mediterranean basin has also been conducted.

Order: 47 **Abstract ID:** 1609 **Type:** Poster **Subject:** Anatomy, Physiology and Health

TEMPORAL VARIATION IN THE ACTIVITY OF ANTIOXIDANT ENZYMES IN THE BLOOD OF BLACK TURTLE (*CHELONIA MYDAS AGASSIZII*) IN PUNTA ABREOJOS, BAJA CALIFORNIA, MEXICO

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Changes in the metabolic status in many aquatic organisms in response to food supply, reproductive stage, habitat, water temperature, pollutants, oil spills, and others factors, can cause an increase of reactive oxygen species

(ROS) which in turn can induce oxidative stress. Oxidative stress has been related to the etiopathogenesis of numerous diseases, including tumors and cancer. Increased antioxidant activity has been found in both vertebrate and invertebrate species exposed to situations that potentially induce oxidative stress, apparently in an attempt to minimize oxidative damage. Blood samples were collected from live black turtles caught during a routine population survey in March, May, June and July of 2005. As part of this survey, turtles were tagged and released after samples were taken. The objective of this work was to evaluate the seasonal variation of the antioxidant defense system of the black turtle (*Chelonia mydas agassizii*) from Punta Abreojos, Baja California Sur, Mexico. The activities of the antioxidant enzymes superoxide dismutase (SOD), catalase (CAT), and glutathion-S-transferase (GST), were measured in blood samples using spectrophotometric techniques. No significant changes ($p>0.05$) in the activities of CAT and SOD were found over time; however, blood GST activity was significantly ($p<0.05$) higher in May. Because GST is an inducible enzyme involved in detoxification processes, the possible relationship between GST levels in sea turtles in May and the presence of environmental contaminants during this month warrants further study. Changing patterns of dominant currents and upwelling in the area during May could contribute to differences in environmental contaminant concentrations within the bay. Studies are on-going at our laboratory to measure contaminants profiles in these same turtles to determine if a relationship exists between oxidative stress markers and contaminants in blood of black turtles.

Order: 48 **Abstract ID:** 1552 **Type:** Poster **Subject:** Anatomy, Physiology and Health

NORMAL COMPUTED TOMOGRAPHY, MULTIPLANAR AND THREE-DIMENSIONAL RECONSTRUCTION OF THE RESPIRATORY TRACT OF LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) USING A MULTIDETECTOR-ROW SPIRAL SCANNER

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Because of the dorsal position of the lungs and their close contact to the carapace, sea turtles often are admitted into rehabilitation centers with pulmonary disorders secondary to shell fractures. The goal of this work is to study the morphology of the respiratory tract using Multidetector Computed Tomography (MDCT) and to provide images of virtual tracheo-bronchoscopy, multiplanar and 3-D reconstructions of airways and lungs of normal loggerhead sea turtles, which could be useful as a reference to diagnose respiratory diseases. MDCT was performed on 7 live and 3 dead juvenile loggerhead sea turtles. Transverse helical sections of 1mm were obtained from the whole body. Multiplanar and 3D-reconstructions were generated on a Vitrea computer workstation. Anatomical 20mm sections in the transversal, dorsal and sagittal planes were performed on the dead turtles to compare with the CT images. The morphology of the trachea, bronchia, lungs and pulmonary blood vessels is described. The virtual bronchoscopy revealed the tracheal mucosa as a smooth surface. The central intrapulmonary bronchus appeared clearly in the transverse sections. The lungs were not lobed and the pulmonary parenchyma was strongly reticular. Two large pulmonary blood vessels around the central bronchus could be identified in all sections. The slow respiratory rate of reptiles associated with the lung-air interface allowed the lungs to be visualized in high quality. The morphology of the lungs of the juvenile loggerhead sea turtles found in our work corresponds with the results reported in a previous histological study performed in hatchlings of the same species.

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TOPOGRAPHIC ANATOMY AND NORMAL MULTI-DETECTOR COMPUTED TOMOGRAPHY OF THE COELOMIC STRUCTURES OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*)

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In most cases of turtle shell or skeletal injuries, plain radiographic data do not show the extent of complex fractures due to the distraction from superimposed structures. Compared with conventional radiography, computed tomography (CT) allows better distinction among specific tissue densities and discrete changes in organ size, shape, contour and position. The objectives of this study are to determine the normal multi-detector computed tomography (MDCT) appearance of the coelomic structures of the loggerhead sea turtle and to use 3D and multiplanar reconstructions to describe the vertebral morphology, indicating the position of each organ relative to the vertebrae and carapace. Transverse helicoidal sections, 1mm thick, were taken from 7 clinically healthy and 5 dead loggerhead sea turtles. Multiplanar and 3D reconstructions were performed on a Vitrea computer workstation. Dead turtles were frozen and sectioned in the transversal, dorsal and sagittal planes to compare with the CT images. Multiplanar sagittal and 3D reconstructions of the vertebral column allowed evaluation of the vertebrae and the vertebral canal. Clinically relevant organs and anatomic structures such as the esophagus, stomach, trachea, bronchia, lungs, gallbladder, heart, spleen and kidneys were identified and labeled in the CT image, in 3D reconstructions and in the anatomical sections. The knowledge of the normal appearance and the location of coelomic structures in relation to the carapace and the vertebrae are of reliable value to facilitate the application of other diagnostic imaging techniques such as ultrasound, magnetic resonance and x-rays and to improve surgical and biopsy procedures.

Acknowledgements: We gratefully acknowledge travel support from UNEP's RAC/SPA (Regional Activity Centre for Specially Protected Areas) and other donors through the Symposium Travel Committee.

ANTHROPOGENIC AND NATURAL CAUSES OF MORTALITY IN OLIVE RIDLEY SEA TURTLES (*LEPIDOCHELYS OLIVACEA*) ON OSTIONAL BEACH ON THE PACIFIC COAST OF COSTA RICA

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Incidental catch in fisheries is widely recognized as a major source of mortality for sea turtles. Current information indicates that sea turtles die worldwide due to trawling, pelagic and bottom long lines, gill nets or entrapment gear, entanglement in buoy or trap lines, and hooks and lines from recreational and commercial fishing (Oravetz, 1999). Recently, increased efforts have been devoted to the conservation of sea turtles. This effort includes management of their medical conditions and investigation of the causes of mortality of stranded animals (Oros *et al.*, 2004) using a necropsy technique developed five years ago in Costa Rica. Anthropogenic causes of mortality included

nylon and hooks inside the mouth and esophagus, ventral incisions for eggs and meat and cerebral traumas by propellers. Mortality from “natural” causes was identified only in 2002 along Nancite Beach, an area protected by the government. Natural mortality was due to predation by crocodiles, coyotes and sharks. The fieldwork was carried out on Ostional Beach, on the Northern Pacific coast of Costa Rica, from August 1, 2004 to January 30, 2005. Only 6 turtles were in good enough condition for histopathological analyses, and they revealed granulomas associated with embryonic eggs of a trematode in the lung, heart, intestine and kidney. There was also one case of vasculitis and chronic kidney insufficiency. The antemortem and postmortem sampling of tissues is necessary to fully understand the causes of lesions, disease, and mortality in living and dead marine turtles. Ultimately when a population is affected or an individual is found dead, postmortem examinations are the best way to try and establish causes of mortality in marine turtles. Although all dead turtles should be necropsied, the degree of decomposition will limit the amount of diagnostic information that can be gained. To investigate a population morbidity/mortality event, it is often more informative to euthanize and necropsy a moribund turtle rather than one that died spontaneously, because one is more likely to find active primary pathological processes in the former case while chronic inflammatory responses and secondary infections may obscure these findings in the latter. Gross and histopathologic evidence of an infectious process provides direction for further diagnostic analyses. The postmortem information obtained from the autopsy reveals the natural and human causes of mortality of sea turtles. Management plans of the marine protected areas should include actions that try to diminish the human causes of mortality, such as educating the fishermen.

Order: 51 **Abstract ID:** 1659 **Type:** Poster **Subject:** Anatomy, Physiology and Health

INCIDENTAL ENTOMOFAUNA ON EGG CLUTCHES OF *LEPIDOCHELYS OLIVACEA* (ESCHSCHOLTZ, 1829) IN THE WILDLIFE REFUGES “ISLA JUAN VENADO”, “RIO-ESCALANTE-CHOCOCENTE” AND “LA FLOR” IN NICARAGUA

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A study was conducted to assess the occurrence and taxonomy of insects associated with egg clutches of the olive ridley sea turtle, *Lepidochelys olivacea* (Eschscholtz), on the beaches of Isla Juan Venado, Rio-Escalante-Chococente, and La Flor Wildlife Refuges on the Pacific Coast of Nicaragua, Central America. A total of 356 insects were collected from 78 *L. olivacea* nests from the three sampling sites from October to December 2004. These samples were duly mounted and dispatched to insect taxonomists for their identification. Two hundred and seventy eight insects were collected directly from the surface of the turtle nests, while 40 specimens were collected from dry, partially empty egg shells. The remaining insects consisted of 38 adult flies which were recovered from eggs collected at La Flor and Juan Venado Island, and showed symptoms of attack by maggots at different stages of development. Those eggs were transferred to the laboratory at UNAN, León, and observed under controlled conditions. The following groups were recognized: Three species of Coleoptera: *Phaleria panamensis* Champion, *Ulus lineatulus* Champion (Tenebrionidae), and *Omorgus suberosus* Fabricius (Scarabaeidae). One more species of Histeridae is pending identification. Two species of Hymenoptera: The fire ant *Solenopsis geminate* (Fabricius) and the carpenter ant *Camponotus* sp. (Formicidae). 3) Five species of Diptera: *Desmometopa varipalpis* Malloch, *D. singaporensis* Kertész (Milichiidae), *Megaselia scalaris* (Loew) (Phoridae), *Eumacronychia sternalis* Allen, and *Argoravinia rufiventris* (Wiedemann) (Sarcophagidae). Diptera emerged as the most relevant group of the three orders, considering that they were the only insects found inside the turtle eggs. The extent of their impact, either

primary or secondary, or their effect on the embryonic development of the eggs remains uncertain. Only one natural enemy of Diptera associated with turtle eggs, *Aleochara* sp. (Coleoptera: Staphylinidae), was recovered during this study. It's potential as a means of biological control remains unknown. Most of the other collected adults of Coleoptera were observed feeding on empty dry egg shells. It was evident that these insects had no effect on viable turtle eggs. Formicidae were observed attacking not only the hatchlings of *L. olivacea* but also the pupal stage of Diptera and different invertebrates associated with the hatchlings. Based on our results, insects seem to play an important roll, sometimes beneficial, other times hazardous, to the overall survival of *Lepidochelys olivacea* eggs and hatchlings. A more thorough and in-depth study should be conducted to confirm the true parasitic or saprophagic effect of Dipterans on turtle eggs.

Order: 52 **Abstract ID:** 1783 **Type:** Poster Reserve **Subject:** Anatomy, Physiology and Health

EVALUATION OF METAL CONCENTRATIONS FROM LOGGERHEAD, *CARETTA CARETTA*, EGGS FROM THE FLORIDA GULF AND ATLANTIC COASTS

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The loggerhead sea turtle, *Caretta caretta*, is susceptible to pollutants as it feeds on the benthos where wastes accumulate. Point and non-point sources of pollution discharge metal wastes in the U.S. waters. These contaminants eventually find their way into the Mississippi River, which leads to the Gulf of Mexico and the Southeastern coastal rivers, discharging into the Atlantic Ocean. The main objective of this study was to compare the concentrations of metals in loggerhead sea turtle eggs collected from beaches along the east and west coasts of Florida. Metal concentrations (As, Cr, Pb, and Hg,) were determined for eggs collected in Franklin County (on the Gulf Coast of northwest Florida) and Flagler County (on the Atlantic Coast of Northeast Florida). The habitat on the Atlantic coast was considered relatively pristine. Additionally, we examined intraclutch variation by separating the nest into four vertical sections. Finally, we compared our results to a study conducted in 1992 on St. George Island, Franklin County, to evaluate any possible temporal trend. Analysis of egg yolks from nests in the two counties showed that the Franklin County site contained a significantly higher concentration of metals ($p < .05$) than those from the Flagler County site. The intraclutch comparison exhibited no significant variation between nest sections for both sites ($p < .05$). Our data suggest some inter-annual variability as the concentrations for each metal varied greatly. Further study of metal accumulation in the Gulf is necessary since the results represent an anonymous sample of the population.

CROSS-REACTIVITY OF ANTI-VTG ANTIBODIES FROM *CHELONIA MYDAS AGASSIZII* WITH *CARETTA CARETTA* VTG - A PRELIMINARY WORK

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Sea turtles are long-lived, omnivorous species that can bioaccumulate organic and inorganic contaminants from food, sediment, or the water column. These species are exposed to a variety of chemical classes including those recognized as endocrine-disrupting compounds (EDCs). These compounds interfere with normal hormonal pathways causing reduced fertility, lower hatch rates in oviparous vertebrates, decreased viability of offspring, altered hormone levels. Environmental EDC have been associated with changes in reproduction, growth and survival with severe effects - especially on endangered species such as sea turtles. Among these chemicals, the best studied are xenoestrogens, or those that mimic estrogens, such as 17 β -estradiol, one of the hormones usually released during the normal reproductive cycle. Vitellogenin (VTG) is the precursor molecule of egg yolk protein produced by female oviparous vertebrates during the reproductive cycle by estrogen stimulation. The protein is subsequently transported by the circulatory system to the ovaries and stored in oocytes as egg yolk. Estrogen-dependent VTG induction can be effected by exposure to chemicals that mimic estrogens. The synthesis and secretion of VTG can occur in liver of males and immature females in response to estrogen stimulation or exposure to xenoestrogens. Therefore, elevated levels of serum VTG in male or immature female animals can serve as a biomarker of exposure to exogenous sources of estrogenic compounds. Until recently the techniques used for the identification of VTG in sea turtles were hindered by the lack of specific antibodies for these species. For that reason this work was focused on the determination of cross-reactivity of anti-VTG antibodies from *Chelonia mydas agassizii* with *Caretta caretta* VTG, by using antibodies produced at the Centro de Investigaciones Biologicas del Noroeste, (CIBNOR) Mexico (Sifuentes *et al*, 2006). Using plasma samples collected from individuals of *Caretta caretta* hospitalized at the WWF Sea Turtle Rescue Centre of Lampedusa (Sicily), we checked the cross-reactivity and specificity of this antibody for *Caretta caretta* through Western blot analysis and where possible and present, we analyzed the differences in VTG levels between males and females. The electrophoretic patterns of these plasma samples showed bands of about 200, 151 and 116 kDa molecular weights, similar to those obtained at CIBNOR for *C. m. agassizii*, giving information about the usefulness of this antibody for the identification of *C. caretta* VTG. However, further investigations are needed to confirm this specificity and to improve the use of this tool for monitoring contaminant effects in sea turtles.

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Behavior and Movements

Order: 54 Abstract ID: 1425 Type: Poster Subject: Behavior and Movements

BEHAVIOR OF GREEN TURTLE, *CHELONIA MYDAS*, HATCHLINGS DURING EMERGENCE AT RAS AL-HADD, OMAN

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In this investigation we report the sequential steps of emergence for the first time in this species. The behavior of the green turtle hatchlings during emergence was observed at peak of emergence season. At the onset of emergence, the first group of hatchlings came to the surface, but did not emerge completely. They remained motionless near the surface, heads partially covered and sometimes part of their bodies exposed above the surface for 15-60 min. As soon as the top hatchlings emerged completely, the rest began to emerge rapidly en masse between 10 to 30 min, depending on the number of hatchlings and softness of sand. Based on 11 nests we observed the number of emerged hatchlings varied from 67 to 132. Apparently movement of sand by the first group triggers the rest to emerge from underneath. Data revealed hatchlings emerged all at one time or in separate groups. The mean sand temperature was $28.3 \text{ }^{\circ}\text{C} \pm 0.4$ and percentage relative humidity was 73.5 ± 3.5 . A significant correlation exists between sand softness and time of emergence ($P < 0.001$). Sand softness was measured according to (Kikukawa *et al.*, 1999). The hatchlings start the emergence with the heads in a vertical position penetrating the sand first aided by the movement of front flippers. The hatchlings are loosely attached by front flippers in groups of twos and threes, with occasional singles. Upon emergence the hatchlings disengage and appear disoriented. Most hatchlings moved towards the sea but some take the opposite direction and soon adjusted seaward.

Order: 55 Abstract ID: 1845 Type: Poster Subject: Behavior and Movements

CANCELLED

Order: 56 Abstract ID: 1549 Type: Poster Subject: Behavior and Movements

STUDY OF THE STRANDINGS ASSOCIATED TO THE MIGRATORY MOVEMENTS OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) ALONG THE ANDALUSIAN COAST

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During the years 2004-2005, the Andalusian Government carried out the Program of Sustainable Management

of Resources for Marine Environment Conservation that included studies on the loggerhead sea turtle (*Caretta caretta*) in Andalusia. Part of this work was focused in the research of the turtles stranded along the Andalusian coast between the years 1996-2005. When it was possible we registered morphometric data and the condition of the specimens, and we collected the epibiotic flora and fauna for later identification. We also took samples of tissue for genetic and toxicological analyses, and performed post-mortem examinations to determine the cause of the death. We analysed over 700 individuals and we studied the spatial and temporal distribution of the strandings according to the size and sex of the individuals, the body condition and the causes of the strandings. The Straight Carapace Length (SCL) indicates that the majority of the stranded individuals were sub-adults. Human activities, especially those linked to fisheries (hooks, nets and impact traumas) and contamination by solid wastes, was the cause of a high proportion of the strandings, so they have important negative impacts on loggerheads. Living animals are more frequently stranded in the Mediterranean zone, whereas the dead ones are more frequent in the Atlantic zone. The majority of the strandings were concentrated between May and September, that is to say, in the warmest seasons (spring and summer). The strandings were more abundant in the Atlantic zone during autumn, winter and spring, whereas in summer they were more frequent in the Mediterranean zone. The results obtained in the present study suggest that the Andalusian coast is a passing-through zone for *Caretta caretta* and it is mainly used by sub-adult individuals. It is possible that loggerheads use the natural bays along the Andalusian coast as sporadic food areas. According to the epibiotic fauna present in the stranded animals, it is probable that *Caretta caretta* uses both neritic and oceanic habitats in front of the coast of Andalusia.

Order: 57 **Abstract ID:** 1722 **Type:** Oral **Subject:** Behavior and Movements

MOVEMENTS OF EASTERN ATLANTIC LEATHERBACKS DURING AND AFTER THE NESTING SEASON: CONSERVATION IMPLICATIONS AT THE ATLANTIC SCALE

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Despite decades of conservation efforts on nesting beaches, the critical status of leatherbacks indicates that their survival depends predominantly on our ability to reduce at-sea mortality. Satellite telemetry has been recently used to identify areas where female leatherbacks nesting in the western Atlantic encounter fisheries during and after their nesting season. However, little is known about the at-sea movements of leatherbacks nesting in the eastern Atlantic, both during and after the nesting season. Here we report the first satellite tracking data for 10 leatherback turtles nesting in 2002 and 2003 on Mayumba Beach (3.7°S-10.9°E), Gabon, Central Africa, a site that supports one of the largest leatherback nesting populations in the world. Additionally, we use flipper tag recovery data to elucidate post-nesting migrations. We show that during the nesting season females performed extended movements frequently visiting waters of neighboring Congo. Leatherbacks exploit commercial fishing grounds and face accidental capture by regional coastal fisheries. During their post-nesting migration, leatherbacks moved either offshore and headed towards the Northern hemisphere to areas also shown to be exploited by western Atlantic leatherbacks, or remained relatively close to the coast when heading to South Africa. Recaptures of leatherbacks flipper-tagged in Gabon indicate that eastern Atlantic leatherbacks also migrate to South America, where they face incidental capture by both coastal and pelagic international fisheries. These results emphasize the need for conservation strategies to be developed at the Atlantic scale, both at sea and on land, to ensure the survival of these leatherbacks.

INSIGHTS INTO HABITAT UTILIZATION AND DIVING BEHAVIOR OF JUVENILE HAWKSBILL TURTLES, *ERETMOCHELYS IMBRICATA*, IN CARIBBEAN FORAGING HABITAT

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We present detailed results of a study of diving behavior and habitat utilization of juvenile hawksbill turtles (*Eretmochelys imbricata*) in the Cayman Islands. In this study, twenty-one Lotek LTD-1110 time depth recorders were deployed and eighteen were subsequently recovered, allowing dive depth, type, and duration to be quantified across a range of hawksbill size classes (mean SCL (cm) \pm SD, range: 37.7 \pm 14.9, 25.5-55.2). Additionally, deployment of VEMCO V16 and V13 coded transmitters permitted manual tracking via VEMCO VR100 receiver, as well as long-term monitoring with VEMCO VR2 fixed station receivers. Ultrasonic acoustic tracking elucidated movement patterns and critical habitat, and in concert with dive data, provides new information on management requirements of critically endangered hawksbill turtles in Caribbean foraging habitat.

MOVEMENT OF GREEN TURTLES (*CHELONIA MYDAS*) BETWEEN NESTING SITES AND SEA GRASS BEDS IN THE SOUTH INDIAN OCEAN: A COMPONENT OF THE S.W.I.O.F. PROJECT

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In the year 2000, countries bordering on the West Indian Ocean requested assistance in the management of the living resources and associated habitats of their shared marine ecosystems. In response, the World Bank initiated, under the Global Environmental Facility (GEF), the development of a multi-national fisheries management and development programme called the South West Indian Ocean Fisheries Project (SWIOFP). This project involves 9 different countries: Kenya, Tanzania, Comoros, Mozambique, Seychelles, Madagascar, South Africa, Mauritius and La Reunion (France) and should begin in 2006. One of its components is related to interaction between biodiversity and fisheries and includes the green turtle (*Chelonia mydas*) as it exists in the WIO. Even if locally, the green turtle behaviour is well known during the feeding and the reproduction periods, the lack of global overview of the movement between the successive habitats does not permit appropriate conservation measures to be taken at a regional level. Indeed, even though the green turtle is present in different countries of the area, the spatial dynamics of this migratory species, which periodically moves hundreds of kilometres between the feeding grounds and the nesting sites, is still poorly known. This duality in nesting and feeding areas and the great distances of migration involved necessitated regional cooperation between the different countries concerned. To this end, the SWIOFP project will develop actions related to the study of the movement of green turtles between nesting sites and foraging areas in the WIO. More than 100 satellite transmitters will be attached to green turtles, in several phases, at different habitats and sites.

FORAGING SITE FIDELITY OF ADULT GREEN AND LOGGERHEAD TURTLES

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Marine turtles, in particular green turtles (*Chelonia mydas*), are renowned for their high site fidelity to their nesting beach, often nesting on small stretches of beach on remote isolated cays or islands. Here we show that both green and loggerhead (*Caretta caretta*) turtles also exhibit high site fidelity to their over-wintering and summer foraging grounds between breeding seasons. We tracked 10 green and 10 loggerhead turtles from their nesting site on the north coast of the Mediterranean island of Cyprus to their foraging grounds (1998-2005). Six of these females (three green and three loggerhead) were tracked for a second time when they returned between 2 and 5 years later to nest. Although one unit, on a loggerhead female, failed before the female had reached her over-wintering site, the remaining individuals, of both species, showed high levels of fidelity to their foraging site.

NEW OBSERVATIONS ON THE REPRODUCTIVE LONGEVITY OF THE LOGGERHEAD SEA TURTLE IN A BRAZILIAN NESTING AREA

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Actions towards the conservation of the loggerhead sea turtle (*Caretta caretta*) comprise the protection of several phases of their life cycle (eggs, hatchlings, juveniles, sub adults and adults); the challenges faced by the different populations vary due to distinct human pressures acting in different areas of the globe. The available population models are based upon parameters frequently estimated and extrapolated from information obtained at one or few populations. Therefore, for most of these populations, aspects as fecundity, remigration intervals and reproductive longevity are just estimated from information obtained in other areas. Determining several of these parameters requires the accomplishment of long term studies, involving tag-recapture data of females in nesting areas. In the northern coast of State of Espírito Santo, in the southeastern coast of Brazil, since 1982, Projeto TAMAR-IBAMA patrols and protects the main loggerhead nesting beaches. Annually, between October and January, the beaches were surveyed by teams of at least two people and females were tagged with monel tags. Until 1990, just one tag was applied; after this period, females were double-tagged. Since 1982, 512 females have been tagged. During the last reproductive season, two females, tagged in November, 1982 were recaptured at Comboios beach, in Linhares, in November, 2004. This interval corresponds to a minimum 22 years period of reproductive longevity, for two different females. Although the population models indicate periods longer than 30 years, corroborated by skeleton-chronological studies, these records configure the longest interval directly registered for this species in beaches monitored all over the world.

LOGGERHEAD (*CARETTA CARETTA*, LINNAEUS 1758) AND LEATHERBACK (*DERMOCHELYS CORIACEA*, VANDELLI 1761) DISTRIBUTION IN THE GULF OF CADIZ (SW OF THE IBERIAN PENINSULA)

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Some marine migratory species can be captured incidentally as bycatch. However, information on marine migratory species in this region is scarce and particularly concerning the fisheries incidental caught species. The Gulf of Cadiz is the Atlantic connecting region with the Western Mediterranean. Both regions and the Gibraltar Strait are important corridors for the marine migratory species. In both regions the main fisheries are artisanal. The fleet fishing for large pelagic species with surface longline (25 vessels) fish seasonally and its components are based in the Gulf of Cadiz ports. Some vessels (<10) based at the Mediterranean ports fish during autumn and spring periods in this Atlantic region. The objective of this study was to analyse the spatial and temporal interaction of marine turtles with the artisanal and surface longline fisheries in the Gulf of Cadiz region. Marine turtles species present in the region are mainly Loggerhead and Leatherback from American, African and Mediterranean populations. Data on marine turtles in this region are scarce and particularly concerning incidental captures in artisanal fisheries. The analysed information was collected in two ways: 1) by scientific observers on fishing vessels and the IEO scientific vessel “Cornide de Saavedra”; 2) bibliographic compilations and interviews to the fishermen during fleet arrivals. The Gulf of Cadiz was divided in 4 Operative Geographical Units (OGUs), considering water depth from 30 m to 200 m: OGU 1 (limits from Cape Trafalgar to Rota), OGU 2 (limits from Rota to Matalascañas), OGU 3 (limits from Matalascañas to Cape of Santa Maria), OGU 4 (limits from Cape of Santa Maria to Cape San Vicente). Chi-squared test show significant differences between the number of individual by each species, OGU and year period. The study was completed with 88 interviews carrying out a single interview per vessel. The objectives of these interviews were to map the main distribution area of the fleet fishing in the Gulf of Cadiz. The results of the analysis indicate a temporal and spatial distribution pattern for the Loggerhead in the Gulf of Cadiz. The surveys done in the landing ports and the onboard data confirm interaction between Loggerhead and drifting longline fisheries during spring period. Nevertheless Leatherback captures are very rare although previous studies confirm the relative abundance and the observation of alive and stranded Leatherback in the Gulf of Cadiz region. Information from the Spanish coast of the Gulf of Cádiz points to the increasing of adults *Dermochelys* in the study area from June to November, with an abundance peak in August. Several fisheries are very important in the area because the large continental shelf extension and 102 Leatherbacks, alive or stranded in different beaches, were registered during 1960 -1996 period. Concerning Leatherback strandings, two different areas could be observed: from the Guadiana river mouth to Mazagon beaches at the western Gulf sector and a second one around Trafalgar Cape at the proximity of the Gibraltar Strait.

NEW RECORD OF THE ENDANGERED KEMP'S RIDLEY TURTLE IN SOUTHWESTERN EUROPE

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The genus *Lepidochelys* is very scarce in the Mediterranean as only two sightings of the Kemp's Ridley turtle (*Lepidochelys kempii*) have been previously recorded, one in Malta in 1983 and one around Santa Pola (Spain) in 2001. However, the species was confirmed using genetic analysis only in the latter record. A *Lepidochelys* turtle (SCL: 23 cm, SCW: 23 cm, 2.3 Kg) was captured on 5 September 2005 in the Cadiz Gulf, west of Gibraltar Straits (Spain). The specimen presented the morphology of the Kemp's Ridley turtle but with 6 costal scutes on each side and 7 vertebral scutes, that is typical of the Olive Ridley turtle (*Lepidochelys olivacea*). To ascertain the species we sequenced a 871 bp fragment of mitochondrial DNA that includes part of the tRNA-Thr, the intervening tRNA-Pro, and the first 806 bp of the 5' end of the mitochondrial control region using the primers LCM-15382 and H8791o. Sequences were compared with published haplotypes of both Ridley species for a 470 bp of the mitochondrial control region. The specimen exhibits haplotype A, corresponding to the Kemp's Ridley species that was found in two individuals from a study comprising stranded animals from Mexico and the Atlantic coast of the United States. However, the exact origin of the animal still remains unknown, as no study has been carried out in nesting or neritic areas. The nearest known nesting area (Florida) is 7,000 km from the Cadiz Gulf and hence this is the minimum distance that the animal should have travelled.

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CLEANING SYMBIOSIS BETWEEN HERBIVOROUS REEF FISHES AND GREEN TURTLES (*CHELONIA MYDAS*) AT PUAKO, HAWAII

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Cleaning Symbiosis between fishes and turtles has been documented in many areas of the world. The increasing population of Hawaiian green turtles (*Chelonia mydas*) has highlighted the occurrence of turtle cleaning stations in waters 10-15 meters in depth at various locations along the west coast of the island of Hawaii. Puako, Hawaii is a designated fisheries management area (FMA), and two turtle cleaning stations have been identified there. Our work centered on one station that has been in existence for at least 15 years, although it has expanded in size over the last three years. This study was conducted from August 2005 to January 2006. The number of green turtles that visited the cleaning station and their behavior were evaluated based on digital video and still shots as well as an in-water Pan Tilt and Zoom (PTZ) wireless remote video camera. A total of 93 hours were spent on scuba at the station, with an additional 23 hours utilizing the PTZ video camera. In order to evaluate the effectiveness of turtle

behaviors in attracting cleaner fish, 35 complete cleaning episodes were video taped. Turtles spent an average of 10 minutes per cleaning episode and would often participate in several successive episodes punctuated by returning to the surface to breathe. The predominant species of fishes involved in cleaning were the yellow tang (*Zebrasoma flavescens*) (present 81% of time) and the golden eye surgeon fish (*Ctenochaetus strigosus*) (present 88% of time). Occasionally, parrot fish (*Scarus dubius*) (present <1% of time), pink tailed triggerfish (*Melichthys vidua*) (present <1% of time), and black triggerfish (*Melichthys niger*) (present <1% of time) were observed cleaning turtles. Turtle behaviors were categorized as swimming, resting, posing and shifting on substrate. Posing was the most effective behavior for attracting cleaners, followed by swimming, resting and shifting on substrate (relative index of effectiveness 1, .37, .04 and <.01 respectively). Posing while on the bottom attracted an average of 10.2 cleaners while posing in the water column attracted an average of 8.1 cleaners. Using head scale patterns for identification, 102 individual turtles were recorded being cleaned at the station. Fifty-nine (58%) of the turtles were present on 5.8% of the scuba dives, 20 were present on 11.6% and 23 were present on at least 17.4% of the scuba dives. Two turtles were present on 37%, and one turtle was present on 42% of the dives. Time allotted to cleaning behavior by turtles at the Puako station varied greatly among individuals with some visiting the station every couple of days and others once every 7 to 10 days. Identification of cleaning station turtles at other sites occurred on two occasions and indicated that the turtles will travel at least 0.5 km between forage grounds and the cleaning station. All data indicates that cleaning symbiosis is an important aspect of green turtle biology at Puako, Hawaii.

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NEST-SITE SELECTION BY LEATHERBACK SEA TURTLES ON PLAYA GRANDE BASED ON BATHYMETRIC DATA OF TAMARINDO BAY

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The conservation of any species requires an understanding of that species life history and behavioral patterns. The conservation of Leatherback sea turtles has been focused mainly on the nesting beach and the location and number of nests deposited during a season. This study investigates how a female chooses a particular nesting beach and specifically a nesting site along that beach which should be of interest to conservation officials. The leatherback nesting population at Playa Grande, Costa Rica, has concentrated nesting activity in the middle 1.9 km of this 3.6 km beach. A possible explanation for this behavior may be the offshore topography of the surrounding Tamarindo Bay. The beach historically has been divided into 100 meter sections numbered 0-36 in order to record female emergence and nest locations. Cumulative data from the past twelve years has shown that 80.0% (n = 10993) of all nesting activity occurs between sections 10–29 and only 20.0% (n = 10933) of nesting occurs between sections 0-9 and 30-36. During the 2004-2005 nesting season the bathymetry of Tamarindo Bay was collected using a Lowrance LMS-480M DF fishfinder with GPS capabilities and mapped using ArcGIS. Resulting bathymetric data showed the existence of a deep water channel running between sections 11–30. The easy and open deep water approach may be a significant characteristic in a female's selection process of a nesting site and further indicates the importance of the conservation of this area along Playa Grande.

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**SATELLITE TRACKING OF CAPTIVE-REARED JUVENILE LOGGERHEAD SEA TURTLES
(*CARETTA CARETTA*) RELEASED IN SOUTHERN NEW ENGLAND**

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Three loggerhead sea turtle hatchlings (*Caretta caretta*) were raised at the New England Aquarium for two years, ten months. The husbandry, veterinary care, and training of these three animals are the subject for other professional submissions. In an effort to determine if these naive healthy turtles could survive in the wild, they were satellite tagged prior to release. Based on information gathered from the release of a rehabilitated loggerhead of the same size class, these animals were equipped with Wildlife Computers, Inc. (Washington, USA) SPOT4 location only satellite tags. The tags were attached to the carapace using fiberglass cloth, five-minute epoxy putty, and two-part five-minute liquid epoxy (Devcon, Inc., Danvers, MA). The tags were duty cycled to broadcast every fourth day and transmitted for 307, 364 and 386 days, providing excellent data on survivorship. They were released off the southern coast of Cape Cod Massachusetts, USA in August of 2004. The tracks of these animals were compared to the track of the rehabilitated, cold-stunned loggerhead released from the same locale in August 2003. Tracks from the two smaller turtles closely resemble the track of the wild turtle with the last transmissions ~ 800 km west of the Azores. The larger turtle followed a more coastal route ending in Pamlico Sound, North Carolina, USA. These tracking data support field observations of geo-spatial information regarding dispersal of juvenile loggerheads as related to size. The data suggests that southern Cape Cod is a viable release point for rehabilitated juvenile loggerhead sea turtles.

**HABITAT DESTRUCTION AND REPRODUCTIVE SUCCESS OF THE HAWKSBILL TURTLE,
ERETMOCHELYS IMBRICATA, IN THE PEARL CAYS, NICARAGUA**

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The nesting population of hawksbill turtles, *Eretmochelys imbricata*, on the Pearl Cays of Nicaragua is probably one of the largest remaining in the central-western Caribbean. Although for decades the main threats to this rookery were the poaching of eggs and nesting females by local inhabitants, six years of conservation efforts have successfully reduced these illegal activities. Nevertheless, this population is currently facing destruction of the nesting habitat derived from the increased presence of humans in the area, both locals and foreigners. Because hawksbill turtles show a marked tendency to nest in the upper beach vegetation, the clearing and burning of plants for the construction of buildings on the upper beach platform and human habitation could potentially influence their reproductive success. To better understand habitat preference of nesting hawksbills in the Pearl Cays, general vegetation types on the beach and upper beach platform were mapped and described. To assess the impact of habitat alteration on reproductive success, we evaluated nest-site selection and hatching success, in relation to ground cover at the nest site.

DIVING BEHAVIOUR OF FREE RANGING JUVENILE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN A PELAGIC HABITAT

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The oceanic realm and its pelagic habitat plays an important role in loggerhead development. We studied the diving behaviour of free ranging pelagic stage loggerhead sea turtles off Madeira Island/Portugal. Turtles were tracked acoustically and using VHF telemetry and behaviour was registered with dataloggers. We describe the time-depth profiles of turtles tracked up to 48 hours in an open ocean environment and explore the various factors that may influence it. Turtle behaviour is also interpreted in relation to the dangers they face in this habitat, mainly in regard to longline fishing activities.

USING OPERANT CONDITIONING TO TRAIN HATCHLING LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN CAPTIVITY

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Rearing hatchling loggerhead sea turtles, *Caretta caretta*, together in one tank may result in intra-specific competition for food, which can negatively affect nutritional intake, cause developmental abnormalities, and/or result in a chronic increase in stress levels for one or all individuals. At the New England Aquarium in Boston, it was theorized that sea turtles could be conditioned to recognize and feed at a designated target, thus reducing food competition. Target training was initiated by introducing unique targets to each isolated turtle while hand feeding. Originally, three, two inch colored letters: an orange “O”, Yellow “I”, and Purple “X” were used as targets, however, the turtles could not correctly identify one target from another. Therefore, a second set of targets were constructed consisting of three, foot long PVC pipes varying in pattern: all white, all black, and black and white striped, from which the hatchlings were able to successfully identify their designated target. Once a hatchling repeatedly identified and fed at its assigned target, different targets were introduced separately, and then together, in order to verify the turtle’s ability to correctly recognize their designated target. The final step of conditioning challenged these turtles to identify and feed at their specific targets in the presence of other hatchlings and targets. As theorized, over three months the hatchlings learned to recognize their individual targets and feed with little or no competition. Finally, ten months prior to the loggerhead’s release off the southern coast of Cape Cod Massachusetts, US, a regime for de-conditioning was implemented. Target feeding was replaced by adding live food and scatter-feeding prepared food, and targets were introduced at non-feeding times. Within two months, the turtles ignored targets and other similarly patterned objects, while hunting and foraging for live and prepared food. At the time of release, satellite tags were attached to each individual to track their survival. All three were successfully tracked until their satellite tag batteries failed between eleven and thirteen months after release. These results suggest that hatchling sea turtles can be conditioned and de-conditioned for specific husbandry activities in public aquaria.

GREEN TURTLE AND HAWKSBILL GENETIC ANALYSIS IN THREE FEEDING GROUNDS IN THE UK OVERSEAS TERRITORIES IN THE CARIBBEAN: PRELIMINARY RESULTS AND CONSERVATION IMPLICATIONS

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⁸ Marine Conservation Society, UK

⁹ Anegada Community, BVI

Molecular techniques have proved effective in gaining insights in population structure, distribution patterns and behaviours difficult to observe in marine turtles. The mitochondrial DNA (mtDNA) control region is a genetic marker providing the appropriate resolution for phylogeographic studies based on matrilineal inheritance. In addition, mtDNA haplotype frequency distributions can be used to link turtles in genetically-mixed foraging aggregations to their nesting beach origins, complementing telemetry or tagging studies. During an extensive conservation and research project on the sea turtles in the UK Overseas Territories in the Caribbean, we collected and analysed 389 genetic samples from green turtles (*Chelonia mydas*, n=150) and hawksbills (*Eretmochelys imbricata*, n=239), primarily at feeding grounds (and some nesting beaches, n=14) in Anguilla, the British Virgin Islands, Turks & Caicos, and Montserrat. We extracted, amplified and sequenced a 850 bp fragment of the mtDNA control region, then aligned our haplotypes against known sequences. Data will be published in more detail elsewhere but in summary: We found 13 haplotypes among the green turtle samples, and 17 among the hawksbills, 6 of which were previously undescribed (3 in each species). We used these data and published baseline rookery compositions, to assess the populations of origin of the feeding aggregates using the software BAYES. We confirm that juveniles of both species recruit to foraging grounds from multiple nesting sites in a range of jurisdictions and highlight the need for conservation efforts to be guided by a better understanding of population distribution, and the effects of threats on nesting beaches, foraging grounds, and migratory corridors.

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SATELLITE-TRACKING OF GREEN TURTLES (*CHELONIA MYDAS*) IN RAJA AMPAT, PAPUA, INDONESIA

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Between 6-9 October 2005, five Telonics ST-20 A 1010 satellite transmitters were attached to female green turtles on Pulau Piai, N-W Raja Ampat, Indonesia (N 0°20'28"; E 129°52'05"). Piai and Sayang Islands, major nesting areas for this species, are under significant threats from poachers and blast-fishers. This study provides the first account of a major nesting ground for *C. mydas* in North-Eastern Indonesia and presents a series of site-specific priority conservation measures which are to be implemented. Data on turtle abundance in the waters surrounding Piai and Sayang as well as interviews with locals suggest that annual nesting activity starts declining in late August. There remains, however, an important knowledge gap on annual nesting activity. Piai's turtle's first location "fixes" were received on Oct. 11th and to date all platforms are transmitting. Argos location data is processed via STAT into daily updated maps (www.seaturtle.org). Data on foraging areas and migratory pathways will help create a wide-ranging ecosystem model for the Bird's Head seascape. This model, encompassing biotic, physical and human factors will in turn be the cornerstone to develop a comprehensive ecosystem-based management plan (EBM) for the coastal and marine resources of the Raja Ampat regency. The EBM program is a joint initiative of Conservation International, WWF-Indonesia and The Nature Conservancy.

SEA TURTLES IN THE FLOW: COUPLING SATELLITE-TRACKING AND REMOTE-SENSING OCEANOGRAPHIC DATA TO ANALYZE NAVIGATION BEHAVIOUR

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During their migrations, sea turtles encounter oceanic currents that may affect their movements by (1) playing a mechanical role, moving them away from their "intended" course, and (2) acting as an information source, bringing chemical cues downcurrent from the goal. To test these hypotheses, we developed methodological tools to couple satellite-tracking data with remote-sensing oceanographic data in a quantitative way. Our approach consists in computing three vectors for each turtle location (derived from satellite-tracking data): (1) a track vector, corresponding to the ground-related movement between two successive locations, (2) a current vectors, estimated from the sum of the geostrophic and Ekman components of surface current fields (derived from satellite remote-sensing oceanographic data) and (3) a heading vector, computed as the difference between the track and current vectors, and corresponding to the turtle's water-related movement. This allows us to distinguish how a turtle actually swam (water-related path) from how it moved (ground-related path). Such a distinction is essential when studying sea turtle navigation behaviour. It requires testing whether or not turtles do compensate for an

unwanted current drift by adopting a biased heading so that the resultant movement points to their goal. If a turtle compensates for the current drift, its heading vectors should be on average better oriented towards the goal than its tracks vectors. We also introduced a unique representation of water-related and track paths with respect to a goal direction that can fully illustrate the tendency of a turtle to head towards its goal or to compensate for the current drift when moving back to it. We exemplify this approach with the homing journeys of 10 female green turtles captured on their nesting sites on Europa and Mayotte (two islands located the Mozambique Channel), and released in the open sea at 98-245 km. As they provide a well-defined goal, such homing experiments are most suitable to test the drift compensation and the use of some water-borne navigational information. All turtles returned to their nesting islands, but apparently displayed poor navigational abilities. Path analysis showed that none of them compensated for the current drift. Rather, they appeared to head more or less accurately towards their nesting site, but the currents made them take less efficient paths. This result highlights the necessity to compute the water-related paths before drawing any conclusion on sea turtle navigation behaviour. In addition, we developed a method to estimate the origin of the water masses encountered by turtles, and applied it to the homing journeys of three individuals displaced from Europa. Statistical analyses of their heading vectors with respect to water masses origins suggested that at large distances, homing turtles do not rely on any chemical information possibly contained in water previously in contact with their goal to orientate towards it.

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Order: 73 **Abstract ID:** 1586 **Type:** Oral **Subject:** Behavior and Movements

AN APPROACH FOR MAXIMIZING LIMITED SATELLITE DATA FOR A SEA TURTLE HOME RANGE: CREATING A COMPOSITE SEA TURTLE

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While satellite telemetry is the tool of choice for sea turtle ocean basin movements, the current technology does not usually provide enough accurate locations on individual sea turtles to confidently estimate home range size (based on minimum sample sizes for other species). The minimum sample size needed to estimate the size of a sea turtle's home range (model dependent) is actually unknown. Furthermore, data selection criteria and home range models for sea turtles have varied in the past, inhibiting comparative studies across projects and publications. This abstract presents a new standardized methodology to maximize limited, yet costly, satellite data by constructing a composite home range. Data selection criteria, choice of a home range model, and minimum sample size are also presented to facilitate future studies. Data were imported into ArcView 3.2a for home range analyses using the Animal Movement extension for ArcView 3x because to date there are no home range analysis extensions or scripts for ArcGIS. The Bearing and Distance, Coordinates Tool Box, and Mean of Points extensions were also used. A composite home range was constructed by combining 13 individual, site-specific, postnesting loggerhead home ranges into one composite home range (n = 859 locations) because of inadequate sample sizes for individual home ranges. This composite also reduced bias associated with the variation in geographic distribution, habitat quality, sample size, and sea turtle behavior. Individual sea turtles were used only if they passed a site fidelity test ($p > 0.85$). To be eligible for the site fidelity test, a sea turtle must be present in the home range for 31 days, and have

at least five location data with a location class of 3, 2 or 1. After an intensive review of home range models, the nonparametric fixed kernel density estimator (FKD) was used because a) it is highly flexible, fitting nonconvex, multimodal irregularly shaped distributions, b) it has been found to be more accurate than other models, and c) it is less affected by sample independence and/or outlying observations. Difficulty with the FKD arises when choosing a smoothing parameter (h) which controls the area from which the FKD is derived. From a biological point of view, the best h is selected by biological or technical criteria independent of the location data. Our h was the mean two-standard deviation for the location accuracies of the data ($n = 859$), which is independent of the data's spatial and temporal parameters. The estimated size of our composite home range using our calculated h (1.33 km) was 744.81 km². Comparisons to this estimate should be made with caution, and only when using the FKD with the same or a similar smoothing parameter. Our h may be used as the standard (using the FKD) for postnesting loggerheads from the northern subpopulation. Minimum sample size to estimate FKD home range size was 350. A discussion of the minimum convex polygon model is also included to highlight its limitations, especially its tendency to overestimate home range size, and its sensitivity to outliers and sample size.

Order: 74 **Abstract ID:** 1715 **Type:** Poster **Subject:** Behavior and Movements

A SATELLITE TRACKING PROJECT IN THE WINDWARD ISLANDS OF THE NETHERLANDS ANTILLES

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Satellite telemetry has become a common tool for sea turtle biologists to discover migration pathways between nesting beaches and foraging grounds. It facilitates a greater understanding of a turtle's geographical range and habitat utilisation, while at the same time providing an indication of potential threats that may be faced while travelling between reproductive and feeding areas. This additional knowledge allows researchers to improve protection and provide more focused conservation efforts in critical habitats. Tracking projects can also be used to great advantage in community awareness programmes; highlighting turtles' migratory behaviour to engage the public in conservation issues. With these two primary objectives, the Dutch Caribbean Nature Alliance (DCNA) initiated a satellite tracking project on the Windward Islands of St Eustatius and St Maarten. The DCNA is a newly created foundation that brings together the nature conservation management organisations of the Netherlands Antilles and Aruba. Their main goal is to preserve biodiversity by ensuring adequate protection and effective management of natural resources through the establishment of sustainable funding sources. This was an inter-island collaborative project of St Eustatius National Parks (STENAPA) and the Nature Foundation St Maarten, and was the first satellite tracking study to be undertaken in the Windward Islands. Transmitters were deployed on two adult female turtles; a green from St Eustatius and a hawksbill from St Maarten. The hawksbill showed typical migratory behaviour; after completing her nesting season she travelled over 300km to a feeding area close to Flanagan Island (British Virgin Islands), located 175km straight-line distance from St Maarten. During her migration she was recorded swimming more than 60km per day and appeared to adjust her course on several occasions. The green turtle from St Eustatius exhibited behaviour that was a little more unusual. She nested for a final time and then was expected to begin her migration; however, all the subsequent location data received showed her remaining within one or two kilometres of the release site at the nesting beach. This suggests that she may be resident in the waters of St Eustatius year round, and not migrating to another foraging ground; if so, this might be the first time such behaviour has been recorded for a breeding green turtle female. It is possible that she is an exception to the general rule that turtles do not feed and nest in the same area, or it may be that other turtles in the St Eustatius population also show this behaviour. Further tracking studies planned for 2006 will determine which of these two scenarios is

occurring. Additional to the biological research, this project also incorporated an extensive education and outreach campaign, focusing on the local schools. Competitions were organised on both islands; winners of an art and essay contest were allowed to choose names for the turtles being tracked. Students were then asked to guess where they thought the turtles would migrate to and how far they would travel. Public interest for the project was maintained through lectures, exhibitions, and the media.

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Order: 75 **Abstract ID:** 1424 **Type:** Poster **Subject:** Behavior and Movements

CONTRASTING DEPTH UTILIZATION BY ADULT FEMALE LOGGERHEAD TURTLES AROUND JAPAN DURING FORAGING PERIODS

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There is an intrapopulational polymorphism in feeding habitat use by adult female loggerhead turtles around Japan. Small females tend to inhabit oceanic areas and are considered to feed mainly on planktonic animals, while large females tend to inhabit neritic areas and are considered to feed mainly on benthic animals. In this study, satellite telemetry was used to reveal the foraging and diving behaviours in their respective habitats. Satellite transmitters that can record dive data were attached to two nesting females (whose straight carapace lengths were 795 and 900 mm) at Yakushima Island, Japan, in late July 2005. During the post-nesting season, the small female migrated along the Kuroshio Current to oceanic areas in the western North Pacific, while the large female migrated to neritic areas in the East China Sea. The small female spent most of the time between 0 and 25 m depths throughout the day and night, implying that she foraged on floating and planktonic animals at shallow depths. The large female frequently dived to 100 to 150 m during the day, and spent most of the time between 0 and 25 m at night, suggesting that she alternated between diurnal foraging on benthic animals and nocturnal resting within the depths where she could keep neutral buoyancy. These diving behaviours were consistent with their estimated feeding habits.

Order: 76 **Abstract ID:** 1542 **Type:** Poster **Subject:** Behavior and Movements

AVOIDING THE HARSH WINTER: LOGGERHEAD SURVIVAL SKILLS

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Loggerhead sea turtles (*Caretta caretta*) from the Eastern United States migrate the length of the coast to forage after breeding. Using satellite tracking technology and the Satellite Tracking and Analysis Tool at seaturtle.org (STAT, Coyne and Godley 2005) we followed the movements of 12 loggerhead turtles from North Carolina, USA

between 2003 and 2005 and integrated their movements with oceanographic data. Turtles foraged as far north as New Jersey, heading south to over-winter in lower latitudes. During the winter, when surface temperatures fell as low as 10.4°C at northern forage grounds, turtles moved south in advance of temperatures likely to induce torpor. The turtles remained approximately 100km offshore of Cape Fear, North Carolina for the winter at the edge of the Gulf Stream. Turtles maintained a balance between the thermal and surface current gradients, getting close to the warm waters of the Gulf Stream without being swept up by strong currents. Data suggest loggerhead turtles in North Carolina are able to sense environmental change and make appropriate decisions to initiate movement to balance productive northerly feeding with tolerable ocean temperatures and currents. Individuals may utilise photoperiodic as well as thermal cues to judge timing of initiation of migration.

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Order: 77 **Abstract ID:** 1803 **Type:** Poster **Subject:** Behavior and Movements

RELATIONSHIP BETWEEN DURATION OF CAPTIVITY AND SWIM FRENZY IN OLIVE RIDLEY HATCHLINGS

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In the recent years the sea turtles have become important part of the development of the Mexican coastal communities through protection programs by locals. Besides protection they also participate in environmental education activities with visitors or students for which captive turtles can be extremely valuable. Sometimes, in spite of their enthusiasm mistaken methods are used, e.g. maintaining olive ridley hatchlings in captivity. The Mexican Turtle Center has been offering training to stop these problems and this study is the first step in research in this subject. The aim of the present study is to determine the relationship between the time in captivity (days) and the “swim frenzy”, with the objective of determining which is the maximum time that captivity can be maintained without affecting recruitment of hatchlings into the marine habitat. We collected 330 olive ridley hatchlings (*Lepidochelys olivacea*) at La Escobilla beach, transferred them to the Mexican Turtle Center where they were kept in 1.4x40x40 m fiberglass tanks with 10 hatchlings per tank. We are releasing each tank each day during 30 days and measuring the time they take to reach a 5 m mark on the beach. Our hypothesis is that the time in captivity is directly proportional to the time they require to reach the 5 m on the beach at release. At this moment we are finishing the experimental work, on April, at the time of the XXVI Sea Turtle Symposium in Greece we are going to present the final results of this project.

THE DIVING BEHAVIOUR OF HIBERNATING LOGGERHEAD TURTLES IN TEMPERATE MEDITERRANEAN WATERS

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Loggerhead and green sea turtles have been reported to hibernate on the bottom of the sea when water temperatures decrease below 15°C. However, because of the long apnoeic periods and the often unknown location of the hibernacula it is difficult to investigate the diving behaviour of hibernating sea turtles. We equipped five loggerhead turtles with satellite transmitters and released them from Italian shores (three in the Gulf of Naples, Tyrrhenian Sea, and two near Porto Garibaldi, Adriatic Sea) to monitor their behaviour throughout the winter. Both “Adriatic” turtles and one of the “Naples” turtles spent the winter in coastal waters off Peloponnese (Greece), while two turtles remained in the Gulf of Naples area. Minimum water temperatures were 14.4°C (Peloponnese) and 13.5°C (Naples). Dive data, also relayed via satellite, revealed a marked change in diving behaviour with the onset of the cold winter period. Dive durations increased with decreasing water temperatures and maximum recorded dive durations ranged between 3 and 7 hours. At no time during the winter did turtles cease to surface. However, surface times remained short (1-2 min), indicating that no excessive lactate was accumulated which would have required prolonged time for post-dive clearance. Our results are in contrast to earlier reports where turtles apparently spent months on the bottom of the sea floor without re-emerging. We conclude that resting turtles have sufficiently reduced metabolic costs at low temperatures, and that short surfacing episodes supply enough oxygen to last for several hours, without the necessity to become anaerobic.

HYDRODYNAMIC DRAG CHARACTERISTICS OF THE LEATHERBACK SEA TURTLE

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A computer program originally developed for ship flow field research was used to investigate the hydrodynamic characteristics of an adult leatherback turtle. CFD-SHIP-IOWA solves the incompressible Reynolds-averaged Navier-Stokes (RANS) and continuity equations with a variety of turbulence models (Wilson *et al.*, 2002). This physics-based flow solver predicts the flow field and forces acting on a surface ship or underwater vehicle in the presence of the free surface. Hydrodynamic drag is normally predicted to within 10% or less for typical ship geometries (Wilson *et al.*, 2000). CFD-SHIP-IOWA can be applied to a leatherback assuming a rigid exterior surface that does not deform under hydrodynamic load. Our simulations are based on a cast model of an adult female with a carapace length of 145 cm, width of 96 cm, and depth of 60 cm. The modeled geometry includes the head, body, and rear flippers but no front flippers. We used a blended k- ω /k- ϵ turbulence model (Menter, 1994) and a multi-block structured grid with about three million grid points. Steady flow solutions required 24 hours of execution time on SGI 3900 computers using 32 processors. All simulations were performed at zero angle of attack, reflecting a turtle swimming in

a straight line, and deep submergence to eliminate interaction with the surface. Simulations were performed for several speeds about an assumed mean of 0.66 m/s, measured for post-nesting leatherbacks (Eckert, 2002). For these flow conditions, the drag predicted by CFDSHIP-IOWA is expressed in nondimensional form as: $C_d = 0.1711/Re^{0.12}$ for $10^6 < Re < 10^7$ where, C_d = drag coefficient = $Drag/\{qL^2\}$ q = dynamic pressure = $1/2\rho V^2$ ρ = sea water density V = swim speed L = straight carapace length Re = Reynolds number = VL/ν ν = sea water kinematic viscosity Future research will include the addition of front flippers, investigation of modified body shape caused by feeding and hydrostatic pressure, effect of attached instrumentation (data logger, satellite tag), and inclusion of more realistic flow conditions such as non-zero angle of attack, expanded range of Reynolds numbers, free surface effects, and the presence of orbital velocities induced by a seaway.

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SATELLITE TRACKING OF PRE-NESTING MIGRATION IN LOGGERHEAD TURTLES, CARETTA CARETTA

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We attached PTTs on eleven female loggerhead turtles, which were accidentally caught by coastal pound nets in Shikoku, Japan. Two turtles (A and B) were subsequently located on the beaches of Shikoku island and Kii Peninsula, respectively, with high level of transmitter signals from the turtles, indicating their landing on those beaches to nest. Turtle A (SCL: 761 mm, Weight: 68 kg) caught in Tosashimizu, Shikoku, was released with a PTT on 20th May, 2003. On 24th July and 9th August, the turtle was predicted to nest on the Tainohama beach, Shikoku. Turtle B (SCL: 844mm, Weight: 95kg) was caught in Muroto Cape. Her flipper tag indicated that she landed to nest on the Hiwasa beach two years before. After she was release from Muroto on 22nd April, 2003, she produced high quality transmitter signals on 27th June and 8th July, from Hironohama beach, Kii Peninsula, which was different from her previous nesting beach. These high quality location classes identifying the turtle to be exactly on sandy beaches during night time indicated her nesting on the beach. A characteristic behavior of these pre-nesting females was to migrate around the Ashizuri Cape, Shikoku before nesting. It was most probably for copulation there. After staying in that area, the two females arrived at the coastal waters of their nesting sites 14 and 11 days before their nesting.

RELATION OF LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) MIGRATORY PATTERNS TO OCEANOGRAPHIC PROCESSES IN EASTERN MEDITERRANEAN BASIN

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The Mediterranean basin supports one of the largest populations of the endangered loggerhead sea turtle (*Caretta caretta*, Linnaeus 1758). Available data on the movements of loggerheads in the Mediterranean basin are rather scarce and based upon analyses of tag returns and by-catch, while satellite tracking has only been applied on a few individuals. In this study, we test the hypothesis of sea turtle's non-random dispersal by investigating the movements of loggerhead sea turtles in relation to oceanographic processes in the Eastern Mediterranean Basin. For this purpose we mapped movement paths of six turtles equipped with satellite transmitters and we identified certain oceanographic features (gyres and eddies) using satellite images of sea surface temperature (SST) derived from Advanced Very High Resolution Radiometer (AVHRR) and sea level anomaly (SLA) derived from TOPEX/Poseidon. Two of the turtle paths used in this study were made available by ARCHELON and were collected within the context of a LIFE Nature project. Four turtle paths previously presented by Bentivegna (2002) were also used. Data processing, analysis and mapping routines were developed using the ARC/INFO GIS. Oceanographic features such as eddies and gyres were identified through combined analysis of SLA and SST satellite images. Circular water movements can be described as temperature differences between a region and its surrounding areas and closed circular structures in SST and SLA images respectively. The turtle paths were superimposed on the derived maps. Results constitute of integrated turtle movement path and cyclonic feature maps and show that the movements of four out of six turtles were associated with the presence of gyres in Eastern Mediterranean Basin. The migratory route of the first turtle passed near the Cretan cyclone, while the movement of the second one was associated with the Ionian anticyclone, the Ierapetra anticyclone and the Cretan anticyclone. The Africa orientated route of the third turtle was related to the Cretan cyclone. The last turtle moved inside the Cretan cyclone and thereafter swam between the Levantine Sea eddies. In all cases, turtles are observed either to follow the surface current patterns associated to the cyclonic and anticyclonic water movements or to move inside productive cyclonic gyres. A possible explanation might be that turtles use the cyclonic and/or anticyclonic circulation during their long distance movements in order to save energy and visit high productivity areas (feeding grounds) in the oligotrophic environment of the Eastern Mediterranean Basin. This study shows the value of combining satellite remote sensed with tracking data to further understand the movement patterns of turtles. It is important to figure out how turtles move through the Eastern Mediterranean Basin and what are the spatial relationships between their reproductive, feeding and wintering grounds. This knowledge, combined with the identification of ocean processes that affect the turtle routes followed, is considered essential for planning effective conservation strategies.

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THE INFLUENCE OF OCEANOGRAPHIC CONDITIONS ON THE MIGRATORY BEHAVIOUR OF SOUTH AFRICAN LEATHERBACKS

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Between 1996 and 2003 we tracked by satellite the post-nesting movements of 9 leatherback turtles (*Dermochelys coriacea*) breeding in KwaZulu-Natal (north-eastern coast of South Africa) which ranged widely in South-West Indian Ocean. This is a particularly dynamic region being dominated by the Agulhas Current system, an intense western boundary current, with a variety of associated circulation features. It therefore represents a very suitable area to investigate whether and how environmental conditions affect the leatherback migratory behaviour. Since leatherback routes vary between different years, such a lengthy study period allowed us to examine how the observed course variability is linked to the occurrence of changing mesoscale phenomena. Tracking data have been analysed with respect to information derived from satellite remote sensing by superimposing the tracks on false-colour images of sea surface temperatures, height anomalies and chlorophyll-a densities as experienced by the turtles during their oceanic movements. Moreover, comparisons have been made between the turtle routes and the tracks of surface Lagrangian drifters ranging contemporaneously in the same region. Tracked turtles wandered over a large oceanic area and reached widely dispersed destinations moving along complex routes including straight segments covered quickly and prolonged, convoluted legs. Most of the tracks presented a southwest-ward movement within the Agulhas Current mainstream parallel to the African coast, although four turtles remained for some weeks at low latitudes. Two turtles made extensive looping movements off the eastern South African shelf, while the other three reached the southernmost tip of the continent, then entering the Atlantic Ocean, or moving eastward along the Agulhas Return Current. The shape of most legs of turtle routes turned out to be nearly entirely determined by the oceanographic circulation features occurring in the areas crossed, which determined such variable paths as circuitous loops or linear segments. Turtles were often associated with eddies and convergence zones, which constituted profitable foraging areas and accounted for the observed variations in routes. Furthermore, the turtle routes closely resembled those of inanimate surface drifters tracked in the same regions, which basically showed the same movement patterns. We hypothesize that the current features encountered just in front of the nesting beach exerted a strong influence on the subsequent migratory pattern followed by the turtles. Moreover, our findings suggest that tracked leatherbacks were drifting with surface currents for long periods, with most of their activity focusing on foraging movements within the water column. It is unclear whether leatherbacks have developed specific abilities to use currents to approach suitable foraging areas, being able to continuously assess their own position with respect to them, or whether they are simply captured and drifted passively by currents. The present findings highlight the importance of carefully considering the oceanographic conditions when interpreting leatherback oceanic migrations tracked by satellite.

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CAN HATCHLINGS EXPOSED TO BEACH LIGHTING RECOVER, AND ORIENT NORMALLY OFFSHORE?

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Artificial lighting often causes hatchlings to crawl landward. In this study, we determine whether hatchlings crawling landward are competent to crawl and swim offshore. Tethered hatchlings were exposed in a beach arena to a landward or seaward light for 2 min. They were then tracked for 15 min in the ocean when waves were present or absent. In waves, all of the turtles oriented offshore though landward-crawling hatchlings showed more scatter. When waves were absent, only the seaward crawling turtles could orient offshore. In a second experiment, one group of hatchlings was exposed to a landward light for 2 h (simulating a longer exposure to artificial lighting) while a second group crawled toward the same light for 2 min. Both groups were then released on a dark beach to crawl and swim offshore when waves were present. The 2 min and a control group (that crawled only on the beach) located the ocean normally and swam offshore. The 2 h group showed less accurate crawling orientation on land, and took significantly longer to locate the ocean. However, once swimming their orientation did not differ from the other groups. These results confirm laboratory studies indicating that a beach crawl influences how hatchlings orient in the ocean, and demonstrates that exposure to artificial lighting can affect later orientation both on land and in the sea. Results also show that the orientation “system” recovers from previous “misinformation”, provided that appropriate cues (visual on land; non-visual in the sea) are present.

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FORAGING STRATEGIES OF THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) ALONG THE NORTHWEST COAST OF AFRICA

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Leatherbacks sea turtles (*Dermochelys coriacea*) are well known to feed on different species of gelatinous plankton both at great depth and within surface waters. However, little is known about specific prey species and how dive behavior may be related to those species. In this study we link leatherback diet, based on stomach content analysis of stranded leatherbacks to dive behavior and movements gathered using satellite telemetry along the NW coast of Africa.

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INVESTIGATING SEA TURTLE NAVIGATIONAL ABILITIES THROUGH SATELLITE TELEMTRY

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It is a widely accepted notion that sea turtles rely upon efficient systems of orientation and navigation, that are necessary to accomplish their long-range oceanic movements heading towards specific, remote targets^{1,2}. Thanks to various international collaborations, our research group has repeatedly investigated the navigational abilities of marine turtles by performing field experiments with satellite-tracked turtles subjected to various experimental treatments. Displacement experiments with nesting females translocated away from their nesting area, proved to be the most fruitful approach to tackle the problem, although research on naturally-migrating turtles has also provided useful information³. Displacement experiments on green turtles nesting at Ascension Island in the Atlantic Ocean have allowed us to document in detail the actual homing abilities of turtles released in the open sea⁴, and to highlight a previously unsuspected navigational role of wind-borne cues⁵. More recently, similar experiments have been performed with turtles nesting at Europa and Mayotte islands in the Mozambique Channel. Displaced turtles have resulted to be able to return to the home island, but only with rather indirect routes and without compensating for sea current drift, as estimated from remote-sensing oceanographic information⁶. Preliminary experiments with magnetically-disturbed displaced turtles have provided indications on the involvement of geomagnetic information in the homing processes, as previously suggested by arena tests on juvenile turtles exposed to magnetic field values simulating translocations away from their feeding grounds². Both arena and field experiments therefore provide indications that geomagnetic cues play a role in sea turtle long-distance navigation.

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CHELONIA IN AND OUT OF THE JACUZZI: DIEL MOVEMENTS OF EAST PACIFIC GREEN TURTLES IN SAN DIEGO BAY, USA

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East Pacific green turtles (a.k.a. black turtles, *Chelonia mydas*) are a subpopulation of the pan-tropical green turtle, ranging from the United States to Chile. San Diego Bay (SDB) USA is the northern-most major foraging area, and hosts a resident population of green turtles that congregate near the artificially heated effluent channel of a local power plant. Whereas sonic tracking, capture data, and visual observations indicate that turtles are moving between the warmer water of the effluent and the cooler water further from the power plant, diel movement patterns have yet to be investigated. In this study we deployed Time-Depth Recorders (TDR's) on green turtles to determine diel movements in this unique group. All turtles were captured using entanglement nets deployed near the heated effluent of the power plant. TDR's were deployed on five turtles from January 2004 to May 2005, logging time of day, depth, light levels, and temperature. TDR's were seated in tubular-shaped, slightly buoyant, syntactic foam drogues. The drogues were attached to the turtle's carapace and had an automatic release mechanism. Drogues were fitted with radio and sonic transmitters to enable recovery. Sea surface temperatures (SST) were recorded at 14 sites throughout the bay. Circular statistics and nonlinear regression analyses were used. A best fit SIN function ($yTemp=c+\alpha*\text{SIN}[xTime+\beta]$) described mean hourly temperature and time of day (transformed to radians) for each deployment. T-tests were used to test amplitude significance ($\alpha = 0.05$). SST varied substantially throughout the bay; ranging from 19.7 – 31.6°C at the power plant effluent to 14.4 - 33.9°C at the other sites. SCL ranged from 62.8 - 94.1 cm ($\mu=84.4 \pm 12.8\text{cm}$, $n=5$). Deployment durations ranged from 2 – 17 d ($\mu =9.0 \pm 5.4$ d, $n=5$). Scatter plots of hour vs mean temp for each turtle illustrated similar movement patterns. Temperature patterns fit a 24-h unimodal SIN function ($r^2 = 0.59 - 0.96$). Mean temperature variations recorded by TDR's ranged from 4.0–13.3°C and all showed significant amplitude ($p<0.001$). Based on temperature measurements throughout the SDB, we were able to use temperature as a relative location indicator. Our graphical illustrations and high regression (r^2) values show a pattern of movement generally characterized by late evening and early mornings spent in the cooler water away from the power plant and late morning and afternoon hours spent near the warm effluent near the power plant. Our results are based on hourly means over the course of multiple days and we found variation among individuals. The turtles from November and January had less pronounced temperature amplitude and peak temperatures occurred between 19:00-20:00h. Turtles from March, April, and May had greater amplitude and an earlier peak temperature period, occurring between 13:30-15:30h. Although the sample size was small in this study, the cyclical behavior of turtles was apparent. Turtles in San Diego Bay exhibit diel movement patterns between warmer water of the effluent and the cooler waters further away from the power plant; furthermore, temperature loggers can be utilized in predicting the movements and behavior of sea turtles.

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A POSSIBLE EFFECT OF LOW FREQUENCY NOISE ON THE ORIENTATION OF LOGGERHEAD HATCHLINGS

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In contrast to the impact of artificial light on the orientation of sea turtle hatchlings, the effect of noise has not yet been studied extensively. It is possible that sea turtles are capable of perceiving the low-frequency sound spectrum of the natal beach, which may even serve as one of the cues in nesting returns. If acoustic orientation is proven it may not be excluded that artificial low frequency noise at high intensities can interact with hatchling seaward orientation. Research was done at a Loggerhead nesting beach in Belek, Turkey, which is strongly affected by mass tourism. The aim of this study was to investigate the response of hatchlings not only to visual, but also auditory cues and vibrations. Hatchlings were taken out of their nests shortly before emergence and kept in the dark until night. Then they were put in a wooden sandbox (80x80x5 cm) set up 26 m away from the surf, which emitted a noise pressure level of up to 35 dB(A) (measurements taken at the surf) and 50 m next to a discotheque, which emitted up to 63 dB(A) (measurements taken at the sandbox). Of four experimental set-ups lights were excluded in Exp.1 and Exp.2 by covering the sandbox. Substrate vibrations were excluded in Exp.2 and Exp.4 by shielding the sandbox. Strong airborne sounds from the discotheque were present constantly. The hatchlings were put in the centre of the sandbox facing inwards. Nearly all hatchlings (100% in Exp.1 and 3, 84,2% in Exp.2 and 94,8% in Exp.4) left the centre of the sandbox and started crawling. Results showed that in the absence of visual cues 60% of the hatchlings oriented seawards (Exp.1). After shielding the sandbox against substrate vibrations there was decreased orientation (42,1%) seawards (Exp.2). When uncovering the sandbox 64,7% of the hatchlings oriented seawards (Exp.3). After shielding against substrate vibrations just 25% oriented seawards (Exp.4). No exclusive orientation towards strong artificial lights was observed in Exp.3, but in Exp.4 excluding substrate vibrations. Frequency analysis revealed a similarity between the spectra of discotheque noise and the low frequency component of natural wave sound at < 1000 Hz. Both spectra are in the audible range of sea turtles. Based on the results it is suggested that in addition to visual cues hatchlings may use auditory cues, presumably substrate vibrations, for seaward orientation. Though results of these explorative field experiments need to be verified with bigger sample sizes, it is strongly recommended that besides artificial lights all human noise sources should be reduced to a minimum at nesting beaches. This could be essential to avoid interactions with natural acoustic cues particularly in times of reduced seaborne vibrations/calm waves. Further research is planned to investigate the effect of low frequency noise on the orientation of hatchlings.

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HAWKSBILL TURTLES IN BRAZIL: PROJETO TAMAR-IBAMA, PRELIMINARY GENETIC AND TELEMETRY STUDIES

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The hawksbill sea turtle (*Eretmochelys imbricata*) is seen on both foraging and nesting areas along the Brazilian coast. Projeto TAMAR-IBAMA, the Brazilian sea turtle conservation program, has been working on nesting beaches since 1982, and on foraging grounds since 1992. To better understand the biology of hawksbills in Brazil, TAMAR has been developing both genetic and telemetry studies. These preliminary results are reported herein. The Mitochondrial DNA control region of foraging (n=93) and nesting (n=140) hawksbills, was sequenced producing ca.750pb. 17 distinct haplotypes were defined by 157 polymorphic sites. The nesting populations presented low genetic diversity indexes ($h = 0.52 + 0.06$ and $\pi = 0.009 + 0.005$) with only 7 haplotypes. The juvenile foraging population in Fernando de Noronha Archipelago and Rocas Atoll presented 14 haplotypes, showing greater genetic diversity indexes ($h = 0.68 + 0.02$ and $\pi = 0.056 + 0.03$) including haplotypes that suggest connections with the Caribbean and west Africa. The Satellite Telemetry studies started in February 2005, tracking 15 hawksbills. The Program STAT (Satellite Tracking and Analysis Tool) has been used to monitor the turtles, and daily data sent by the Argos system is analyzed. Maps to visualize the turtle's movements are produced after the received data has been filtered in order to provide accurate information. Geographic references such as bathymetry are added to the individual maps to better understand each turtle's migratory behaviour. The hawksbills monitored have remained along the coast, distributing themselves throughout the north-eastern and northern Brazilian coast.

HIGH-USE PELAGIC ZONES: THE OVERLAP OF LOGGERHEAD (*CARETTA CARETTA*) FORAGING AREAS AND LONGLINE FISHERIES BYCATCH IN THE NORTH ATLANTIC OCEAN

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To obtain an accurate picture of watermass characteristics where turtles were found, we used data on turtle locations from pelagic fisheries' bycatch and from satellite-tracked turtles. Bycatch data is biased by the behavior of fishermen, so limited conclusions about turtle habitat can be drawn from analyzing those data alone. The fisheries data analyzed include both commercial data from US longline vessels (1998-2003) and data from scientific longline cruises conducted during summers of 2001 and 2002 in an area of the central North Atlantic that is rarely fished. Satellite tracks were from 10 turtles tagged in the Azores and West Africa in 1998 and 1999. To determine ocean conditions both at catch locations and along satellite tracks, we analyzed geostrophic currents, sea surface temperature (AVHRR), and chlorophyll a (SeaWifs). We then compared the habitat preferences from the tagged turtles with the characteristics of bycatch locations. We used a Kalman filter to obtain the likely track from the raw tracking data, and GAMs and GLMs to elucidate the characteristics of both high-catch and high-use areas.

The analyses indicated that both satellite tracked and incidentally caught turtles were located near oceanographic features such as fronts, possibly due to the high concentrations of prey items at those features. The data also show that turtles are not entrained in currents, but exhibit directed movement in some cases counter to the prevailing geostrophic current patterns. This work showed that satellite tracking and fisheries data can be successfully integrated to identify important pelagic habitats for marine turtles.

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PATTERN AND VARIATION IN THE USE OF NERITIC HABITATS BY JUVENILE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)

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Identification of critical habitat is necessary for most conservation efforts, but this information is lacking for many threatened and endangered marine species. In the estuarine and coastal waters of North Carolina, sea turtles are captured in a number of economically important fisheries. Management of these interactions is hindered by a paucity of data on the habitat use of sea turtles and their spatial and temporal overlap with fisheries. Telemetry affords us the ability to monitor the distribution and movements of individual animals through time and, when combined with relevant environmental data, can provide significant insight into the habitat requirements of a species. In this analysis, we describe the neritic habitats used by 35 juvenile loggerhead sea turtles equipped with satellite transmitters in North Carolina between 2002 and 2004. Individual turtles were tracked for up to 13 months, allowing us to characterize both summer foraging and over-wintering habitats, as well as migratory corridors that link these areas. We followed 14 individuals back into estuarine waters in the year following tagging. We describe the physical features of the habitats used by these turtles, focusing on sea surface temperature, bathymetry, and distance from shore and to inlets. Our analysis reveals considerable individual variation in the habitats used by these turtles and in their fidelity to particular areas. It is important to recognize such individual variation, as this may be an important source of unexplained variance in analyses of behavior at the population level.

MOVEMENT PATTERNS OF LOGGERHEAD TURTLES (*CARETTA CARETTA*) IN CUBAN WATERS INFERRED FROM FLIPPER TAG RECAPTURES

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Like most marine turtles, the loggerhead turtle (*Caretta caretta*) carries out extensive migrations and uses a variety of habitats at different stages of its life cycle. Despite this general understanding, information on the migratory habits and distribution of juvenile and subadult loggerhead turtles is limited, and knowledge of movements by adult loggerhead turtles between feedings grounds is incomplete. Within the Greater Caribbean, the Cuban shelf offers optimal conditions for the various life stages of marine turtles and hosts habitats for five of the region's six species. The loggerhead turtle is one of the most common sea turtle species. Our primary goal in this paper is to enhance current knowledge about the movements and distribution patterns of this species in Cuban waters and throughout the Caribbean Sea. In addition to identifying possible migratory routes, we also provide data on speeds and distances traveled by tagged turtles along the Cuban shelf. To study the movement patterns of loggerhead turtles (*Caretta caretta*) in Cuban waters, tag-recapture data from the Cuban National Tagging Program (1989 – 2002) and others international programs (1959-2002) were compiled. Of the 210 loggerhead turtles tagged in Cuba at fishing areas and nesting beaches, 7.1% were recaptured, mostly in Cuban waters (93.3%). Loggerhead turtles tagged elsewhere and recaptured in Cuba included nesting females from Florida (84.0 % of foreign recaptures) and Mexico (10.0 %), wild juveniles from the Canary Islands (2.0 %) and the Spanish Mediterranean (2.0 %), and one head-started individual from the Bahamas (2.0 %). Recaptures of tags applied at sites north of Cuba clustered in the northwest region of Cuba. The minimum speeds estimated from non-nesting loggerhead turtles (large juveniles and adults turtles) tagged and recaptured within Cuban waters, were on the lower end of the spectrum of previously published studies of flipper-tagged loggerheads. The comparatively low swim speeds derived for loggerheads in Cuban waters suggests that turtles are undertaking multidirectional movements associated with local residency in addition to the higher speed transit movements. Recaptures of the Cuban national tagging program combined with the recaptures of international programs that included juvenile and adult individuals from different geographic places converging in Cuban waters, elucidate movement patterns of loggerhead turtles within the Greater Caribbean, particularly along the Cuban shelf. Further, these data confirm the importance of the Cuban habitats as foraging areas for both juvenile and adult loggerhead turtles.

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TRANSATLANTIC MIGRATION OF JUVENILE LOGGERHEAD TURTLES (*CARETTA CARETTA*): MAGNETIC LATITUDINAL INFLUENCE

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The Canary Islands together with the archipelagos of Azores and Madeira and the western Mediterranean are feeding grounds for loggerhead turtles. Though most of turtles that inhabit Azores, Madeira and southwestern Mediterranean come from the North Atlantic coast of America, the origin of turtles from the Canary Islands was unknown. With this aim, we analyzed sequences of 391 b.p. of the mitochondrial DNA control region in 93 samples of stranded turtles in the Canarian archipelago between 1999-2005. Then, we compared their haplotypes to those observed in the major Atlantic and Mediterranean nesting colonies and other Atlantic and Mediterranean foraging grounds using the Chi square test (CHIRXC) and the Zs* test (DNAsp). Additionally, we realized a Bayesian mixed stock analyses for the Canarian and Andalusia's foraging grounds and reanalyzed all published results from feeding ground using BAYES, including new information on nesting populations. The Chi square test ($p=0.033$) shows differences between Canary Islands and Andalusia foraging grounds but no differences were found with the other foraging grounds. We made two mixed stock analysis, the first with equal contribution from each stock and the second with contribution weighted by population size. The mixed stock analysis of Canarian turtles revealed that they mainly originate from South Florida (0.39 with equal contribution / 0.74 with weighted contribution), Northwest Florida (0.24 / 0.02), Quintana Roo (0.20 / 0.19) and Northeast Florida-North Carolina (0.06 / 0.03). The contribution of other nesting sites, Dry Tortugas, Brazil, Greece and Turkey was very little (0.10 / 0.01). The analysis using weighed contribution revealed more realistic results, mainly because the small size of the NWFL population. The Mexican contribution is very surprising because the population size of this nesting site constitute only the 2% of all the North Atlantic nestings. Though Mediterranean nesting beaches are closer than America's to the Canary Islands, the estimation of the contribution of Mediterranean stocks to the Canarian feeding grounds is only 0.0068. Few individuals were not assigned to any considered nesting populations and some of them may have their origin in Cabo Verde nesting beaches. This relevant contribution of the Mexican populations (0.19) to the Canary Islands stock could be explained with the possible influence of magnetic latitude on transatlantic migration. The minor contribution of this southern nesting area (Mexico) to Madeira, Azores and Andalusia stocks, corroborate this idea (0.13, 0.03 and 0.04 respectively). However we found a high negative correlation between magnetic latitude and the contribution of the Mexican population in foraging areas ($r=-0.84$).

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THE MARINE TURTLE RESCUE CENTER OF LINOSA: SEA TURTLES RECAPTURE DATA

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Linosa (35°51'N - 12°51'E), a small volcanic island (approximately 5 km²) South of Sicily, together with Lampedusa and Lampione, forms the Pelagie Islands. Linosa is known as an important nesting site for this species. From 1995 Rescue Centre activity on the island focused on loggerhead conservation, sustained from 1999 by EU Life Projects (Life99 NAT/IT/006271 "Urgent conservation measures of *Caretta caretta* in the Pelagian Islands" and Life03 NAT/IT/00184 "Del.Ta - Dolphins and Sea Turtles Protected"). More than 600 sea turtles have been marked and released in these years; of these, sixteen specimens have been recaptured in different areas of Mediterranean. Most recaptures occurred in the Pelagian area, showing in some cases important site fidelity. Meaningful is the case of a turtle which was marked and released in 1996, soon after nesting, and observed again during laying eggs on the beach of Linosa eight years later, in summer 2004. In this paper are analysed data on recapture, focusing on dispersal and grow rate.

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FINE-SCALE DIVING BEHAVIOUR OF MIGRATING TURTLES REVEALED BY AUTO RELEASING LOGGER SYSTEM

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According to satellite tracking studies, sea turtles are known to migrate over several thousands kilometers in the open ocean. To understand detailed diving behaviour, animal-borne recorders were deployed on adult females during interesting period. However, information during migrating period is still limited due to difficulty of data retrieval. Immature loggerhead turtles, *Caretta caretta*, and green turtles, *Chelonia mydas*, are occasionally caught by set-net during summer to autumn at the study site, Sanriku coastal water, northeastern Japan. Since there is no nesting ground around the study site, they seem to migrate for foraging. In this study, newly developed auto releasing system was used to reveal fine-scale diving behaviour without recapturing animals. Data loggers (temperature, depth, swimming speed and two-axis acceleration recorder: Little Leonardo Ltd, Tokyo, Japan) were attached with time-scheduled releaser to two loggerhead turtles (SCL: 65.5cm and 70.3cm) and one green turtle (SCL: 44.8cm). They were released after transferred to the mouth of Otsuchi Bay (39°20'N, 141°56'E). At scheduled time (approximately 6.5 h), the data loggers were automatically detached from the turtles and were retrieved via VHF radio signals at a distance of 5 – 18 km from the releasing point. Turtles spent more than 90% of time for diving (depth>0.5m) showing several dive types. Mean dive durations for two loggerhead turtles and one green turtle were 62.7 sec (s.d. = 210.5 sec, n = 346 dives), 125.2 sec (s.d. = 272.4 sec, n = 173 dives) and 109.1 sec (s.d. = 211.4 sec, n = 184 dives), respectively. Mean dive depths were 2.9 m (s.d. = 9.0 m) and 5.0 m (s.d. = 8.2 m) for loggerhead turtles and 5.4 m (s.d. = 4.0 m)

for green turtle. Mean swimming speed of loggerhead turtles was 0.6 m/s, and that of green turtle was 0.6 m/s. Flipper stroking and body angle were detected from two-axis acceleration data recorded: the surging acceleration along the longitudinal body axis and the heaving acceleration transversely across the turtle's body from dorsal to ventral. Using swimming speed and calculated body angle, horizontal speed was calculated. Mean horizontal speeds of shallow dive bouts (a series of shallow dives (>0.5m and <4m)) were 0.4 m/s (s.d. = 0.2 m/s, n = 16) and 0.6 m/s (s.d. = 0.1 m/s, n = 13) for the two loggerhead turtles, respectively, and 0.6 m/s (s.d. = 0.04 m/s, n = 9) for the green turtle, whereas that of deep dives (>4m) were 0.7 m/s (s.d. = 0.08 m/s, n = 32) and 0.7 m/s (s.d. = 0.08 m/s, n = 43) for loggerhead turtles, and 0.5 m/s (s.d. = 0.09 m/s, n = 108) for green turtle. Our results suggested that deep dives contributed to horizontal transit of migrating sea turtles.

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Order: 95 **Abstract ID:** 1507 **Type:** Poster **Subject:** Behavior and Movements

BEHAVIOR AND FEEDING ADAPTATION OF HEAD-STARTED HAWKSBILL TURTLES, *ERETMOCHELYS IMBRICATA*

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Five head-started (SCL: 40.4 ±1.3cm) and five wild juvenile hawksbill turtles (SCL: 44.5 ±4.5cm), *Eretmochelys imbricata*, were released at the same time onto the reef of Yaeyama Islands which is located to the southwest of Japan. Their behaviours were monitored by ultrasonic telemetry. The head-started turtles had been reared for two years in the Yaeyama Station, National Center for Stock Enhancement. All wild turtles moved out of the monitored area along the reef edge, which took 2 to 9 days. The direction of each of their movements indicated they were returning to their original capture locations. Two of the wild turtles were then recaptured at their original site six months later. Four of five head-started turtles also moved out of the monitored area, but not along the reef edge and the directions of their movements were scattered. Their residence periods in the monitored area (4 to 14 days) were longer than those of wild ones. The other head-started turtle stayed around the release point for 88 days until it was recaptured by a fisherman. This recaptured turtle had been foraging on sponges, *Chondrosia* sp., which was similar to the wild ones from which faeces samples were analysed. The difference in movement pattern between wild and head-started turtles was considered to be due to presence or lack of their destinations in Yaeyama waters. There was no difference in diving depth and diurnal rhythm between two groups. These results indicate the head-started turtles have ability to grow up in natural environment, but further study needs whether they become residents or not.

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POST-NESTING MIGRATIONS OF GREEK TURTLES INTO THE AEGEAN SEA, MONITORED THROUGH SATELLITE TELEMETRY

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During the summer of 2005 two loggerhead sea turtles nesting at important breeding areas in Greece, one at Kyparissia Bay (west Peloponnese) and one at Rethymno (Island of Crete), were equipped with satellite transmitters to follow their post-nesting movements. This action was undertaken within the framework of European LIFE project "Reduction of mortality of *Caretta caretta* in Greek seas". Transmitters were attached to the turtles' carapaces after nesting, using 2-part epoxy. Locations were produced through the Argos system. The Argos data were collected and managed using the Satellite Tracking and Analysis Tool (STAT) from SEATURTLE.ORG (Coyne & Godley, 2005). The turtle from Kyparissia Bay, after nesting again, departed the Ionian Sea, passing south of the Peloponnese, and migrated to the north Aegean Sea, arriving at Thasos Island in mid-August. She remained there until late October when she headed south along the Turkish coast settling near the Island of Lesbos until late December 2006. She left Lesbos and headed approximately 100km south, still in the Aegean, to the Island of Psara from which her last transmission was received. The turtle from Rethymno had already nested prior to transmitter attachment and may have nested again afterwards, but because of poor-quality location fixes and because the turtle was not observed to nest again, we can not be sure. However, after approximately two-weeks she headed north, into the Aegean, to the Island of Mykonos where she remained for 4.5 months. She subsequently moved approximately 100km to the south and her last location, in January 2006, placed her off the Island of Folegandros, still in the Aegean. In contrast to results yielded by over twenty years of tagging data indicating that turtles most often frequent the northern Adriatic and Gulf of Gabes (Margaritoulis *et al.*, 2003), both turtles in this study moved to the Aegean Sea after completion of their nesting seasons. Hence, these turtles' movements may highlight the bias inherent in tagging studies in which records of turtle recaptures are often more frequent in areas of higher fishing activity, such as the Adriatic and the Gulf of Gabes.

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SWIMMING BEHAVIOUR OF LOGGERHEAD SEA TURTLES RECOVERING FROM SEVERE ILLNESS ASSESSED BY SATELLITE TELEMETRY

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Successful readaptation to the wild of three loggerhead sea turtles after veterinarian treatment was assessed using satellite telemetry. The average straight carapace length (SCL) of the three turtles was 55.1 cm (range: 39.0-63.3 cm). All of them were found floating offshore, were unable to dive and suffered from acute internal infection when arrived to the Marineland Turtle Rescue Centre (Mallorca, Balearic archipelago, Spain). Examination revealed that one of them had been hooked in the throat and another had probably been entangled in a net, as the fore flippers were injured. The third one did not exhibit any evidence of hooking or any external injury. The hook was removed and all them were treated with antibiotics and remained in the rescue centre for a time span ranging from 33 to 131 days. They were released on November 5th, 2004 and tracked for 9.3 months on average (range: 9-10 months). Swimming behaviour was compared with that of other five turtles (average SCL: 51.4 cm; range: 47.3-61.1 cm) caught while basking off the Balearic archipelago from February to October 2004. They were instrumented with satellite tags and released immediately. Tracking lasted on average 9.0 months (range: 5-12 months) and overlapped with that of the treatment group for 56 days. One-way ANOVA was used for assessing the existence of statistically significant differences between the swimming behaviour of the two groups of turtles within the period of simultaneous tracking. They did not differ in swimming velocity ($F=0.350$; $p=0.576$), cosine of turning angle ($F=1.043$; $p=0.347$), and the percentage of time spent at the ocean surface either in the morning ($F=2.427$; $p=0.170$), the afternoon ($F=0.758$; $p=0.417$) or at night ($F=0.315$; $p=0.595$). Furthermore, both groups of turtles preferred oceanic habitats and used similar foraging areas. These evidences demonstrate that loggerhead sea turtles readapt successfully to the wild after long and complicated veterinarian treatment.

DISTRIBUTION OF OCEANIC STAGE NORTH ATLANTIC LOGGERHEADS: ARE SEAMOUNTS IMPORTANT HOTSPOTS?

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North Atlantic loggerhead sea turtles (*Caretta caretta*) exhibit a complex life cycle with ontogenetic shifts that involve major changes in their ecology, behaviour, and distribution. In oceanic habitats, oceanographic and topographic features, such as seamounts, might generate eddies providing prime habitats for sea turtles. Here we will discuss the influence of seamounts in the distribution of this species. We considered the associations of sea turtles with seamounts using two approaches. First, we evaluated the patterns of distribution with respect to sea-bottom slope using data from 343 longline sets collected during experiments conducted in 2000-2004 within the EEZ of the Azores archipelago. Sea-bottom slope was computed from the bathymetry lattice using ArcGIS. Our

second approach to evaluate the association of sea turtles with seamounts employed satellite telemetry. The results support the hypothesis that distribution patterns of loggerheads are related to local topographic characteristics and that seamounts appear to be important habitats for juvenile oceanic loggerhead sea turtles.

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MOVEMENT AND BEHAVIOR OF FLORIDA NESTING LEATHERBACKS

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Two archival satellite tags were deployed in May 2005 on leatherback turtles nesting on Juno Beach, Florida. One tag was deployed for the programmed 90 days, and one was recovered on a beach 20 km away 9 days after deployment with the tether cut. Data on movement and dive behavior during the inter-nesting and post-nesting periods are presented.

Order: 100 **Abstract ID:** 1725 **Type:** Poster **Subject:** Behavior and Movements

PRELIMINARY DOCUMENTATION OF LOGGERHEAD SOLITARY AND SOCIAL BEHAVIOUR IN THE MARITIME BREEDING AREA OF LAGANAS BAY, ZAKYNTHOS, GREECE

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Knowledge about animal behaviour is essential to determine how individuals may prolong survival and/or maximise reproductive fitness by the differential partitioning of energy stores to meet the metabolic demands of reproduction, body maintenance, locomotion, and food-processing (Hays,2000). Information describing loggerhead sea turtle behaviour in marine breeding areas (courtship and inter-nesting) remains rudimentary, with recent studies deducing behaviour from data collected by aerial surveys, data-loggers, tracking-devices and genetics studies. Laganas Bay, on Zakynthos Island, is one of the most important breeding rookeries for endangered loggerhead sea turtles in the Mediterranean (Margaritoulis, 2005). The National Marine Park of Zakynthos was established to protect all habitats utilised by this population during the breeding period. Therefore, the NMPZ developed a sea-based research programme, complementing an ongoing ARCHELON nesting-beach project, to investigate loggerhead population dynamics and behaviour ecology in the protected maritime area. Due to NMPZ policy to minimise harassment of sea turtles and because Zakynthos attracts over five-hundred thousand visitors each summer, traditional invasive 'mark-recapture' methods were avoided. Instead, the low-stress and promising data-rich technique of photo-identification was selected, whereby individual turtles are recognised based on natural facial-markings. Information about environmental conditions, turtle location (GPS), biology and behaviour was also collected. Surveys were performed

at Laganas Bay across three years, during both the courtship (April-May) and inter-nesting (June-July) periods. 1658 behavioural observations were compiled across 287 hours of day-time surveys. In total, 149 observations of 45 unique males and 1509 observations of 402 unique females were made, this bias partly reflecting females being found closer to shore where surveys were concentrated. A total of twelve behavioural states were recorded, comprising of seven solitary and five social behaviours. Solitary behaviour includes resting (18%male, 46%female), surface-basking (3%male, 15%female), swimming including patrolling males (30%males, 27%females), foraging (3%males, 0.3%females), self-cleaning (0.4%females), symbiotic fish cleaning (1%females). Social associations include female-female defence (8%females), male-male conflicts (7%males), courtship (23%males, 2%females), copulation (13%males, 1.5%females) and copulatory male attendants (3%). Chi-squared statistical analysis indicated a highly significant difference between the diurnal solitary and social behavioural states for male and female loggerheads ($P < 0.001$), with males being four times more likely to be encountered in a social situation. When solitary, males performed significantly more active behaviours than females ($P < 0.001$). Animal behaviour carries energy costs, hence activities that maximise reproductive fitness should be selected (Hays, 2000). Female turtles should therefore primarily invest in inactive behaviours to channel energy reserves towards increasing the rate of egg gestation. In contrast, males should expend energy through active mate search and acquisition techniques, to increase their chances of copulating with more females. Our findings support these basic assumptions however more research is required to improve our knowledge about sea turtle strategies and implications to reproductive fitness, by obtaining complete activity energy budgets and documenting changes in behavioural state across the breeding period.

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Order: 101 **Abstract ID:** 1387 **Type:** Oral **Subject:** Behavior and Movements

MOVEMENTS OF IMMATURE AND POST-NESTING KEMP'S RIDLEY SEA TURTLES IN THE NORTHWESTERN GULF OF MEXICO

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The Kemp's ridley sea turtle, *Lepidochelys kempii*, is exhibiting a modest recovery from devastating declines that reduced its nesting activity from a single-day estimate of 40,000 in 1947 to 702 nests during all of 1985. Increased ridley nesting at Rancho Nuevo, Mexico has been complemented by commencement and growth of nesting on the Texas (USA) coast. This activity has grown from 1–2 nests annually prior to 1995 to a record 51 in 2005 (D. Shaver, pers. comm.), with most of these occurring on the lower Texas coast. Five nests laid on the upper Texas coast in 2004 and eight in 2005 suggest a northern expansion of the nesting range and increased survival among immature and adult conspecifics. Although beach monitoring is crucial to estimating nesting population size and activity, at-sea data are essential for evaluating management strategies and understanding in-water dynamics of all life history stages. The Kemp's Ridley Recovery Plan lists determining "seasonal use of nearshore habitat by juveniles/subadults" and determining "migratory paths and foraging areas" as necessary components of a strategy to achieve this species' recovery, but such data are currently sparse. Eight Kemp's ridleys were outfitted with satellite transmitters and

released off the upper Texas coast during 2004–2005. These were comprised of three juveniles caught on recreational hook-and-line gear, one juvenile captured in a dredge relocation trawl, and one rehabilitated subadult, as well as two “headstarted” females and one wild (non-headstarted) female that nested on Galveston Island during 16–30 May 2005. Duration of satellite tracks ranged from 12 to 59 days (average = 37.8 days, SD = 15.6 days, n = 8). The five immature ridleys frequented Sabine Pass, Texas; Calcasieu Pass, Louisiana; and waters near upper Texas coast fishing piers during September–November 2004 and May–October 2005. Ultrasounds of the adult females indicated that each possessed developing egg follicles after her first documented nest, and satellite locations indicated that all three exhibited fidelity to the Galveston area during May–June 2005. One tracked individual was intercepted nesting a second time on Galveston Island on 20 June, whereas ultrasound results and satellite tracks suggested that the other two females each nested at least once during June 2005. The only female tracked during July 2005 had migrated about 250 km east of Galveston Island into waters offshore of Louisiana when transmissions ceased on 19 July. Although relatively short, these satellite tracks suggested that tidal passes and areas near fishing piers were important seasonal foraging areas for immature Kemp’s ridleys in the northwestern Gulf of Mexico during 2004–2005. Additionally, three nesting females exhibited fidelity to Gulf and bay waters off Galveston Island during the 2005 nesting season, supporting previous indications of a northern expansion of the Kemp’s ridley’s nesting range. Transmissions over longer durations are necessary to further examine the migrations and habitat preferences of both immature and post-nesting ridleys. Various measures, including use of anti-fouling paint and a different antenna orientation, will be taken to increase the life of satellite transmitters deployed during 2006–2007.

Order: 102 **Abstract ID:** 1592 **Type:** Poster **Subject:** Behavior and Movements

POST-NESTING DIVING BEHAVIOR, MOVEMENTS, AND DISTRIBUTION OF PACIFIC LEATHERBACK SEA TURTLES TAGGED AT PLAYA GRANDE, PARQUE NACIONAL LAS BAULAS, COSTA RICA FROM 2003-2004

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Twenty-seven Pacific leatherback sea turtles were tagged with Satellite-Relay Data Loggers (SRDL, n=17) and Smart Position and Temperature (SPOT, n=10) tags during their 2003-2004 nesting season at Playa Grande, Costa Rica. The movements, behaviors, and rates of travel of these 27 animals are analyzed during a period of over 5000 cumulative days. Track durations for the turtles tagged during 2003-2004 ranged from 49-478 days. Maximum dive depths for individual turtles following their departure from nesting beaches ranged from 775-1140 m. Turtle movements during the early phases of migration from nesting beaches at Playa Grande are consistent with previous tagging studies that suggested a leatherback “migration corridor” along the Cocos Ridge from Las Baulas National Park towards the Galapagos Islands (Morreale et. al., Nature 1996). Post-nesting behavior and movements are compared with interesting movements and behavior. Changes in travel rate and dive behavior will be described in the context of migration from Costa Rican nesting grounds in the Eastern Pacific to potential foraging areas in the equatorial and South Eastern Pacific Ocean. High use areas are also delineated throughout the geographic range of the tracking data.

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RESPONSES OF LOGGERHEAD AND GREEN TURTLE HATCHLINGS TO FLOTSAM DURING THE FRENZY AND POSTFRENZY PERIOD

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Loggerhead and green turtle neonates migrate from Florida's East coast during a 24-36 h frenzy. Postfrenzy loggerheads, days to weeks old, are often found resting in flotsam (typically, Sargassum), but green turtles of comparable age "disappear". In this laboratory study, we compared the frenzy and postfrenzy activity of the two species to determine how long they are active, where they rest, how they respond to flotsam, and whether experience plays a role in habitat (flotsam) selection. Hatchlings from six loggerhead and four green turtle nests served as subjects. Hatchlings were placed at night in either a large tank without (naïve group) or with (exposed group) flotsam (Sargassum) confined to ¼ of the tank. Location and activity of each exposed turtle were recorded three times daily over the next three days. Green turtles showed a longer frenzy than loggerheads. During the postfrenzy, greens rested in flotsam during the day, and flotsam or open water at night. Postfrenzy loggerheads rested either in flotsam or open water, regardless of photophase. On day 4, exposed turtles were removed and artificial plastic flotsam (green "plants") was added to the tank. On day 5, naïve and exposed siblings were tested together and could choose between residing in open water or within each flotsam habitat. Neither naïve nor exposed turtles showed a flotsam "preference". In nature, green turtles are rarely found in flotsam. Perhaps they abandon rafts when approached by observers or swim farther offshore before expressing this behavior. Field data are required to resolve the issue.

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NESTING SITE FIDELITY IN FLORIDA LEATHERBACKS DETERMINED USING GPS TAGS

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Through our ongoing mark-recapture study of Florida leatherbacks we had frequently observed the phenomenon of one-time nesters and so we became interested in examining nesting site fidelity for this increasing population. Were these females really only nesting once or twice? Or were they traveling long distances for subsequent nests? To address these questions and to assess the usefulness of the Global Positioning System (GPS) for leatherbacks, we harnessed five nesting female turtles with a platform transmitter terminal (PTT) containing an Argos transmitter, a GPS subsystem and a VHF beacon. The purpose of our study was twofold. We wanted to gain an appreciation for how far a turtle might travel for a subsequent nest and we wanted to compare the accuracy between two current tracking systems (Argos and GPS). Our results were surprising and informative. Females traveled between 2 and 140 km for subsequent nests, and took 9 to 12 days at sea for their internesting interval. Our GPS tags were instrumental in allowing us to definitively determine nesting sites that were far from Juno Beach. Each of these

one-time nesters (at Juno) did deposit up to 5 clutches (at some distance). Additionally, the GPS units provided some useful information about the direction and rate of travel once the female left the nesting site. However, we found that Argos transmitters remain the most reliable method of data collection for leatherbacks in the water. These results have important implications for future tracking experiments and for evaluating the theory of one-time nesters.

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SATELLITE TRACKING OF THREE ADULT LOGGERHEAD TURTLES (*CARETTA CARETTA*) IN THE MEDITERRANEAN SEA

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The northern Adriatic Sea has a most important role in the life-cycle of loggerhead turtles, as indicated by the large number of animals recovered in this area. In particular the Italian coast between the mouths of Po and Reno rivers is known to be a suitable foraging site for juveniles and non-breeding adults that reside there especially during summer months. Because little is known about the movements of these turtles in the cold season, in autumn 2003 and 2004 three turtles which had been accidentally fished, were equipped with satellite transmitters and tracked for about 10 months. After release at Porto Garibaldi (FE, Italy), all the turtles swam south, parallel to the eastern coast of Italy covering almost 800 km. Upon reaching the extreme southern tip of Italy, their routes divided, an adult-sized male, released in 2003, moved offshore swimming northeast until transmissions stopped when he was in front of Durazzo (Albania), after a 1747 km trip that lasted nearly two months. One of the two turtles released in 2004, an adult female already tagged while nesting in 1996 in Kyparissia Bay (Greece), continued her SE movement and reached the Greek Ionian islands after a 308 km-long open sea stretch. At the end of December she approached the region between Zakynthos Island and the Peloponnese, remaining there until mid-March, before she finally reached Kyparissia Bay, where she sojourned for nearly five months in 2005. The location frequency was low probably since the turtle was in a shallow water foraging area, where she spent most part of the time submerged. The turtle was witnessed nesting once during the summer. In July 2005, the turtle left this area and headed towards southern Italy with an open sea leg. The transmissions ended on 23 August, when she was in front of the eastern Apulian coast. The turtle covered 3714 km in total. Upon leaving the Italian coast, the second turtle from 2004, an adult-sized female, first moved southeast to southern Ionian Sea, circling for about two months in a relatively narrow area located in front of the Peloponnesian western coast. After having approached the Peloponnesian southern coast, she headed eastwards moving round until reaching the Cyclades Islands. Afterwards the turtle remained for 6 weeks in the Saronic Gulf, before moving south to Crete in spring 2005, where she spent the summer, possibly nesting on Messara Bay beach, on the southern coast. Contacts with this turtle were lost in August 2005 when she was heading back towards the northern Adriatic Sea after 6838 km of tracking.

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SEA TURTLE RESERVE AND SATELLITE TRACKING IN CHINA

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There is only one sea turtle nature reserve in China, the National Guangdong Huizhou Sea Turtle Nature Reserve; located adjacent to Daxiang mountain and facing Daya Bay and Honghai Bay of Guangdong Province. The Reserve is situated at 22°33'N, 114°54'E, total area of the Reserve is 1,800 ha. The southern part of the Reserve is the South China Sea other side is surrounded by mountains. The Reserve contains a sandy beach, 1,000m long and 70m wide, on which sea turtles breed annually from June to September. Historically, thousands of sea turtles came to breed, but now, less than one hundred turtles are nesting there. The Reserve was set up in 1986 by the Government of Guangdong Province, China and in October 1992 the Reserve was upgraded to national reserve status. Between 17 and 28 August 2001, three green turtles were equipped with satellite linked transmitters utilizing the Argos location and data collection service. In order to follow the turtles' post-nesting migrations, transmitters were attached to their carapaces after they had nested at the Reserve. The results show that two of the turtles migrated to the South China Sea and the remaining one migrated north to the coastal region of Japan. Due to the limited sample size it is not possible to present a definitive model of sea turtle migration from China. As a representative example of modern biotelemetry, tracking sea turtles by satellite needs the integration of various disciplines and technologies as well as international cooperation. In China, there are few data for tracking sea turtles by satellite. China needs to expand this study in the future to obtain more results and expand the range of the studies. Sea turtles are registered as endangered worldwide. Their migrations often cross seas and oceans. Therefore, satellite tracking sea turtles, and successful actions based on the results, require international cooperation with exchange of data and technical expertise etc. In fact, there are not only many international collaborative projects for the tracking of sea turtles, but also many new products are being produced. Other fine electronic telemetry instruments with biophysical sensors as well as new analysis software tools are also under development. In brief, international cooperation is important for the development of modern biotelemetry.

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LOGGERHEAD TURTLES FORAGING IN THE GULF OF ARGOSTOLI, KEFALONIA, GREECE (2000-2004): REJECTION OF AN OVERWINTERING HYPOTHESIS

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The coastal waters of western Kefalonia, Greece, were studied over five years (2000-2004) to: 1) identify the marine habitats used by turtles, 2) identify periods when sea turtles were present, 3) determine if turtles used Koutavos Lagoon, Argostoli, during the winter months (as suggested by Houghton *et al.* (2000), based on anecdotal evidence from local recreational fishermen). Fieldwork in the Gulf of Argostoli was divided into two phases: 1) daily surveys were conducted from May-October onboard a glass-bottomed boat 'SUN', 2) shore-

based observations of near-shore coastal waters continued throughout the year. Sightings of marine megafauna (turtles, dolphins and seals) were recorded within seven contiguous sea areas (total area 75 km²). Sea surface temperature (SST) was recorded throughout the year. It was possible to identify the distinctive breathing posture of turtles surfacing in the distance; however, some loggerheads were within 1-2 metres of the author. The Gulf of Argostoli is a summer foraging ground - mainly when SST was >22°C - for non-nesting turtles, adult males, and adolescent turtles of both sexes. The Gulf does not appear to be a place of residence, although some individual turtles remained foraging in the area for >26 weeks. Only a single loggerhead was confirmed (by photo-recognition) as using the Gulf of Argostoli in more than one year. Loggerheads were absent from local waters for 22-25 weeks over the winter months (mid-November until April or May). The data suggest that Kefalonia may also be a final-stage developmental habitat, because all of the loggerheads encountered (apart from a single juvenile) were large animals, close to adult size. Adult males are easily identifiable (by the long tail), however, the majority were short-tailed animals, which, as only one had been tagged, suggests they had yet to nest (White, 2004). Loggerheads were confirmed as being mainly solitary animals. Only 7% of sightings involved multiple turtles (n=28 of 391 records), and these were all at Argostoli quayside feeding on fishery discards (White, 2004).

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Order: 108 **Abstract ID:** 1618 **Type:** Poster **Subject:** Behavior and Movements

USING HYDROACOUSTICS TO PREDICT HABITAT USE OF FORAGING JUVENILE LOGGERHEAD TURTLES IN BAJA CALIFORNIA SUR, MEXICO

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Predicting habitat use of highly migratory endangered megavertebrates can be useful in reducing fisheries mortality. In addition, habitat use of a full range of pelagic species show strong correlation to trends in the distribution and abundance of their prey (Croll *et al.*, 2005). Studies by Peckham and Nichols (2002 and unpublished data) have shown that juvenile loggerheads (*Caretta caretta*) foraging off Baja California Sur (BCS) feed primarily and exclusively on the pelagic red crab (*Pleuroncodes planipes*). We are developing an integrated approach for testing the hypothesis that loggerhead distribution can be predicted by the distribution and abundance of swarms of red crabs in the water column. We will test the efficacy of measuring prey abundance by using hydroacoustics to chart red crab aggregations along the inshore edge of loggerhead foraging hotspots. Preliminary results show targets that appear to be red crab frequency and density increase along transects of increasing loggerhead abundance. We conclude that hydroacoustic surveys are useful in ascertaining red crab distribution within loggerhead hotspot areas. In 2006 we will be initiating hydroacoustic surveys on larger vessels to map red crab abundance across a full range of loggerhead abundance, onshore and offshore.

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BASKING BEHAVIOR OF GREEN TURTLES IN THE GALAPAGOS ISLANDS

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Land basking in Galapagos green turtles (*Chelonia mydas*) was first recorded in the 1960's by buccaneers William Dampier and William Ambrose Cowley. Several observations were made during the 1970's and 1980's by several researchers who analyzed the possible role of this behavior in avoiding predators, mating and thermoregulation. We present results of a study that carried out between December to May from 2002 – 2005 in the nesting beaches of Bahía Barahona and Quinta Playa (Isabela Island), Las Salinas (Seymour Island) and Las Bachas (Santa Cruz Island). We tagged, measured, and examined every turtle found along the beach during day and night hours in order to conduct comprehensive studies of the population. We encountered more than eight hundred land basking turtles on two of the primary nesting beaches in the Galapagos, Quinta Playa and Bahía Barahona. Many turtles rested on the sand for prolonged intervals during both day and night. Ninety percent of basking turtles were females; the trend for relative abundance of basking females was consistent with the nesting female abundance trend among nesting seasons. Basking females encountered with flipper tags were all identified as nesting females from current season, thereby suggesting that basking behavior is related to reproduction.

Order: 110 Abstract ID: 1427 Type: Poster Subject: Conservation, Management and Policy

SUCCESS OF DELAYED TRANSLOCATION OF LOGGERHEAD TURTLE NESTS: IMPLICATIONS IN MANAGEMENT PROGRAMS

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Traditional protocols (e.g. Miller 1999) for translocation of sea turtle nests advise to move the eggs within 2-12 hours following egg-laying, to protect developing embryos. However, this recommendation generally obliges the manager to move eggs at night: decreasing visibility, reducing the manager's ability to detect nests, interfering with risk assessment and decision-making, and potentially compromising the convenience of translocation to the new location. Moreover, nocturnal translocation may interfere with turtle nesting and the tagging of nesting females. Finally, it is generally not possible to identify infertile eggs because the white "fertility circle" (cf. Blanck 1981) is not perceptible for at least 24 hours. Most of these problems can be solved by a diurnal delayed translocation protocol. To test the viability of a delayed translocation, we translocated in Boavista Island (Republic of Cape Verde) 50 loggerhead sea turtle, *Caretta caretta*, nests after periods of time varying from 0 to 96 hours following egg-laying. Eggs were carefully placed in a rigid plastic container, while maintaining their original vertical orientation. The transport was pedestrian and all nests were incubated in a beach hatchery (50 x 15 meters). Hatchery nests were reburied in standardized hand-dug cavities that resembled natural nests in shape, size and sand characteristics (maximum nest depth = 50 cm; cf. Miller 1999). The treatment did not have any effect overall (MANOVA: Wilks=0.643, F 4, 16 =1.19 P=0.282). Neither did egg translocation at 0, 12, 24, 84 or 96 hours after egg-laying have effect on hatching success (F 4, 45 =0.099 P=0.982), incubation period (F4, 43 = 0.425 P=0.790), hatchling size (length: F 4, 43 =0.41 P=0.802; width: F4, 43 =0.02 P=0.999), or hatchling mass (F 4,43 =0.672 P=0.615). Delayed translocation slightly increased the duration of the process, including the precautions taken (e.g. maintaining axial orientation, protecting eggs from mechanical shocks; Limpus *et al.* 1979, Parmenter 1980). We conclude that delayed nest translocation can be done in a safe and effective way, thereby increasing the efficiency of the whole monitoring program. Finally, delayed translocation, accompanied by a skilled evaluation of fertility, would appear to permit the removal of undeveloped eggs and to facilitate their subsequent exploitation by local communities without affecting turtle nesting success.

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Order: 111 **Abstract ID:** 1398 **Type:** Poster **Subject:** Conservation, Management and Policy

GOLDEN JACKAL PREDATION ON MARINE TURTLES IN GOKSU DELTA, TURKEY

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Between the 1st June and 15th September 2005, nesting activities and interactions with predators of loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) sea turtles were monitored daily in Goksu Delta, Turkey. Although nests were caged immediately upon discovery by the field team, these efforts could not prevent acts of depredation that occurred prior to our identification of the nest site. The Golden Jackal (*Canis aureus*) was the most destructive predator on adult females, eggs, and hatchlings during the study. In the 2005 season, jackals killed eight adult females, depredated 42% of 151 nests, and destroyed 24% of 1,528 hatchlings. Furthermore, “half-moon” (u-turn) crawls and uncompleted nests were often associated with the predator’s foot prints nearby, providing indirect evidence that the jackals caused stress to the nesting females. Jackal-associated predation on sea turtles was first reported in 1991 (40.2% of 117 *Caretta* nests, 20.0% of 20 *Chelonia* nests) in Goksu Delta. The following year (1992), three gravid *Caretta* were killed during nesting but no nest depredation was recorded (despite the fact that jackal footprints were observed on the beach). In 2004, 52 nests (34.43%, 5 nests partially exhumed) were depredated and 12 gravid females (10 *Caretta*; 2 *Chelonia*) were killed by jackals. For those years with complete nesting beach coverage throughout the egg-laying season, we calculate that an average of 103-154 nests were observed in Goksu Delta each year in spite of the consistent jackal predation in all years. Current data are insufficient to demonstrate a trend in nesting numbers, but we believe that if the predation cannot be controlled, there will be a decline in sea turtle population and nest numbers in Goksu Delta in the near future. Considering the large size of the area (~30km), we recommend that depredation be reduced through the use of a variety of non-lethal conservation strategies, including repellents, attractants and deterrents. We recognize that these strategies have not always been effective in other areas, but there are few viable alternatives. Therefore the adaptation and refinement of these various methods, to our particular situation, will be an important focus of our future studies.

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THE STATUS OF MARINE TURTLES IN ATLANTIC MOROCCO

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The loggerhead (*Caretta caretta*) is the sea turtle species most frequently observed along the Moroccan coast. Records of leatherback (*Dermochelys coriacea*) and green (*Chelonia mydas*) sea turtles are more rare. Morocco does not have any known sea turtle nesting beaches. The migration of loggerhead turtles between the Atlantic and the Mediterranean must include passage through the Straits of Gibraltar, highlighting the ecological importance of the northwestern Atlantic coast of Morocco, including Tangier. Based on stranding information, reports from fishermen and market surveys, the majority of sea turtles that occur in Atlantic Moroccan waters are juvenile and sub-adult loggerheads. Mortality from fisheries interactions and pollution appears to be relatively small. We also report on other actions being undertaken for sea turtle conservation in Morocco, including education-awareness of fishermen, stimulating regional/international cooperation, and efforts to strengthen national laws to protect turtles.

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LEGISLATION THAT PROTECTS SEA TURTLES IN GUATEMALA

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Conservation of sea turtles and the actions developed for that purpose represent the longest existing program to protect endangered species in Guatemala. In 1971 the government of Guatemala promoted two major actions to protect sea turtles: sea turtle egg incubation and liberation of hatchlings to the sea. For these last 34 years both activities have been developed by governmental, non governmental organizations and individual persons. In 2002 specific regulations were enacted by the National Advisory Committee of Protected Areas in Guatemala (CONAP in Spanish), under regulations CONAP No. ALC 056/2002. These regulations were later ratified in 2004. New regulations include:

- Collection of sea turtle eggs according to an established conservation quota of 20% per nest.
- Incubation of eggs and liberation of hatchlings to the sea. From 2002 to 2005 a total of 166,117 eggs were incubated.
- Control activities to curtail poaching and illegal trade of sea turtles and its eggs. From 2002 to 2005 a total of 69 monitoring operations took place and 3,582 eggs were confiscated.

- Enforcement of Turtle Excluder Devices in shrimp boats to reduce the number of accidental deaths. From 2002 to 2005, 21 inspections were performed in a total of 106 boats from which only four reported problems.
- Collection and analysis of data from each conservation farm during each nesting season. Specific numbers are available per nesting season from 1999 to 2005. This presentation includes a brief review of Guatemalan sea turtle legislation over the years and its legal analysis under the framework of international agreements and current Guatemalan law and regulations related to sea turtles.

Order: 114 **Abstract ID:** 1574 **Type:** Oral **Subject:** Conservation, Management and Policy

MARINE TURTLE CONSERVATION IN THAILAND: A POST TSUNAMI RECOVERY

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Thailand recorded a high number of human fatalities (ca. 8,600 dead or missing) and extensive damage to coastal areas in the provinces of Phang Nga, Krabi and Phuket, which account for over 95% of the deaths reported (Source: UN Office for the Coordination of Humanitarian Affairs). The Sea Turtle Project located at Phra Thong island since 1996, was completely washed away by the wave and other sea turtle conservation sites along the coast were damaged. The tsunami caused a traumatic effect on some marine endangered species particularly sea turtles, dolphins and dugongs. Turtles in captivity were washed away at Phra Thong island, at Phuket Marine Biological Center (PMBC), at Taimuang National Park, at Thab Lamu Naval Base and at the Ranong Marine Research Station. In addition, 37 sea turtles were stranded on land, 6 of which were found dead, 26 were rescued and released and 5 were hospitalised at PMBC. Three dolphins and one large male dugong were washed ashore. A rapid assessment of the tsunami effects on marine resources was conducted in order to evaluate the impact. Although erosion is one of the main wave effect on nesting beaches, 3 nests of leatherback turtle were recorded at Phuket island in January 2005 after many years of absence. Even if there are many difficulties the Sea Turtle Project at Phra Thong island will be operative starting January 2006 continuing the monitoring programme and nest protection along 15 km of beaches likewise the environmental education programme in the schools.

Order: 115 **Abstract ID:** 1645 **Type:** Poster **Subject:** Conservation, Management and Policy

BYCATCH POLICY ALL AT SEA?

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Bycatch rose from an issue of concern to particular fisheries in the 1970's to the "issue of the decade" in the 1990's. However, in 2006, marine wildlife-fisheries interactions, including those with sea turtles, continue to be contemplated by most countries on a species and fisheries-specific level. If bycatch is to be managed in anything other than an adhoc and uncoordinated manner, then an overarching approach is needed. There is no single correct way to manage bycatch. There are, however, essential elements necessary for a truly effective regime. These can

loosely be split into three groups or phases: 1. Prioritization - data collection, bycatch status assessments, fishery impacts; 2. Mitigation - policy formation, consultative decision-making, education, quantitative limits, gear/technology development; and 3. Implementation/compliance - incentives, training, funding, labeling and oversight. Such an approach would benefit sea turtles by ensuring that fisheries with the greatest impact are remedied first and the most effective mitigation mechanisms are established to protect the most endangered species of sea turtles. While political will is crucial, individual countries can establish overarching bycatch management regimes over waters and vessels within their jurisdiction. Mandatory bycatch actions on the high seas are unlikely to be agreed upon by all significant fishing nations. However, international principles, priorities and methods could be enforced. Sitting under neither a fisheries nor an environmental protection umbrella is the UN Department of Oceans and the Law of the Sea, which has under its ambit, the Law of the Sea Convention and Fish Stocks Agreement, ideal parent/sibling conventions for an international bycatch accord.

Order: 116 **Abstract ID:** 1763 **Type:** Poster **Subject:** Conservation, Management and Policy

FUNDRAISING FOR ANIMAL REHABILITATION: A STRATEGIC APPROACH FOR TURTLE-FOCUSED WORK

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Greece represents a significant crossroad for endangered animal biodiversity in the Euro-Mediterranean region: the loggerhead turtle, the brown bear and the golden eagle are but a few examples of the diverse threatened fauna encountered in the country. The declining number of such animals has led to significant investments in rescue and rehabilitation, from the part of wildlife preservation organizations. Three major centers have been operating professionally in the Greek territory for more than a decade, each focusing on different species, namely turtles, birds and bears. They are the Sea Turtle Rescue Center of ARCHELON, the Greek Wildlife Hospital in Aegina and the Environmental Center of ARCTUROS, respectively. Complementing their core rescue and rehabilitation work, the three centers are very active in public information, lobbying and environmental education, in an effort to reduce animal mortality through awareness, sensitization and institutional development. Furthermore, they engage in a multitude of fundraising activities in order to support the significant costs involved in wildlife rehabilitation. This poster presents an overview of the fundraising tools employed and the experience gathered by the three centers. The field research is based on interviews with the employees and volunteers of the three facilities as well as on-site observation of visitors. From the variety of fundraising tools used by the three centers, four were identified as a major source of income: donation boxes, supporter programs (including sponsorship of individual animals), sales of memorabilia, individual and corporate sponsorships. It is estimated that the centers contribute 10% to 30% of the overall income of the organization they belong to. In each center, visitors are offered a guided tour of the facilities. By their own account, the experience of being in a rehabilitation center greatly surpasses information provided by posters and leaflets, or second-hand descriptions of volunteers and employees. During their stay, visitors gain a better understanding of some or each of the every day activities of the rehabilitation center: care for the animals, maintenance of facilities, environmental education, office work, and scientific research. This provides a unique perspective for the necessity of resources and funds. As a highlight of their tour, visitors come into visual contact with animals under recovery; these may be ill, injured or handicapped; just like humans may occasionally be. This “solidarity by association” effect seems to be a significant mobilizing factor. It is worth noting that it surpasses the mammal – reptile barrier. Each fundraising tool may be seamlessly integrated into the tour. Thus, people may choose those which are most suitable to their preferences as well as economic background. One may assist with a donation of a few cents, or be a corporate sponsor for tens of thousands of euros. The enhanced experience of observing the complete range of activities and animal states, augments the will to support the centers financially. Additionally, the proper integration of fundraising tools, within the full spectrum of the centers’ activities, increases their overall effectiveness in terms of volunteer engagement, social acceptance and support, as well as promotion of wildlife protection policies.

DIFFERING TRENDS AND RESPONSE TO CONSERVATION EFFORTS BY TWO PROTECTED MEXICAN MARINE TURTLE ROOKERIES INDICATES NEED FOR CHANGES IN STRATEGIES

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The response of marine turtle populations to regulations and protective actions to revert the decline produced by overfishing and poaching is analyzed in the light of differing conservation and management results observed in two natural protected areas in Mexico: Playa Las Glorias, (Playón de Mismaloya, Jalisco) and Playa El Verde, Sinaloa, located in the central and northern Pacific coast of Mexico, respectively. The components we analyze are: (1) the species present, (2) nesting abundances estimated for the recent past prior and/or during the commercial fishing through the 1960s, (3) nesting trends over the last 3 decades for El Verde and the last 2 decades from Las Glorias, (4) impacts derived from fishery interactions with olive ridleys, hawksbills, East Pacific green turtles and leatherbacks, (5) other anthropogenic pressure factors on turtles and nesting environment, (6) condition of nesting habitats. Possible factors causing the different conservation results in these two rookeries are discussed and strategies for a more effective conservation are proposed.

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POACHING AND PROTECTED NESTS RATE TRENDS OF SEA TURTLES IN CHALACATEPEC AND MISMALOYA BEACHES, TOMATLÁN, JALISCO, MEXICO, 1995-2004

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The Playón de Mismaloya, Tomatlán, Jalisco State, Mexico, in the Eastern Pacific, is one of the most important beach systems for nesting sea turtles in the World. Despite protection by Mexican law since 1986, human depredation of leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), black (*Chelonia agassizii*) and olive ridley (*Lepidochelys olivacea*) sea turtles continues illegally in this area. Various governmental organizations and NGOs are working to restore populations in this region through the daily patrolling of nesting beaches during the reproductive season, and by locating nests and translocating eggs to incubate and hatch in

protected hatcheries. During the last ten years (1995-2004) we have recorded data from protected nests and poaching at two sites: Chalacatepec (19°46'N-105°19'W) -1995 to 2001- (20km) and Mismaloya (20°05'N-105°32'W) -1997 to 2004 - (28km). During this time, nest poaching rates ranged from 14.6% to 52.0%, and protected nests from 48% to 84%. Over this same time period, the number of nests increased: Chalacatepec 1997=831 total nests recorded (TNR), 2004=2,672 TNR; Mismaloya: 1995=416 TNR, 2001=1,006 TNR. During 2004, we calculated a hatch success rate of 69.59%. This fact illustrates the value of patrolling these beaches daily during the nesting season. Hatch success from the hatcheries and nesting activity recorded each year also tended to increase, although it is still clearly necessary to eradicate illegal activities, such as egg poaching and the fishing and killing of adult sea turtles, because legal arrangements are simply not sufficient in this region. We are optimistic in our results but we recognize that it will require many years of work to restore these populations, and it will require the sustained effort of many organizations and persons. The most important aspect, however, and that which seems to be most lacking, is fundamentally a commitment by Government to surveillance and law enforcement.

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POACHERS, KILLERS AND SKINNERS OF SEA TURTLES IN PLAYÓN DE MISMALOYA, TOMATLÁN & CABO CORRIENTES, JALISCO, MEXICO

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Despite Mexican and international laws protecting all sea turtle species in Mexico, illegal exploitation is common on both coasts. Since the 1950's, exploitation of sea turtle products and by-products has been regulated by the Government, many groups benefited from these productive activities, legally and illegally. Years later, the promotion of conservation of these animals began, and by 1986 many beaches were protected by Presidential Decree (including 'Playón Mismaloya', 69km long – the largest Reserve for sea turtles in Mexico). In 1990 the total protection of all sea turtle species was approved, but many continued these activities until today. We have collected and analyzed material and data about adult sea turtles killed and skinned in Talpichichi Cove, Tehuamixtle Bay, Mismaloya, Majahuas and Chalacatepec beaches (20°14'N-105°33'W/19°38'N-105°12'W) from April 2000 to March 2005. Talpichichi Cove is used as a hiding place to kill sea turtles and to skin them on motor boats. By analysis of skeletal remains we counted 27 IMN (individual minimum number) in April 2002, 19 IMN in October 2002, and 9 IMN in January 2003. Throughout our study we encountered many dead sea turtles of four species: leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), black (*Chelonia agassizii*) and olive ridley (*Lepidochelys olivacea*), with objective evidence of damage caused by human actions. In this work we present almost two hundred documented cases. We also show that local mafias operate illegal activities; they are powerful and it is very dangerous to confront them - government action is very much needed.

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CO-MANAGEMENT MODEL: GANDOCA BEACH CASE

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This project took place in the Gandoca/Manzanillo National Wildlife Refuge (9° 59.972' N, 82° 60.530' W) in Talamanca County in Limon Province, Costa Rica between 1986 and 2005. The objective was to improve the conservation status of the Marine Turtles and increase the local community's income to reduce the threats of this marine species. For 19 years, several organizational models were provided to address the local threats over marine turtles; those models have increased local participation (especially of women), opened dialogue, increased family income and job opportunities, created funds under local administration and increased the numbers of local groups improving the community. At the same time, community participation was complemented with training sessions to increase professional opportunities as ecotourism guides and handcraft artists. Actually, 3 groups have emerged, 90% of the participants are women, the government investment for this protection is reducing, the nest poaching rate by local people in Gandoca Beach is just 1%, compared to 100% in 1985, and adult female poaching has been zero in the last 10 years. The conservation initiatives are now divide into three areas: Sustainable Development, Control & Law enforcement and Conservation & Research carried out by local, governmental and NGO partners. The direct use of marine turtles on Gandoca Beach is vanishing while indirect use is increasing, producing fees from volunteers and services for visitors, which is at least 5 times the income of the value of all eggs in the black market.

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THE NATIONAL MARINE PARK OF ZAKYNTHOS: THE FIRST MANAGEMENT AGENCY OF PROTECTED AREAS IN GREECE

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Since the beginning of 80's, the Greek State issued a series of legislative acts for the protection of the sea turtle nesting habitat in Laganas Bay (Zakynthos Island). The interventions of relevant NGOs, since 1985, at the Bern Convention (Council of Europe) led the Ministry of Environment to declare, in the period 1991-1997, the wider area of the nesting habitat a National Marine Park. The pressure, on one hand, of the NGOs at national and international level for the protection of the nesting habitat, and on the other hand the noted delays in issuing

appropriate legislation and materializing an effective system of protection has guided the European Commission, in agreement with Article 228 of the Treaty, to issue a "Reasoned Opinion" and to commit the Greek State to the European Court of Justice (ECJ). The formation and operation of the Management Agency (the first of its kind in Greece and a pilot scheme for 25 similar agencies to follow in 2002) is a result of the committal of this case to the ECJ, the condemnation ruling of which (31 January 2002) - the first in the context of the Habitats Directive 92/43 - has created a legal precedent. The protection of the nesting habitat and the operation of the Park are now under the guardianship of European Commission after the recent issue of a new "Reasoned Opinion" (18 October 2004) towards ensuring the effective political and financial support of the operation of the Management Agency of the National Marine Park.

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RESULTS OF THE ANALYSIS OF THE NESTS PROTECTION OF MARINE TURTLE *LEPIDOCHELYS OLIVACEA* IN CEUTA BEACH, SINALOA, MEXICO (1994-2004)

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Marine turtle conservation and protection programs were born as a result of great operations in the sixties causing an unusual loss in their populations and a risk of extinction. As mentioned before, the Universidad Autónoma de Sinaloa (UAS) considered the commitment to protect, to conserve and to investigate these inoffensive animals, as well as the natural environment (the ocean and coast). In this work, an analysis of the last 10 years is shown, including the protection and conservation activities in Ceuta Beach Sinaloa, Mexico, focussing on one of the species of marine turtles that nest in the sinaloan coasts, the olive ridley (*Lepidochelys olivacea*). Significant differences ($p=0.001$) exist with respect to the number of nests recorded throughout the beach (35 km), as well as in the years analyzed ($p=0.015$), suggesting a declining trend over the years.

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MARINE TURTLE PRODUCTS IN MAPUTO CITY MARKET

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The sale of marine turtle products is banned by national legislation, however illegal trade continues in Mozambique. WWF Mozambique carried out a rapid assessment to establish the status of marine turtle products in domestic trade in the most important market in Maputo City in April 2004 and October 2005. In the market survey of April 2004, the trade of marine turtle products, particularly inside the shops and galleries, consisted of well-crafted products compared with the ones sold in pavement markets. The results from 13 tourist outlets, including one within Maputo International Airport and another inside the duty free shop, show that they were selling marine turtle products. These products included turtle shell (CITES Appendix I-listed Hawksbill turtle) with ivory and

wood in composite pieces. The total products surveyed corresponded to 37 carapaces. In October 2005 we repeated the survey after a WWF campaign undertaken in collaboration with local NGOs and the Government concerning the status of the marine turtle trade products. The repeat survey focused in particular on the Maputo International Airport and duty free shop, as well as city galleries and shops. Inside the shops, no turtle products were seen for sale amongst other wood carving. There is a need to publicise conventions, international agreements and Mozambican laws, most importantly concerning the status of marine turtles in the world. Interviews with salesmen and shop owners revealed that very little is known about laws and international agreements of endangered and protected species.

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ASSESSMENT, MONITORING AND REPORTING OF CONSERVATION STATUS – HOW DOES THE APPROACH OF THE EUROPEAN UNION FIT TO SEA TURTLES?

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The 25 member states of the European Union are preparing the 2001-2007 report under Article 17 of the Habitats Directive. The Habitats Directive is one of the EU's most significant contributions to the aim of halting the loss of biodiversity by 2010 as set out by the EU heads of state at the Gothenburg summit in 2001. This aim was thereafter confirmed by the World summit on sustainable development in Johannesburg 2002. The overall objective of this EU Directive is to achieve and maintain favourable conservation status for all habitats and species of Community interest. Monitoring, assessment and the reporting should: (a) Help assessing the effectiveness of management measures in Natura 2000 protected areas; (b) Assess the contribution of the Directive to broader biodiversity conservation (2010 target); (c) Help setting priorities for further monitoring; (d) Give indication in how far the annexes of the Directive need adaptation. In order to show how this system of defining favourable reference values and hence the favourable conservation status could work, WWF has started a "Shadow Monitoring" project including different species and habitats. The experiences on how this system is applicable for sea turtles in the Mediterranean illustrate strengths and weaknesses of this EU approach.

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AN ENVIRONMENTAL EDUCATION KIT AS A COMPLEMENTARY TOOL FOR THE MANAGEMENT OF THE NATIONAL MARINE PARK OF ZAKYNTHOS

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Zakynthos island in Greece hosts the most significant *Caretta caretta* nesting population in the Mediterranean, with an average of 1,300 nests on a total of 5,5 km of beaches. In 1999, the National Marine Park was established and in 2000 the first ever Management Agency for a protected area in Greece was formed. As with all protected areas, the viability and success of the National Marine Park will depend on the support and involvement of the public. Therefore knowledge and attitudes must be enhanced to induce positive behaviour toward sea turtle management and conservation. Schoolchildren are considered a good starting point as they are more open to innovations and have a longer period to influence environmental quality. This paper refers to a doctoral research work on Zakynthos regarding 5th and 6th graders. A sample of 332 students was selected from across the island. A 32-item questionnaire was designed, to record and analyse the knowledge and attitudes toward sea turtles. The results indicated a relatively low knowledge level but high scores in attitudes. Based on these findings, and in accordance with environmental education principles, a kit was constructed comprising 15 activities aiming at affecting knowledge and attitudes. After implementing the kit a statistically significant increase in knowledge but not in attitudes was recorded. However, a pattern was formed in the way students replied and reinforcement of attitudes was witnessed. The results confirm the critical role the kit can play in assisting the Management Agency to pursue its longstanding objectives.

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LOCAL COMMISSIONS, A SAMPLE OF IMPLEMENTATION IN CONSERVATION OF SEA TURTLES IN TURKEY

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Turkey has an important role in the conservation of sea turtles throughout the Mediterranean just because most of the populations of loggerhead and green turtles inhabit their coasts. Especially the majority the green turtles, which are critically endangered for the Mediterranean, nest in Turkey coasts including Samandağ. Sea turtles are exposed to many threats because of increasing civilization, technologies and pollution etc. The Ministry of Environment has provided solutions, including the arrangement of local commissions as a part of scientific commission in Turkey. The local commissions consist of local governmental and non-governmental organizations. In total, 5 local commissions were arranged in priority areas of sea turtles in Turkey. In addition, the local commissions were supported scientifically by university teams in some regions. The most reliable advantage of those local commissions was the ability of collecting final products in a roof. Local commissions were useful just because rapid defining of threats, collecting of supports and effective usage of source, rapid

reaction to problems in order to do away with troubles with the advantages of team study. However, the local commissions didn't respond to some expectations in all five areas. There was not a skilled person in the local governmental and non-governmental organizations. Furthermore, there were some difficulties in training the responsible attendant. Local commission got a desirable result thanks to university teams with their continuous studies in Samandağ.

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SEA TURTLE STRANDING PATTERNS IN CALIFORNIA: 1982-2004

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Analysis of records of sea turtle strandings provide an important source of information on spatial and seasonal sea turtle distribution, as well as an identification of local threats to subpopulations. Records of sea turtle strandings (live and dead) off California have been collected since 1982 by a network of individuals and organizations dedicated to responding to stranded marine wildlife. This paper provides the first detailed summary of the California sea turtle stranding network and an analysis of stranding data in California since information was first collected in 1982. From 1982 through 2004, a total of 274 sea turtles have stranded in California. Of this total, approximately 35.8 % were leatherbacks, 34.3 % were green turtles, 13.5 % were olive ridleys, 11.7 % were loggerheads, and 4.7 % were of unknown identification. Analyses of the data reflect spatial and seasonal patterns of strandings with annual variations, and these patterns are coincident with incidental capture in fisheries, at-sea observations, and other available information. Documented causes for strandings include: entrainment in power plants (18%), illness-related (9.1%), boat collisions (8.3%), fisheries interactions (6.6%), and marine debris (1.8%). Nearly 55% of sea turtle strandings were due to unknown or undocumented causes, which is cause for concern since valuable information may be lost from these strandings. In order to address these concerns and improve response to sea turtle strandings and data collected by the network, NOAA Fisheries' Southwest Regional Office (SWRO) held a two-day sea turtle stranding and necropsy workshop in August, 2005. Representatives from the stranding network and NOAA Fisheries' SWRO and Science Centers (La Jolla and Honolulu), as well as invited wildlife veterinarians, participated in the workshop. Following recommendations made at the workshop, the SWRO, with assistance from the Marine Turtle Research Program, NOAA Fisheries, in La Jolla, will establish a protocol of data collection on live and dead-stranded sea turtles, in addition to standardizing and designing a U.S. west coast sea turtle stranding form. In addition, there is a critical need to synthesize information collected on dead sea turtles, including necropsy results. SWRO will investigate existing and potential collaborators or contractors that can serve as the recipient of all stranding and necropsy results, synthesize and summarize known information and make recommendations for future collections. SWRO has also worked to identify facilities within the stranding network to respond to sea turtles that strand dead in Orange, LA, and Ventura counties. Furthermore, the SWRO will work with the offshore Channel Islands to increase reporting and response to stranded sea turtles and consider the logistics of transporting live-stranded sea turtles that may need rehabilitation on the mainland. Lastly, the SWRO will work to design and provide outreach materials to the general public, lifeguards, etc. regarding response and contact information for sea turtle strandings.

THREE YEARS OF MEETINGS ON RESEARCH AND CONSERVATION OF SEA TURTLES IN THE SOUTHWEST ATLANTIC OCEAN (ASO)

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The Southwest Atlantic Ocean (ASO) is comprised of Argentina, Uruguay and Brazil. This region includes developmental/foraging habitats and migratory corridors for five species of sea turtles: *Caretta caretta*, *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata* and *Lepidochelys olivacea*. These sea turtles are threatened due to human-related causes such as habitat modification and incidental captures of juveniles and adults during fishing activities. The Meetings on Research and Conservation of Sea Turtles in the Southwest Atlantic Ocean (ASO) were conducted in Montevideo, Uruguay (2003), San Clemente del Tuyu, Argentina (2004) and Rio Grande, Brazil (2005). Approximately more than 150 people including representatives of the government, scientific sector, fishing communities and NGO's from Argentina, Brazil and Uruguay have participated in these meetings. The main objective of the meetings was to share scientific information about the biology, conservation and rehabilitation techniques of sea turtles. Also, the meetings intended to standardize working methods and scientific protocols for all the projects in order to improve management practices and strengthen collaboration among researchers within the region. We are please to say that the proposed objectives have been achieved in these 3 years. Moreover, several international projects are going on and some others are being planned. Sharing our cultures is an important aspect of the ASO integration and is helping us to understand and address the conservation problems that affect sea turtles in the region.

DECREASING LOGGERHEAD NESTING AT FETHIYE BEACH, TURKEY: POTENTIAL TOURISM IMPACT

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Fethiye beach is one of more than 17 major sea turtle nesting sites in Turkey and was also declared a Special Protected Area in 1988. The beach is 8.5 km long and divided into three sections (Calis, Yaniklar & Akgöl) based on physical features and degree of development. In 1994 the University of Vienna, in cooperation with Dokuz Eylul University in Izmir, began long-term studies in this loggerhead nesting area. During this period, we have observed and documented a number of changes here, most of which are clearly incompatible with the status as a Special Protected Area. From 1994 until 2005 the number of nests in Fethiye varied between 64 and 190. The 12-year data set, however, indicates that nest number has continuously decreased. Here, we highlight the potential contribution of anthropogenic factors to this trend. The tourism industry is the key driving force behind the negative developments along the beach. Although Fethiye beach is within SPA borders, various construction projects have been completed and several are in the building and planning stages. The wetlands directly behind the beach between Calis and Yaniklar, and therefore also including the associated beach, have apparently been approved for tourist development. Sand mining, vehicles, and campers were recorded on the beaches during the nesting season. Floodlights of a newly built apartment hotel cast light on a wide

beach area in Calis. Calis beach along the concrete boardwalk has fine sand and exhibits the highest nest density of this section, but also suffers most from major light pollution from restaurants and bars. Calis beach is highly frequented by tourists at night. In 2005, for example, two female turtles stopped digging their nests due to tourists on the beach and camera flashes. At all sections, garbage was abundant. In Calis, nest cages were used as litter boxes because all the official litter boxes along the promenade were removed for security reasons. At all three beach sections, new facilities are being built and existing bars and sport facilities continue to be enlarged. At Yaniklar beach, two major resort hotels are constantly expanding their watersports facilities (including jetskis and speedboats). These activities are conducted close to the beach, threatening sea turtles. Based on the decreasing number of nests, some urgent implementations of SPA guidelines are necessary to avoid losing this nesting area. A conservation action plan for Fethiye should be designed which satisfies both the interests of the tourism industry and ensures the conservation of sea turtles.

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I INTERNATIONAL MEETING ON SEA TURTLES OF SAO TOME E PRINCIPE

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In an effort to increase the national and international awareness and action of the Sea Turtle Program of Sao Tome e Principe, the local NGO MARAPA is organizing the I International Sea Turtle Meeting scheduled for the last week of January. The meeting has a multidisciplinary approach and the main theme is the conservation of sea turtles in STP. Sub-themes will focus on research, community action, fisheries and tourism. The objectives are to: 1) educate the society in the importance of protecting sea turtles in STP; 2) look forward for the approval of the Project of Law; and 3) establish research and conservation partners for future sea turtle work. As a follow-up; two lists of recommendations will be compiled by the participants, one for the government authorities and the other for partners with research and conservation recommendations for future work.

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EFFECTS OF TRANSLOCATION TIME ON HATCHING SUCCESS RATE FOR *LEPIDOCHELYS OLIVACEA* IN PROTECTED HATCHERIES, MAJAHUAS SOUTH BEACH, TOMATLÁN, JALISCO, MEXICO

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The 69km stretch of beach known as “Playón de Mismaloya”, Tomatlán, Jalisco State, Mexico, in the Eastern Pacific, is one of the most important beach systems for nesting sea turtles. Despite protection laws, the human predation of four species continues illegally in this area. Various governmental organizations and NGO’s are working to restore populations in this region through the daily patrolling of nesting beaches during the reproductive season, locating nests and translocating them to incubate and hatch in protected hatcheries. In this work we evaluate the effect of time between collection and translocation of nests of the olive ridley (*Lepidochelys olivacea*) on hatching success rate in the hatchery. The study site was Majahuas South Beach (9Km long, 19°50’N-105°23’W) in the Reserve of ‘Playón de Mismaloya’; data were collected between January and December 2003 during protection work. Three groups were formed representing translocation times: I: up to 2 hours; II: 2 to 4 hours and III: more than 4 hours. Within these there were 3 subgroups: A: nests collected during ovoposition (n=198), B: nests collected from incubation chamber (i.e. adult female not present during collection) (n=798) and C: A+B (n=996). We found that AI had a hatching success rate of 47.47%, AII=36.7%, AIII=29.75%; BI=38.47%, BII=36.79%, BIII=26.84%; CI=40.3%, CII=36.76% and CIII=29.32%. Using a series of ANOVA tests we found that there were significant differences between all groups; showing a negative correlation between the lapsed time and the hatching rate. This tells us that the hatching rate increases with a decrease in the translocation time.

HUMAN IMPACT ON SEA TURTLE NESTING AT A BEACH IN GUANACASTE, COSTA RICA

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The effects of egg poaching and coastal development on Olive Ridley (*Lepidochelys olivacea*), Leatherback (*Dermochelys coriacea*) and Black Turtle (*Chelonia mydas agassizi*) nesting were studied at Junquillal beach (5.3km long), Guanacaste, Costa Rica, during two years. Poaching destroyed 137 Olive Ridley (88.9%) and 16 Black Turtle nests (84.2%), and it affected 33 Leatherback nests (73.3%). Nests (17 Olive Ridley and 3 Black Turtle) that were hidden when being marked escaped poaching. Average hatching for Olive Ridley term nests were 62.1% (wet season), and 33.4% (dry season). Egg poachers averaged 4.8 per night and covered the whole beach. Nesting spatial patterns did not vary according to species or timeframe, but depended on beach categories (dark beach without buildings, beach sodium lighting, and in front of dark buildings). Most nesting occurred in

front of dark buildings (125.3 nests/km); there was less nesting in dark beaches (61.0 nests/km), and even less in lit beaches (21.3 nests/km). Most non-nesting emergences occurred on lit beaches; fewer desertions were detected in front of dark buildings, and the fewest occurred in dark beaches. Nesting trend information and social patterns for egg poaching were obtained from 36 key informants. According to locals (77%), during the last three decades, the number of Olive Ridley nests has declined. Interviews indicated that there are cultural and economic roots for poaching. Since turtle eggs are seen by poachers as a highly-valued, nutritional, and revitalizing commodity, and as a main source of financial income, their activity is increasing.

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MARINE TURTLES OF ERITREA

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From the seven species of sea turtle representing two families, Cheloniidea and Dermochelyidea, five of them are known to exist in the Eritrean waters namely, Green turtle (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Loggerhead (*Caretta caretta*), Olive Ridley (*Lepidochelys olivacea*) and Leatherback (*Dermochelys coriacea*). The Green and Hawksbill turtles are the most common nesting turtles. One Olive ridley has been found nesting in the Southern Eritrean Red Sea, the first record in the whole Red Sea. Nesting season commences usually at the end of December and lasts until the end of August and it reaches peak from January to March. Almost all nesting sites are found in the offshore islands. Nesting in big numbers is rare, usually two to four per night. Studies have shown that subsistence harvests of marine turtles occur along the Eritrean coast, with several discarded carapaces found at artisanal fishing villages, mostly acquired through incidental capture in nets. However the most pressing issue in this region is the mechanised trawl industry that takes place on offshore waters of Eritrea. This has led to hundreds of turtles being caught as bycatch over the last few years (about 3324 (2462 alive and 690 dead) sea turtles with in the years 1994 - 2004). Other threats to sea turtles on the main coastal areas and islands are over- harvesting of eggs and adults. It was possible to observe that large quantities of eggs (about 90%) were harvested by humans and animals such as foxes and cats. On the coasts of the southern Eritrean Red Sea hundreds of turtle carapaces are found on the fishing camps and coastal villages of which more than 90% of the carapaces are of Green turtles. Almost all fishing gear used by the local fishermen are gill nets and hooks & lines (do not use trawl nets and long lines); therefore no incidental catch except in rare cases. The Ministry of Fisheries is working to conserve marine turtles through the Eritrea Coastal Marine and Island Biodiversity (ECMIB) Project. This began in 1998, with the support of the Global Environment Facility (GEF) and UNDP Eritrea. The project in cooperation with the Ministry of Fisheries is planning to make efforts to enhance public awareness through the community-based turtle protection and monitoring programmes through cooperatives of the fishermen set every coastal village and islands including fishing camps. Since sustainability of sea turtle conservation efforts depends mainly up on the participation and education of the local people it is useful to incorporate local people in the monitoring and management programme. Educational programme could be the best method to apply to halt the dangerous situation.

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**A COMPARISON OF TWO METHODS TO PRODUCE LEATHERBACK HATCHLINGS
(*DERMOCHELYS CORIACEA*) EX SITU: GREENHOUSE AND INCUBATION CHAMBER**

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The critical state of the Eastern Pacific leatherback population requires that, among other measures, nesting beaches throughout the breeding range are protected, and that a maximum of viable hatchlings are produced to prevent the species' extinction. Agua Blanca, a 36 km stretch of beach on the Pacific coast of Baja California Sur, is the northernmost nesting beach in the East Pacific and is considered of secondary importance among the main nesting beaches in Mexico. However, low temperatures that average from 20 to 23°C, from November to March do not allow hatching, because embryonic development stops at early stages. Since 2000, an artificial incubation chamber with temperature control has been used to produce hatchlings, where nests are incubated in Styrofoam boxes. However, hatching success was relatively low (9-40%) and preliminary studies showed that all hatchlings were females. Therefore, in the nesting season 2004-2005, a greenhouse was built on the beach, and temperatures in the sand were monitored throughout the season. The average temperature in the sand at 80cm depth rose by 5-7°C in the greenhouse, when compared to control measurements on the beach, and temperature variations were much lower than in the incubation chamber. This indicates that the greenhouse may be a better method to incubate Leatherback nests on beaches where temperatures are too low for natural hatching. The results of the comparison of nests incubated with both methods during the nesting season 2005-2006 are being discussed.

**ANTHROPOGENIC IMPACT ON NESTING BEACHES OF THE OLIVE RIDLEY SEA TURTLE
LEPIDOCHELYS OLIVACEA IN SOUTHERN BAJA CALIFORNIA PENINSULA**

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The extent of potential habitat degradation in the nesting beaches is addressed here and how it could be related with nest productivity. This presentation is focused on the nesting zone of Los Cabos in the Gulf of California, Mexico, from Punta Palmilla (23°01'N, 109°42'W) to Las Destiladeras beach (23°08'N, 109°29'W), 30 km long, during the nesting season of 2004 started in May and finished in January 2005, with a total production of 374 olive ridley nests. In order to assess the impacts on coastal dunes and nesting beaches from human activities, a method is proposed assigning one of five numerical values or scores to several beach or dune characteristics, depending on their damage or vulnerability conditions. The human impact for each place is calculated as the sum of scores divided by the maximum possible. This index showed that two adjacent beaches near the fishing village named La Playa, La Playita and El Ranchito, were highly affected by human activities. Particularly La Playita had the maximum impact in seven concepts, all of them related to settlement. The tourist corridor was not as highly

impacted as one can expect, thanks to surveillance promoted by hotel administrations. Two related concepts provoked higher impacts on nesting beaches: open access and motorized vehicles driving, excepting those localized in the tourist zone, where some constraints are imposed to visitors and driving is not possible. On the contrary, horse riding and ephemeral infrastructure did not cause significant impacts.

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GREEN TURTLE HUNTING IN TORRES STRAIT: COMPLEXITIES OF LOCAL MANAGEMENT FOR AN INTERNATIONALLY ROAMING TURTLE

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In this paper we (1) provide a robust evaluation of hunting issues and Indigenous and Government perspectives on hunting management in Torres Strait and (2) assess options for local management of Torres Strait turtle populations by community organizations in light of the Torres Strait treaty, broader legislation at the international and foreign Government levels, and the ecological scales necessary for successful turtle management. Torres Strait lies between Australia and Papua New Guinea. It includes 17 island communities, and Torres Strait Islanders identify themselves as Indigenous Australians. The breeding population of green turtles in Torres Strait and northern Queensland (Raine Island) is among the world's largest (Seminoff 2002) and it is subject to a large and legal harvest in at least three countries (Australia, Papua New Guinea and Indonesia) (Limpus *et al.* 2003). Green turtles are important aspects of Torres Strait Islander culture and under Australian Legislation Islanders can hunt marine turtles for traditional purposes as an unmanaged harvest. The development of local management strategies is difficult given 1) the strong association between turtle harvest rates, and the harvest rates of other traditional and commercial fisheries such as dugong and lobster and 2) the complex multi-Government structure responsible for the management of natural resources and Governance in the region. Leaders of Torres Strait communities have asked for help from the Australian Government with co-management strategies for two decades. Yet despite these requests there have been no Government attempts at managing the harvest of marine turtles in Torres Strait. However, although "local management" is necessary, it is more than a "local issue". Under the international Torres Strait treaty Papua New Guineans are permitted to hunt turtles from Torres Strait, but are not subject to the same hunting restrictions as Torres Strait Islanders – they use nets and sell their catch (Kwan 1991). The Balinese (Indonesian) turtle trade is still occurring with thousands of turtles being caught per year (Adnyana 2004). Indeed, molecular studies indicate 12% of turtles caught for the Bali turtle trade were from the Torres Strait/nGBR breeding population (Dethmers and Broderick 2002). Illegal vessels from Indonesia are regularly seen in Torres Strait with catches of turtle, shark fin and dugong which compound the issue further. The results of our study indicate that communities in Torres Strait are interested in the development of co-management strategies that work towards equitable outcomes. However, Torres Strait islanders perceive other "international" threats as main issues and feel more should be done at a regional scale to prevent illegal hunting. Solutions will need to be International in nature, whole of Government and involve strategies that address key socio economic issues in coastal communities in Australia and overseas.

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MARINE TURTLE CONSERVATION AT THREE NESTING SITES IN SIRTE, LIBYA

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From 12 July to 24 September 2005, a program for marine turtle nesting conservation was conducted at three nesting beaches west of Sirte, Libya, in cooperation between EGA and MBRC and the support of RAC/SPA-MAP-UNEP. 73 loggerhead sea turtle *Caretta caretta* nests were protected both in situ (n=16, 22%) and through translocation into two separate hatcheries (n=57, 78 %) due to high canine predation and illegal poaching (29.1% and 12.5% respectively). All nesting activity reported was done by Loggerheads. Track density was 13.58 tracks/km (n=77, beach length 5.67 km, Site 1: Al-Ghbeba beach); 17.7 tracks/km (n=63, beach length 3.56 km, Site 2: The thirtieth beach) and 6.3 tracks/km (n=36, beach length 5.72km, Site 3: The fortieth beach). Mean hatching rates were varied between translocated nests and nests protected in situ: 69.8 % and 89.4% respectively at site 1; 85.1 and 95.9% at site 2, whilst at site 3, the mean hatching rates were 74.2 % and no in situ protection was applied. A total of 3,179 hatchlings were successfully released to the Mediterranean Sea. Measurements for four stranded loggerheads (CCL 60, 61, 63, 72 cm) and potential causes of mortality were discussed. The program was setup and achieved for the first time in Libya to protect marine turtle nests at selected sites for the whole nesting season, in implementation of national and regional Action plans for the conservation of marine turtles adopted by MAP, in addition to the recommendations of past surveys (1995-1997-1998). The program also targeted training of national biologists and 35 Libyan scout volunteers. The program was a main news line at the local radios and press of Sirte, Misurata and Libyan TV presented for interviews with team members throughout the program period. A final seminar was organized on 2 October 2005 to present the results to the local authorities.

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THE DONATION SYSTEM OF GUATEMALA

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Sea turtle conservation in Guatemala has historically relied heavily on the use of community-based hatcheries and a voluntary donation system where egg collectors are asked to donate 12 - 20% of each nest to these hatcheries. Although the donation system is not perfect, it does have its advantages and in resource-poor developing countries such as Guatemala, may be a viable alternative to more strict conservation measures. The donation system has managed to encourage local support for sea turtle conservation activities in certain communities and has continued to provide poor coastal communities with a sorely-needed source of income. With the increase in ecotourism and an interest in sea turtle watching, the donation system and the use of hatcheries is an increasingly promising source of long-term, self-sustaining income. Strict conservation measures implemented in other developing countries such as the establishment of protected areas and all-out bans on egg-collecting often fail, leading to the creation of paper parks and empty legislation lacking any level of community support. Hatchling success rates of in situ nests are often very low, and research carried out by Project Parlama in Guatemala has found that in-situ nest temperatures in most years are much too high for the successful incubation of nests. Given these socioeconomic and biological factors, the donation system being implemented in Guatemala may be a feasible alternative for other stricter, less participatory conservation measures.

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UPDATE ON POPULATION STATUS AND DEVELOPMENT OF MULTI-STAKEHOLDER MANAGEMENT OF LEATHERBACKS IN PAPUA, INDONESIA

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The importance of leatherback turtle nesting beaches, on the Birdshead Peninsula of Papua, Indonesia has generated support and interest from many parties. Geographic isolation, the complexities of local village and regional politics, and socio-economic hardships are some of the challenges to establishing a cohesive research and conservation effort. Communication between government and community-based patrol systems to eliminate egg poaching have been advanced and implementation of scientific research activities (telemetry, genetic stock identification, hatching success, aerial nest counts) have provided a new understanding of the population and its distribution. As a result of this increased monitoring, year-round nesting has been confirmed at Jamursba Medi and

Warmon, the two major nesting sites in this region. Based on monitoring data (collected by patrollers) from January to September 2005, at least 2,780 clutches were recorded in Jamursba Medi, while in Warmon 2,080 clutches were counted from November 2004 to September 2005. Temporal clutch distribution over last two consecutive years in Warmon and recaptured of tagged turtles from Jamursba Medi (during 2005 nesting season) showed the year-round use of Warmon beach for nesting. With highest peak occurred in February and smaller peak occurred in July. It is concluded that Warmon beach and several unprotected beach to the east is a critical nesting habitat for leatherback turtles during winter when the natural beach erosion in the western stretches like Jamursba Medi, but also important during summer. Recent data on migration routes indicate that this substantial population has been using multiple foraging grounds in nearby and distant waters. Recaptured of two female turtles PIT tagged in 2003 and two females in 2004 also confirmed the presence of nearby foraging grounds. Preliminary studies also suggest low hatchling production resulting from nest destruction due to seasonal beach erosion, widespread feral pig predation, and low hatch success. These results underscore the holistic approach that will be necessary to effectively manage this population. Current on-site protection (through beach patrol) has been successful in eliminating poaching, however non-human induced threats (such as predation, poor beach quality) are critical in maintaining the population in a long term basis. Involvement of all stakeholders in ensuring effective protection and management of the turtle population and habitat is currently being pursued by community groups, landowners, researchers, local government and national management authorities. Coordinated activities, including population monitoring and research and management activities (such as feral predator control) are planned that will involve local communities directly in their implementation. Long-term support from local communities is jointly pursued by WWF, NOAA and partners through an incentive agreement scheme for this region.

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MARINE TURTLE CONSERVATION, MANAGEMENT AND POLICY DEVELOPMENTS IN THE INDIAN OCEAN - SOUTHEAST ASIA REGION

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Technological advances over the past decade have greatly enhanced our ability to exchange useful information about marine turtle conservation and management across vast areas. The Indian Ocean – South-East Asian (IOSEA) Memorandum of Understanding has been at the forefront of developing innovative applications to aid practitioners in over 40 countries. Tools found on the IOSEA website (www.ioseaturtles.org) include a sophisticated online reporting facility to monitor implementation progress in 24 Signatory States, a searchable database of marine turtle conservation projects in over 20 countries, a wide-ranging electronic library, and current news and features. Improvements made to the IOSEA reporting system enable it to make an important contribution towards monitoring application of the 2004 FAO Guidelines to Reduce Sea Turtle Mortality in Fishing Operations. A regional overview of strengths and weaknesses in IOSEA MoU implementation, knowledge gaps, and opportunities for improvement will be presented, drawing on objective analyses made of the IOSEA national reports. Information will also be presented on the conclusions of a region-wide assessment of leatherback status and tsunami impacts; progress towards the development of a network of sites of importance for marine turtles in the IOSEA region, and activities underway and planned for the IOSEA Year of the Turtle campaign, launched officially on 1 March 2006.

DEFORESTATION: RISK OF SEX RATIO DISTORTION IN HAWKSBILL SEA TURTLES

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Phenotypic sex in sea turtles is determined by nest incubation temperatures, with warmer temperatures producing females and cooler temperatures producing males. The common observation of highly skewed female-biased hatchling sex ratios in sea turtle populations could have serious repercussions for the long-term survival of these species and prompted us to examine the thermal profile of a relatively pristine hawksbill nesting beach in Guadeloupe. Data loggers placed at nest depth revealed that temperatures in the forested areas were significantly cooler than temperatures in the more open, deforested areas. In addition, palm trees provided insufficient shade and sand temperatures were similar to treeless areas. Using these temperatures as a predictor of sex ratio, we were able to assess the relative contributions of the different beach zones to the primary sex ratio: significantly more males were likely to be produced in the forested areas. Coastal forests are therefore important male-producing areas for the hawksbill sea turtle and this has urgent conservation implications. On Guadeloupe, as on many Caribbean islands, deforestation rates are high and show few signs of slowing as there is continual pressure to develop beachfront areas. Nesting beaches per se may still remain, giving the illusion of the preservation of critical habitat, but systematic destruction of forested areas could be catastrophic for hawksbill demography and continued survival. Given there is strong nest-site fidelity, both to specific beaches and to specific beach zones, it is unknown what effects the destruction of a particular microhabitat will have on nesting behaviour as well.

THE ROLE OF NGOS IN SEA TURTLE CONSERVATION ON ZAKYNTHOS, GREECE

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The establishment of the National Marine Park of Zakynthos in 1999 proved pivotal in changing the role of NGOs involved in the protection of loggerhead sea turtles and their nesting habitats at the local level. Prior to the NMPZ, the activity of NGOs was viewed negatively by local society because (i) during field monitoring NGOs tried to enforce national legislation for the protection of sea turtle nesting habitats, (ii) national and international NGOs lobbied Greek governmental bodies and the European Union towards establishing the NMPZ, and (iii) on many occasions, the financial investment by locals in the booming tourism industry clashed with NGO efforts to protect the sea turtles. The NGOs soon recognized and began to rectify these problems by establishing links and organising regular meetings with local governmental authorities, affected stakeholders and businesses, in parallel to their field monitoring and public awareness schemes. Furthermore, WWF-Greece undertook the pioneering initiative to purchase the land surrounding the most significant nesting beach on Zakynthos, thus securing its long-term protection against illegal development. The long conservation and lobbying presence of NGOs on the island facilitated a series of coalitions with local stakeholders. The establishment of the NMPZ diversified the roles of locally active NGOs and strengthened links with the local community by giving them an official voice on the NMPZ management body. This improved the level of acceptance of NGOs by local society, although a general feeling of mistrust remains. This presentation discusses the diversification of the roles of NGOs aiming at sea turtle conservation on Zakynthos over the last 20 years.

PILOT SAND DUNE RESTORATION AT KOTYCHI-STROFYLIA LOGGERHEAD NESTING BEACH, NORTHWESTERN PELOPONNESUS, GREECE

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The aim of the paper is to study whether implementation of fences could contribute to the restoration of depleted embryonic shifting dunes at the Kotychi-Strofyliia protected area (also a loggerhead nesting site), Northwestern Peloponnesus, that hosts one of the most extensive dune ecosystems in Greece. The natural embryonic dunes are N-S oriented, have 0.5-2.0m height and form a natural barrier along a 7km beach. The northern part of the beach (1.5km) is heavily affected by visitors while the rest is well preserved. Vehicle traffic, illegal parking, moto-cross events, camping and sand extraction are the major reasons for depletion. Five sites were chosen to be restored at the most popular part of the coast. Vegetation, beach inclination, height of the surrounding dunes and distance to the sea differed from site to site in order to investigate whether these factors influence or not sand accumulation. In total, 400m of fences (0.5cm height, 45-50% porosity net) were placed in single or double rows (2m distance) in two stages (autumn 2004 – summer 2005) and accumulation rates have been monitored for one year (September 2004 – August 2005). 33 main fences were placed against the prevailing W winds trapping sand carried away from the beach and 12 secondary ones against N and S winds preventing sand loss along the main fences. Different sand accumulation rates among fences and seasons were attributed to meteorological changes and variations in dune morphology and vegetation. Higher accumulation rates were observed in: a) November and February due to strong wind events (over 6 Beaufort, >11 m/sec) b) April-May-June due to significant percentage (>12%) of prevailing winds over 4 Beaufort (>5.5 m/sec) and low precipitation c) July-August due to dominant prevailing winds (16.5-21%) over 4 Beaufort, strong wind events (>6 Beaufort) in August (0.5%) and very dry conditions. Higher rates were observed in flat blowouts having wide openings towards the beach and no vegetation. Existence of plants in other sites resulted to the expanding of vegetation at newly restored areas contributing to their stabilization and showing that plantations are needed for successful dune restoration. The placement of fences contributed to the creation of natural dune profiles, even when they weren't totally covered, according to the following procedure: a) accumulation of sand (up to 30cm) in front and behind of 1st row fences b) accumulation of sand between the two rows of fences and in a wide area (3-4m) around them c) covering of first row fences and significant accumulation of sand at the 2nd row ones (>30cm). Additional activities such as fencing, construction of wooden trails facilitating access to beach and sign-posting are under implementation for the management of visitors and protection of the ecosystem.

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CIRALI: AN EXAMPLE FOR COMMUNITY-BASED CONSERVATION OF MARINE TURTLES

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Cirali is a small coastal village on the Mediterranean coast of Turkey, backed by the high mountains of the Olympos National Park. Its natural and cultural richness was enjoyed by the locals and a few tourists. Cirali hosts numerous rare and endemic plant species and the endangered loggerhead turtle (*Caretta caretta*). The town, which previously was based on an agricultural economy, moved towards tourism in the late '80s. Cirali beach is one of the important nesting sites for the loggerhead turtle along the Mediterranean coast of Turkey. The field surveys on marine turtle nesting in Cirali are done since 1994. These surveys and conservation efforts were done by DHKD and WWF Turkey between 1994-2001 with national, international volunteers and local people. Since 2002, conservation and monitoring activities are organized by a local NGO namely Ulupinar Cooperative with the financial support of the United Nations Development Programme (UNDP)/ GEF-SGP. The efforts in Cirali have given good results such as increased track and nest numbers (the number of nests was 34 in 1994 and 54 in 2005) due to restriction of vehicle entrance. Entrance to the beach at night, fires, light and noise pollution are now under control and the marine turtle nests are protected by caging. This conservation and monitoring studies will continue in the future. Cirali, due to its natural characteristics, can be considered as an alternative to already destroyed marine turtle nesting beaches in Antalya region.

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CANCELLED

CUSTOMARY VERSUS LEGAL GOVERNANCE: INTEGRATED APPROACH IN ADDRESSING TRADITIONAL HUNTING PRACTICES ON LEATHERBACK TURTLES IN KEI ISLANDS, MALUKU-INDONESIA

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Leatherback sea turtles (*Dermochelys coriacea*), known locally as Tabob, are the most important marine species for indigenous people at several villages in the Kei Kecil Islands (called Nu Fit) for serving subsistent and ritual needs. Despite catastrophic declines in Pacific leatherback turtle numbers (Spotila *et al.* 1996) and strict laws prohibiting their use and accidental catch in fisheries, this species remains a part of the traditions and cultural identity of the Nu Fit. Substantial advancements in scientific studies provide critical information for protection strategies, but

are often difficult to apply when dealing with deeply rooted traditional beliefs. The final decision on conservation is often in the hands of people acting in their own benefit, as well as in a way that is perceived to benefit the turtles. Building trust through friendships and sharing on community issues, values, and beliefs (knowledge) was the first step taken when this initiative started. Monitoring involving hunters is a form of people engagement in conservation activities, and by involving hunters we were able to gather information on the numbers, locations and seasonality of turtles killed. This continuous process over two years has led to a better understanding of the socio-cultural relationship between people, leatherback turtles, and hunting dynamics, including which groups and/or families are principally involved and under what circumstances leatherbacks are killed. Scientific knowledge on turtle biology, status, and community conservation initiatives elsewhere were later shared with communities using popular media such as video presentations, booklets, displays and informal conversations including discussing the relationship between science and local perceptions of the fate of the leatherback as a species. Connecting Nu Fit people with other communities and individuals involved in conservation was considered important. To this end, visits by scientists from the US National Marine Fisheries Service and other conservation scientists, as well as cross-visits with Nu Fit representatives to nesting beach and community patrols in Papua New Guinea were sponsored. Conservation results from those approaches showed behavior changes in some individual villages and individual hunter/groups in giving up hunting practices and the consumption of leatherback meat. Hunting monitoring activity recorded that only two out of nine hunting villages have the highest hunting intensity. However, this result did not necessarily impact the number of turtles hunted. It was later observed that leatherback issues were very much related to the power within the communities (customary governance versus legal governance), thus conservation efforts might create potential conflict between groups of people in power, especially in the case of these two villages. Aiming at the short-term objective to reduce hunting activities by influencing people to redirect time and energy to other popular activities (e.g football/soccer competition, Nu Fit festival) and the long-term objectives to institute a management mechanism for local enforcement, adaptive management will be used to maintain flexibility. This approach includes promoting non-consumptive use of the species, the involvement of people in research and monitoring, marine eco-tourism and education. Continuous process of building understanding on the foraging ecology of leatherback turtles, implementing effective ways to reduce social conflict and connecting people with outsiders to share experiences and knowledge are fundamental approaches for this conservation initiative.

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LEATHERBACK NEST ECOLOGY IN THE GAMBA COMPLEX, GABON: IMPROVING HATCHERY OUTPUT

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Gabon, West Africa has recently been recognised as supporting one of the largest leatherback populations in the Western Atlantic. Due to the relatively new discovery of this population, limited data have previously been collected on nest success, hatching success and associated threats. Several aspects of the nest ecology of leatherback turtles were investigated on a 5.75 km stretch of nesting beach within the Gamba Complex of Protected Areas situated in the Congo Basin. The main hazards for nests were identified to be erosion and inundation by tides, heavy predation by ghost crabs, and occasional predation by monitor lizards and civettes. Egg poaching was not

witnessed in the study area, but was seen sporadically along the adjoining coastline. In 2004 an enclosed hatchery was created for the translocation and protection of threatened nests, mainly from crab predation. As well as a conservation measure, the hatchery proved successful in attracting visitors, helping to raise awareness and generate funds for conservation work. The overall nest success was higher in the hatchery. However, as found in many hatcheries, the hatching success of nests in the hatchery was found to be significantly lower than in undisturbed natural nests. In creating a baseline of data on the nest ecology (depth, temperature, hatching success and hatchling fitness) of in-situ nests in 2005/2006 and revising translocation methods, improvements have been made to the hatchery to increase hatchling output. Comparisons of the leatherback nest ecology in the Gamba Complex are made with other leatherback populations in the Atlantic.

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A SUCCESSFUL CO-MANAGEMENT OF MARINE TURTLE CONSERVATION IN MNAZI BAY- RUVUMA ESTUARY MARINE PARK, TANZANIA

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Mnazi Bay – Ruvuma Estuary Marine Park is located in Mtwara region at the Southern tip of Tanzania's coast that borders with Mozambique. It was gazetted in 2000 after having been recognized as an area of rich biodiversity of national and international value. The long-term conservation strategy for marine turtles was developed in October 2003. The aim was to ensure their long-term survival and reduce the threats from hunting, habitat disturbance and fisheries by-catch. The implementation of the strategy began in January 2004 and emphasized involvement of local communities in conjunction with awareness raising, education, research, monitoring and eco-tourism. There are currently four trained Community Turtle Officers who are involved in management of four key nesting sites in the park. In 2004 a total of 34 nests were protected with average incubation period was 54 days. Five Skin samples for DNA genetic analysis have also been collected and 2 turtles have been tagged. This information suggest that the strategy is having a positive impact on turtle populations, and is encouraging a feeling of ownership of natural resources by local communities. This is essential for the long-term sustainability of conservation activities. The implementation of the conservation strategy will continue with emphasis on researching the movements of turtles between nesting sites and foraging grounds, encourage trans-boundary conservation, improve local community knowledge on effective information gathering as accurate as possible. The awareness raising through village meetings, conservation competitions and the development of boat-based eco-tourism to inaccessible sites will be encouraged. The success of the strategy will accelerate tourism industry, promote research, fishing industry which together will accelerate the national economy hence alleviate poverty.

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DO TURTLES MOVE WITH THE BEACH? BEACH PROFILING AND POSSIBLE EFFECTS OF DEVELOPMENT ON A LEATHERBACK (*DERMOCHELYS CORIACEA*) NESTING BEACH IN GRENADA

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Grenada, West Indies hosts a regionally significant nesting leatherback population. Located in the northeast corner of the island, Levera Beach is one of the primary nesting sites for this population. From May-June of 2005, I conducted a nine week study to examine the correlation between leatherback nest distribution and beach erosion patterns and to document possible effects of a recent beach front development project on this index nesting site. Data I collected includes weekly beach profiles, nest positions, and photographic evidence of the development. Beach markers georeferenced with GPS were placed along the length of the beach at the vegetation line and were used as origins for the beach profiles and to triangulate nest positions. The beach erosion patterns and impact to nest sites were assessed using GIS analytical tools. Recent reductions in buffer vegetation due to development at the west end of the beach may be increasing the runoff of fine-grained sediments, which may alter sand composition in that area. Nest distribution data from nesting seasons in 2000-2005 were compared to assess whether there is a significant difference in the proportion of nesting turtles that have chosen to nest in areas impacted by the development. The spatio-temporal placement of turtle chosen nest sites was modeled with the erosion/accretion pattern of the beach for the 2005 season. Implications of a possible change in sand composition coupled with nest distribution in the area affected by development are presented.

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BASTIMENTOS ISLAND NATIONAL MARINE PARK AND PLAYA CHIRIQUI: PROTECTED AREAS VITAL TO THE RECOVERY OF THE HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) IN CARIBBEAN PANAMA

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Bastimentos Island National Marine Park in Bocas del Toro Province, Panama, confers protection to four species of marine turtles, but it is particularly important for the conservation of the hawksbill turtle (*Eretmochelys imbricata*). The park provides developmental and adult foraging habitat, serves as a mating area, and offers well-protected

beaches for nesting. The park was created in 1988, and nest surveys conducted on the Zapatilla Cays in most years from 1990 through 2005 document an increase in hawksbill nesting activity. Hawksbill nest totals recorded in 2003, 2004, and 2005 are 82, 130, and 196. Favorable characteristics such as the lack of mammalian predators, absence of lights, and limited presence of humans contribute to high levels of nesting success and nest productivity as measured by careful nest inventories of nearly all nests. Playa Chiriqui, the most significant hawksbill and leatherback nesting beach in the region, has recently gained protected status as the Damani-Guariviara Wetland and is proposed for RAMSAR status. Hawksbill nest totals recorded in 2003, 2004, and 2005 are 389, 473, and 401. Threats from poaching and predators, especially dogs, are more difficult to address on this mainland beach, although progress is being made through significant community involvement in the turtle monitoring project. Throughout the province, hawksbills are still threatened by harpoon fishers and lobster divers, and nests are subject to poaching. Bastimentos Island National Marine Park and Playa Chiriqui play a critical role in ensuring successful hawksbill reproduction in Caribbean Panama. The need for careful management of ecotourism is becoming evident at the Bastimentos Park, where daytime recreational use has increased dramatically. Long-term survivorship of this recovering population will depend on the social, economic and environmental sustainability of the region.

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A MODEL MANAGEMENT PLAN FOR SEKANIA, THE MOST IMPORTANT MEDITERRANEAN SEA TURTLE NESTING BEACH

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WWF-Greece took an unprecedented step on a national scale in 1994 by purchasing 32.4 hectares of land, adjoining the most densely nested loggerhead sea turtle beach of Sekania on Zakynthos Island. Sekania beach, every nesting period, hosts the half nests of the six nesting beaches in Laganas Bay (600-1000 nests). For the purpose of conservation WWF-Greece immediately developed the framework for a multidimensional management plan involving activities in field and social level. The compiled Management Plan includes:

- Research of the biotic and abiotic parameters of the marine and terrestrial habitats of the area; meteorology, geology, topography, ecology, flora and fauna, as well as land use by humans and impacts incurred.
- Active field management to optimize the beach nesting area; erosion containment and control, monitoring beach vegetation encroachment, monitoring beach slope dynamics, beach cleaning.
- Wardening programme; regulating visitors to the nesting beach, safeguarding against fire.
- Public interface; representative on the National Marine Park of Zakynthos Management Body, visitor and local public awareness activities in hotels and at schools, collaborations with local, national and international businesses, authorities and NGOs.
- Infrastructure; information and guard kiosk, access road maintenance and water tanks for fire control.
- Facilitating operation; hiring appropriate personnel, fund-raising activities, regularly re-evaluating and updating activities in response to anthropogenic and/or environmental changes.

WWF-Greece management decisions are carefully researched in collaboration with the Management Body of the National Marine Park of Zakynthos, the Forest Directorate of Zakynthos, environmental agencies, universities and

NGOs. The collaboration with ARCHELON through: a. the implementation of ARCHELON monitoring nesting programme at Sekania beach and b. the common representation to the Management Agency of the National Marine Park of Zakynthos ensure the holistic and effective monitoring and protection of the area. This poster provides an overview of the WWF-Greece integrated management plan implemented at Sekania between 1994-2004, and the implications to the future of this important yet fragile loggerhead sea turtle nesting habitat.

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TOWARDS THE IDENTIFICATION OF KEY AREAS FOR SEA TURTLE CONSERVATION IN THE GULF OF VENEZUELA

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The identification and characterization of feeding and nursery habitats have been recognized as important areas of investigation for the conservation of the sea turtles on a global scale. The Gulf of Venezuela is considered to be one of the most important feeding areas along the Venezuelan coast, with regional (Caribbean) significance as well. Four species of sea turtle have been reported in the Gulf: green, hawksbill, loggerhead and leatherback. The identification and characterization of feeding and nursery habitats are recognized as critical areas of investigation for the conservation of these species in Venezuela. As a first step toward understanding these areas, we used Geographic Information System (GIS) tools to integrate layers of data on locations of capture, poaching, and sale of these species (obtained between 2000 and 2005) with data on the depth, substrate type and vegetation cover in the Gulf. We also included roads and centers of human habitation, data from flipper tag recoveries, and preliminary genetic results. At least 625 turtles are killed in the Gulf annually by turtle hunters who sell the meat of green, loggerhead and hawksbill turtle, and the oil of the leatherback turtle. The main centers of commerce are Tapuri, Paraguaipoa, Casusain, Porshoure, Parashiou, and Castilletes, which are near to roads. All capture sites (n=129) had shallow waters (less than 15 m) with three main substrate types: seagrass beds, rocky, or sand/ mud substrate. For all species the most common life stages captured were subadults and juveniles; however, adults were captured principally of green and leatherback turtle. The most common tag returns were of turtles tagged in Costa Rica, but tags were also recovered which had been placed in Bermuda, Florida, and Panama. An analysis of these results permitted us to estimate the minimum potentially available area for each of the five Gulf species, by assuming that the preferred habitat of these species is similar to the areas where poaching is highest. Similarly, we identified the areas of greatest poaching intensity for all species to be: Castilletes, Tapuri, and Puerto Chuwaruluu; our results suggest that the green turtle is the most threatened by these activities in the Gulf, followed by the hawksbill.

NOURISHED BEACH BIOLOGY AND DYNAMICS

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Sea turtle nesting habitat is disappearing as urban development increasingly encroaches on native coastlines. This development impairs a beach's ability to undergo seasonal erosion and accretion, particularly after storm damage. Beach nourishment projects have become common practice in Florida to protect coastal property. Beach nourishment replaces native sand with that usually dredged from an offshore burrow site. Although this serves as a temporary remedy for erosion, it creates an environment that may be suboptimal for sea turtle nesting and incubation. This project investigates the biology and dynamics of a nourished beach by examining the correlations of over 15 physical and 21 chemical properties measured on a total of 45 nourished and native Florida beaches. Ideally, every beach nourishment project will try to match the burrow sand material to that on the native beach. However, a beach is a 3-dimensional feature that varies temporally and spatially in form and sediment composition. As such, data show that nourished beaches can have properties that are similar as well as different to those of native. These properties vary depending on factors such as sand sources, geography and nourishment protocols. However, based on the physical nature of sand as well the correlation between its properties, certain statements can be made on how nourished beaches can impact sea turtle nesting and incubation. For example, nourished sand is unsorted and holds more water. This makes it more compact, and with higher bulk density and humidity. These factors influence nest integrity and egg water potential that can negatively impact sea turtle incubation and hatchling emergence. Nourished beaches also tend to have higher organics, metals and carbonate content. These in turn can negatively affect beach hardness, incubation gas concentrations of oxygen and carbon dioxide as well as their diffusion rates, incubation duration and hatchling viability. Because the relationships and correlations between all measured parameters are complex and interrelated, we developed a flow chart to model how specific sand parameters influence each other. This can serve as a guide to help forecast how a particular beach nourishment project will impact nesting and hatching on your beach.

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OLIVE RIDLEY POPULATION TRENDS ON THE PACIFIC COAST OF GUATEMALA – CRAWL COUNTS AS MANAGEMENT TOOL

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ARCAS is a Guatemalan NGO managing an integrated coastal zone management effort in the Hawaii area of the Pacific coast of Guatemala, Central America. As part of its sea turtle conservation program, it has been conducting crawl count surveys since 1997 in an attempt to determine nesting density and long-term population trends of

the olive ridley and leatherback sea turtles nesting in the area. In 2004, ARCAS entered into a collaborative relationship with the British NGO AMBIOS and other NGOs to improve and standardize data-gathering and management efforts at the hatcheries operating along the coast. This collaborative effort - dubbed Project Parlama after the local name for olive ridleys - is the first time that sea turtle conservation and research activities in Guatemala have been relatively coordinated, holding great promise for future conservation efforts and an important first step in mapping out population trends along the entire coast of Guatemala. Using crawl count data as well as data gathered in the course of the management of its hatcheries, ARCAS and Project Parlama hope to: 1) establish baseline data and determine population trends along the entire coast; 2) determine the economic value of the trade in sea turtle eggs in Guatemala, and; 3) monitor local compliance with voluntary egg donations. In following an active policy of information-sharing, ARCAS hopes to document the importance of egg collection in local culture and economy and guide future policy towards a balanced approach to both social and conservation needs.

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RESULTS OF THE 2005 NESTING SEASON OF THE SEA TURTLE RESEARCH AND CONSERVATION PROJECT IN THE PARIA PENINSULA, SUCRE STATE, VENEZUELA

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The goal of this seven-year project is to protect the gravid females and their nests on the two most important nesting areas on the Venezuelan mainland. Beach surveys were initiated by March 2005. The Project Team arrived to the beaches in early April, first to Cipara Beach (62°42'W, 10°45'N) and shortly after to Querepare Beach (62°52'W, 10°42'N). The work included tagging the female leatherback turtles (*Dermochelys coriacea*) with a metallic tag and an AVID PIT tag. The Cheloniidae species only received a metallic tag. Curved carapace measurements (SCL and CW) and notes on the general condition of the turtles and the presence of tag scars were recorded. Daily censuses were conducted to estimate the total number of reproductive events and related information. The nests were transferred to protected hatcheries. In addition, blood samples were taken from the leatherback turtles on Querepare Beach in order to evaluate hematology patterns. The field activities were finished by August 30th on both beaches. Eighty-eight new leatherback females were tagged on Cipara and Querepare Beaches and several recaptures were observed. The exchange between nesting beaches was reported again. A loggerhead turtle and a hawksbill turtle were tagged in Querepare Beach. A total of over 5,000 hatchlings were released, which was half of the 2004 total. It is assumed that this was a result of a hurricane and several storms on the beach. The public awareness activities continued including classes for military personnel and at schools. A guide for docents was finished to evaluate during the 2005-2006 school year.

Order: 157 **Abstract ID:** 1399 **Type:** Oral **Subject:** Conservation, Management and Policy

CANCELLED

EFFECTS OF BEACH DRIVING ON LOGGERHEAD SEA TURTLE NESTING

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Loggerheads face many anthropogenic nesting threats including beach armoring, beach nourishment, artificial lighting, beach vehicular driving, and pollution (Loggerhead Recovery Plan 1991). Most potential threats have been thoroughly evaluated, but there remains a dearth of information about the effects of beach vehicular driving on nest success. Several factors were evaluated to determine the effect of beach driving on nesting activity and nest success of loggerheads. Data on light, beach slope and width, sand compaction, grain size of sand, moisture content of sand, incubation temperature and pedestrian activity were collected during the 2005 nesting season at Cape Lookout, Cape Hatteras and Pea Island, NC. These data were used to compare driven and non-driven beaches. Data collected in the 2000 to 2005 nesting seasons were assessed to determine differences in nest success and the proportion of false crawls between driven and non-driven beaches. The model analysis involved the following factors on driven and non-driven beaches: 1. Sand-Samples were taken from nesting and false crawl sites. These samples were analyzed to determine moisture content and grain size. The sand characteristics were not found to be significant factors in determining the type of activity. 2. Pedestrian use - The number of pedestrians were measured by counting footprints along transects in nests and false crawl sites. This study indicated that pedestrian use was greater on non-driven beaches and not a significant factor in determining type of activity. 3. Beach slope and beach width - These factors were evaluated through the use of a pentrometer, board and protractor. It was noted that the width of driven beaches was greater than the width of non-driven beaches. There were no statistically significant differences in the slope of driven and non-driven beaches. Slope and beach width were not indicated as significant factors in activity. False crawl and nesting activity was recorded on driven and non-driven beaches. Logistic modeling indicated that false crawls were more likely to occur on driven beaches. Consequently nests were more likely on non-driven beaches.

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GRAFT, DRUGS AND STEAL: THE ELEPHANT IN THE CORNER OF MARINE CONSERVATION

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Narco-trafficking and associated impunity, corruption and criminal behaviors are increasingly obvious, yet largely undocumented factors in environmental, biodiversity and conservation management, literature and discourse. In

many Latin American biodiversity hotspots the multi-billion dollar narcotics industry is a major economic, political and social force influencing key conservation actions. The link between trafficking of drugs and wildlife has been explicitly established. This illicit economy and related culture undermine efforts to protect the environment. During two decades of marine conservation and sea turtle recovery efforts in northwestern Mexico researchers have encountered obstructions related to narco-trafficking. On Mexico's Baja California Peninsula, trafficking of sea turtles is intimately related to trafficking of narcotics--from hunting of turtles to their transport and sale. Law enforcement agents are unwilling to intervene for fear of retribution from drug traffickers. Additionally, drug-trafficking impedes marine conservation by making field research unsafe. Case studies and examples will promote: 1) conversations around a topic that has remained off-limits, 2) understanding of narco-industry related barriers to conservation, 3) conservation actions and programs with improved chances of success.

Order: 160 **Abstract ID:** 1432 **Type:** Poster **Subject:** Conservation, Management and Policy

METHODOLOGY FOR THE OBSERVATION AND THE CONSERVATION OF THE MARINE TURTLES IN CAYO LARGO, CUBA

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The high density of nesting by Green sea turtles (*Chelonia mydas*) at Cayo Largo, Cuba, could potentially become the primary attraction and tourist choice for this resort during the traditionally "low" tourist season between May and September. This is a unique site, one of the few high-density Green turtle nesting sites left in the hemisphere. For this reason, tourists could participate directly in guided sea turtle tours, as well as other opportunities to contribute to conservation. With this in mind, our research enumerates indispensable activities and requirements to be achieved for the proper and beneficial use of this resource by all parties (e.g. turtles, tourists, corporate interests). We discuss the potential income earned, and the expected benefits to the species, including rising rates of survival and successful reproduction in these charismatic and vulnerable species.

Order: 161 **Abstract ID:** 1521 **Type:** Oral **Subject:** Conservation, Management and Policy

PROGRESS IN IMPLEMENTING THE WESTERN INDIAN OCEAN (WIO) REGION MARINE TURTLE STRATEGY: THE CASE OF KENYA

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Marine turtles in the Western Indian Ocean (WIO) Region are mainly threatened by illegal exploitation, marine fisheries, habitat degradation and coastal development. The WIO Regional Strategy (IUCN, 1996) for the conservation and management of sea turtles lists actions that need to be undertaken to reverse the decline of marine turtle populations in the WIO. Action areas are organized into three broad categories namely research and monitoring, education and awareness, and local community participation. In Kenya, although a Sea Turtle Recovery Action Plan (STRAP) exists to provide guidelines for specific action areas, it was not until 2002 that a coordinated national effort was implemented. Under research activities a national patrols and monitoring exercise

has been initiated in more than 14 sites targeting to collect data and information on sea turtle nesting, stranding, tagging, sightings and associated morphometric data in over 50% of the entire Kenyan coastline. The monitoring program is supported by a targeted education and awareness program focusing mainly on local fishers, coastal communities and learning institutions. Local community involvement follows on the recommendations of a one year Participatory Rural Appraisal (PRA) exercise that was accomplished in 2004 and resulted in the development of a national community action plan (CAP) for the conservation of marine turtles in Kenya. Local people as well as other social actors are also involved in sea turtle habitat rehabilitation activities including mangrove replanting and beach clean-ups. During the PRA phase, marine fisheries were identified as an important source of turtle products for trade and consumption. This realization was confirmed during a just concluded national survey on trade and consumption of sea turtle products which provides estimates of more than 3000 sea turtles being consumed in various parts of the Kenyan coast annually. The pace of implementation of the WIO strategy is primarily constrained in many countries by lack of clear national policies and legislative frameworks on the conservation of marine resources. This has led to inadequate commitment on the part of WIO governments to provide or attract the requisite capacity in terms of financial and human resources to implement the listed action areas. The strategy also recognizes the importance of regional collaboration to deal with the migratory nature of marine turtles and promote information exchange. However the region has accomplished very little in terms of sustaining collaborative mechanisms in turtle conservation. Several regional meetings have been organized and held in South Africa, Kenya and Oman and it has been challenging to follow on the recommendations of these meetings. To help address these problems, other regional fora for example the Indian Ocean and South East Asia Memorandum of Understanding (IOSEA - MoU) for the conservation of marine turtles and their habitats have developed a conservation and management plan (CMP) with specific actions to reverse marine turtle population declines within its geographic scope which includes the WIO. At least seven of the WIO countries are member states of the MoU thus demonstrating increasing government commitment and recognition of the importance of conservation of marine turtles. However the participation of local communities in conservation programs seeking to protect sea turtles has been lacking in many countries of the WIO who instead adopt a top-bottom approach with limited success records. In Kenya the success of marine turtle conservation programs has for the last few years depended on the commitment of local socio-actors and government agencies supported by setting up of long term research and monitoring programs.

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PARTICIPATORY HABITAT CHARACTERIZATION AND GIS DATABASE DEVELOPMENT FOR THE CONSERVATION AND MANAGEMENT OF SEA TURTLES IN SOUTH COAST KENYA

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Three sites in south coast Kenya i.e. Msambweni, Funzi and Bodo were studied with an overall objective of characterizing the existing sea turtle nesting and foraging habitats. Nesting beach stretches in Msambweni and Funzi were evaluated based on human and natural predation indices and environmental factors which considered temperature measurements. The targeted foraging grounds consisted of seagrass beds and associated food items which included sponges and mollusks. Participatory approaches as well as a stratified sampling design were used in studying both habitats. A total of 10 beach stretches measuring 5.84km were identified in both Funzi and

Msambweni. Msambweni beaches had a higher index of human pressure than Funzi beaches although the later had a higher natural predation index in relation to clutch and nesting females' survival. The mean temperature range at a depth of 10-30cm was higher for the Funzi hatchery when compared with samples from Funzi beaches ($t= 2.7$, $p<0.05$) but was not significant when compared with measurements from Bodo beach stretches ($t= 0.05$, $p>0.05$). However there were significant differences in temperature range reported within sites i.e. Funzi ($t= 1.73$, $p< 0.05$) and Msambweni beaches ($t= 4.00$, $p<0.05$) at depths of 10-30cm. Funzi had the highest mean temperature range at all depth measurements. Seagrass cover ranged from 1.3-44.23% but there was no significant differences ($p>0.5$) between sites. Most of the sampling stations were dominated by *Thalassodendron ciliatum*, *Thalassia hemprichii*, *Siringodium isoetifolium*, and *Halodule uninervis*. A two-factor ranking exercise identified fisheries, sea urchins and pollution as the most immediate threats to sea turtle habitats within the study sites. The overall mean densities of sponges were higher in Msambweni than in Funzi - Bodo sites pooled ($p<0.001$) while there were more mollusks within the Funzi-Bodo channels compared to Msambweni ($p<0.001$). The distribution of gelatins was not significant between the two sites ($p>0.05$). Interviews with fishermen and observations suggest a spatial coincidence between specific seagrass pastures and green turtle sightings. During the survey period 67 green turtle nests were sighted in Funzi and Msambweni beaches and a total of 32 mortality cases reported.

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THE ACTION PLAN FOR THE CONSERVATION OF THE MEDITERRANEAN MARINE TURTLES ADOPTED WITHIN THE FRAMEWORK OF MEDITERRANEAN ACTION PLAN (MAP)

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There are several international conventions containing provisions for the protection of marine turtles in the Mediterranean region. These conventions are applied to various degrees in the Mediterranean countries with the exception of the Barcelona Convention, to which all riparian Mediterranean nations are signatories. The significance of the Barcelona Convention for marine turtles is reflected not only in the Protocol concerning specially protected areas and biological diversity in the Mediterranean, but also in the elaboration of an Action Plan for the Conservation of the Mediterranean Marine Turtles in 1989 and its recent revision in 1999. The Revised Action Plan takes a holistic approach to processes threatening Mediterranean turtle populations. Its main objectives are to enhance the population of marine turtles, conserve their critical habitats in the Mediterranean region and to improve scientific knowledge about these species. Since its adoption 17 years ago, several questions should be asked. Do we know enough about the marine turtle species in the Mediterranean? Do we know enough about the different populations? Do we know the exact size of the damage caused by the different fisheries in the Mediterranean? Do we know their migration routes? Do we know all the nesting beaches? Are they efficiently protected and managed? Do we really exchange data in the Mediterranean? Data on marine turtles could be compared and analysed to get a regional view of their conservation status.

VOLUNTEERS & SEA TURTLE CONSERVATION: WHY TIME EQUALS MONEY FOR AN ENVIRONMENTAL NGO

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ARCHELON, the Sea Turtle Protection Society is an NGO founded in 1983 to protect sea turtles and their habitats in Greece. Every year ARCHELON oversees conservation projects on Zakynthos, Crete and Peloponnesus. ARCHELON also operates a Sea Turtle Rescue Centre, organizes collaborative programmes with fishermen, conducts environmental education activities with the public, including children, and lobbies local, national and EU authorities for the compilation and implementation of management plans for these important nesting areas. The workload is immense and impossible to undertake without the aid of volunteers. Every year, ARCHELON co-operates with 450-500 young people from all over the world. ARCHELON recruits volunteers through the Internet, universities, environmental NGOs, and nature magazines in Greece and abroad. 44.6% of ARCHELON volunteers between 2003 and 2005 participated based on recommendations by other volunteers; 31.1% learned about our projects and applied via the Internet; 17.6% chose them via articles or books about volunteer work; and 6.7% used volunteer recruitment agencies or career advisors for their selection. A typical ARCHELON volunteer profile involves a student or university graduate, averaging 22 years of age although it is not uncommon to work with older people (even in their seventies). Based on post-experience questionnaires, volunteers indicated that they chose to work with ARCHELON: to obtain work experience in order to improve future employment/studies prospects (39.9%), to experience an “alternative holiday” (29.8%), because they were interested in sea turtle conservation (29.4%); and because it was inexpensive to participate (0.9%). (n=516) Every year, ARCHELON volunteers monitor a total of 75 km of nesting beaches on a daily basis, protect an average of 2.700 nests against predation, inundation by sea water, human disturbances and light pollution, tag 350 nesting females, and ensure that an average of 210,000 hatchlings are added to the population. At the Rescue Centre, they assist in the daily treatment of 40-50 sick and injured sea turtles. Volunteers are also involved in public awareness activities, informing the local community and tourists through information Stations or slideshow presentations, reaching more than 200,000 people. ARCHELON volunteers are a never ending source of new ideas for improvement, and some of them return as part of the Society’s seasonal or permanent personnel. As a result, the quality of ARCHELON’s work remains high while consistency and continuity are ensured. In 2005 alone, volunteers contributed a total of 15,318 working days, which, calculated with the minimum wage in Greece, corresponds to 399,800€ of paid employment. This is the reason why ARCHELON considers the work of volunteers a major form of sponsorship and support, their contribution being time instead of money. ARCHELON’s system of relying upon volunteers works in a manner that benefits everyone involved; the Society is in a position to undertake many and diverse tasks in a cost-efficient manner which ultimately are beneficial for the long-term protection of sea turtles. It is also a beneficial situation for the volunteers as they can make a start in their career, or have the opportunity to enjoy themselves by doing something useful and worthy.

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NATIONAL MARINE PARK OF ZAKYNTHOS: A SCALE-DEPENDENT GOVERNANCE PROCEDURE

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The National Marine Park of Zakynthos (NMPZ) was established in 1999 as a protected area, and its Management Body in 2000. The European Committee's legal procedure against Greece acted as a driving force for this establishment. This was a pilot implementation of conservation management of protected areas in Greece, where a national environmental strategy was missing at the time. Therefore, the Management Body was forced to handle three responsibilities simultaneously. First, at the European Union level, it had to show immediate results so as to avoid legal procedures. Second, at the national level, it had to fulfill the expectations of different stakeholders (i.e. Ministry of the Environment, environmental NGO's and conservation experts). And third, at the local level, it had to build the local community consensus, given that, for over twenty years, the authorities and local people were in conflict over management measures regarding the loggerhead turtles' nesting sites. The history of NMPZ can be divided into two periods: from 2000 until autumn 2003, the phase of establishment and rapid growth, and from autumn 2003 until March 2005, the period of "dormancy". In this presentation, I discuss the successful implementations and the arising problems in the different levels of action arenas. Emphasis is given to the conflict arising from determining policies by a top-down approach, problems arising from the implementation of management at the local level. Furthermore, the role played by the different actors is investigated. And the need for a bottom-up feedback in decision making procedure is highlighted.

Order: 166 Abstract ID: 1663 Type: Poster Subject: Conservation, Management and Policy

IMPLEMENTATION OF GIS IN SEA TURTLE STRANDINGS ALONG THE GREEK COASTLINE: A MODERN MANAGEMENT TOOL

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A Geographical Information Systems (G.I.S) was applied to study the spatial distribution of dead and injured sea turtles that are found stranded along the Greek coastline. ARCHELON has been recording stranded turtles since 1990 involving local people, fishermen and Port Authorities. The application was carried out using ArcGIS 8.3, Microsoft Excel and Access software. A database was first developed containing information about the date and place of the stranding, turtles' anatomy characteristics (species, sex, carapace curved and straight length and width), cause of stranding (direct or indirect human action, fisheries, natural and unknown), lesion (head, carapace, flipper or plastron injury, hook or plastic ingestion, tar, hypothermia), treatment and other comments. Moreover, a digital map of Greece (scale 1:250000) was created in the Greek geographical reference system (GGRS87) and was divided into 13 State Regions and 51 State Prefectures. The spatial data was then "joined" or "related" by a "one to one" or "one to many" relationship to ARCHELON's database within a Personal Geodatabase using "Prefecture" or "Region" ID as Primary Key. As a result, feature classes and tables could be queried correlating information about turtles' anatomy, causes and place of stranding and presenting their spatial distribution. Application of GIS resulted in: a) the study of the distribution of stranded turtles in the Greek region during 15 years of monitoring. Different layouts were created indicating areas with significant number of stranded *Caretta caretta*, *Chelonia mydas* or *Dermochelys coriacea*, and moreover, post-hatchlings, juveniles and adult turtles. Furthermore, areas showing strong interaction between human activities (i.e. fisheries) and turtles were mentioned. Additional information such as spatial distribution within seasons of the year was also presented b)

the management of turtles through public awareness. Distribution of stranded turtles within a specified time frame (i.e. six months) was used as a “Red Alert” system allowing immediate awareness of authorities (municipalities, port police, fishermen associations etc). Updating of the database and continuous awareness of the public can contribute to the reduction of the mortality of the sea turtles c) the development of vector data that can be used for the projection and analysis of nesting activity, tag recoveries and telemetry tracking. Future enrichment of the GIS application with more detailed spatial data, such as State Municipality limits, coast and seabed morphology and human activities (i.e. fishing effort and coastal development) is important in order to investigate more complicated correlations, allowing better understanding of the threats and reasons of strandings and effective protection of the turtles in the Mediterranean Sea.

Acknowledgments: This project was part of the LIFE-Nature project “Reduction of mortality of *Caretta caretta* in the Greek seas” (LIFE 2002NAT/GR/8500). AK gratefully acknowledges travel support from UNEP’s RAC/SPA (Regional Activity Centre for Specially Protected Areas) and other donors through the Symposium Travel Committee.

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EVALUATION OF INCUBATION TEMPERATURE AS A METHOD FOR ESTIMATING HATCHLING SEX RATIOS IN THE KEMP’S RIDLEY RECOVERY PROGRAM

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The Kemp’s ridley sea turtle, like all species of sea turtle, possesses temperature dependent sex determination. This type of sex determination can produce a wide array of sex ratios. Therefore, it is of ecological and conservational importance to monitor the hatchling sex ratios produced in nesting beach conservation programs. The Kemp’s Ridley Conservation Program relocates the majority of nests to protected egg hatcheries. The purpose of the current study was to use histological analysis of hatchling gonads to validate the use of nest incubation temperature as a method of estimating hatchling sex ratios. Nest incubation temperatures were monitored with data loggers and sex ratios were predicted based on the average incubation temperature during the middle third of incubation. Dead hatchlings were collected from freshly excavated nests after live hatchlings had emerged during several nesting seasons. The histological data from the current study significantly enhances the previous data available on sexes derived from different incubation temperatures. Further, the histological data corroborates the use of incubation temperature as a method of predicting hatchling sex ratios.

THE FORGOTTEN SPECIES FROM OSTIONAL BEACH, COSTA RICA: WHAT ABOUT THE LEATHERBACKS AND GREENS?

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ISV-International Student Volunteers, Costa Rica Projects Program

Ostional Beach is been well known for its olive ridley (*Lepidochelys olivacea*) arribadas worldwide for decades. Sea turtle research and conservation efforts at this beach have mainly been focus on this species for many years although in November 17, 1983 when the Ostional National Wildlife Refuge (ONWR) was created, the importance for the conservation, protection and research of the occasional nests from leatherback (*Dermochelys coriacea*) and Pacific green (*Chelonia mydas agassizii*) sea turtles at this nesting ground was also stated. In October 2004 after over 20 years since the creation of the ONWR ISV Projects Program-(International Student Volunteers.Inc), the Costa Rican Ministry of Environment and other members of the community of Ostional united efforts to start a leatherback sea turtle conservation and research project base on nightly beach monitoring, morning nests surveys, nesting females biomonitoring, tagging, nest relocation and nest exhumations in order to know more about this considered “occasional nesting”. The project was carried out from November 08, 2004 to March 15, 2005 and a total of 19 nest of *D. coriacea* were documented. Two of the estimated three animals found by night patrols nesting during this season where previously tagged in Playa Grande, Costa Rica the main nesting ground for this species in the Pacific coast of the Central American Region. Exhumations were carried out on 10 nests and there was no hatchlings success because of: overheating, predation and beach erosion. The project continued for 2005-2006 with more night patrols, better beach coverage and a hatchery. More nests have been documented this season compared to the 2004-2005. During the 2004-2005 nesting season, 4 ISV student volunteer groups which supported the leatherback project generated US\$7605 of gross income to local families for room and board, transportation and local tours payments. About 12 families were involved in the program. During 2005-2006 more student groups supported the leatherback project at Ostional Beach generating more revenue, and the local families have been more involved with the project becoming important supporters of the hatchery protection. This season the leatherback program has extended its work and permits to carry on research with Pacific greens which have shown an important nesting activity during this nesting season 2005-2006.

MICROBIOTA ISOLATED FROM SEA TURTLE NESTS AND ASSOCIATED HEALTH RISKS FOR TURTLE RESEARCHERS

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Microbiota have been isolated from sea turtle nests and are often implicated in the failure of eggs to hatch. However, there has been little focus on the consequences of exposure to egg microbiota by humans, other than after ingestion of raw eggs (Campos *et al.* 1996). This paper reviews the bacteria and fungi that have been reported from sea turtle eggs and discusses the effects of contact with such. The excavation of nests after emergence of hatchlings is a common practice in sea turtle research. Categorising the nest contents involves handling the nest substrate, eggshell, unhatched eggs and dead hatchlings. Gloves are rarely worn during these procedures as single-use latex or vinyl surgical gloves are too fragile to be worn during the removal of sand from the egg chamber, and more

robust rubber gloves (e.g. washing up gloves) do not allow the wearer to be sensitive to the handling of fragile hatched and unhatched eggs. Infection of pre-existing wounds and abrasions can occur, while inadequate hygiene by researchers would allow transfer of pathogens to mucous membranes and food, therefore the health implications of exposure to nest microbiota should be considered as part of the research procedure.

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MARINE TURTLE CONSERVATION ACTIVITIES IN SOUTHEASTERN COASTAL ECOLOGICALLY CRITICAL AREAS OF BANGLADESH

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Conservation activities of sea turtles have invigorated with the initiation of the GEF-funded Coastal and Wetland Biodiversity Management Project (CWBMP). The mainland coastline from Cox's Bazaar to the southern-most tip of the Teknaf Peninsula, Sonadia island and St. Martin's Island have been gazetted as a protected areas, termed Ecologically Critical Area (ECA) in 1999. Detailed surveys are being conducted and 25 important nesting sites have been identified within the \pm 120 km stretch of unbroken coastline between Cox's Bazaar and Teknaf (between N 20°43'50", E 92°21'30" and N 21°27'00", E 91°57'30"). Plans are underway to develop joint monitoring programs for sea turtles nesting at St. Martin's Island ECA (between 20°33' - 20°40' N and 92°17' - 92°22' E) with another similar project (St. Martin's Project) under the same Ministry of Environment & Forest. Initiatives have been taken to monitor the nesting sea turtles at Sonadia Island ECA (21°28' - 21°33' N and 91°50' - 91°56' E). At all these sites local communities are involved in sea turtle conservation activities through formation of Village Conservation Groups (VCG). Activities include protecting sea turtle nests in-situ, establishment of several beach hatcheries and facilitating sea turtle hatchlings back to the sea. In addition, imparting training to the local community members is a priority for the project. The project is also developing awareness materials for awareness raising of local government officials, local community and tourists. Two species, Olive Ridley, *Lepidochelys olivacea* and Green Turtle, *Chelonia mydas* regularly nest along this mainland coastline and islands, while *Dermochelys coraicea*, leatherback and hawksbill, *Eretmochelys imbricata* are rare visitors.

Order: 171 **Abstract ID:** 1843 **Type:** Oral **Subject:** Conservation, Management and Policy

LONG-TERM COMMUNITY INCENTIVE AGREEMENTS AS A NOVEL APPROACH TO CONSERVING SEA TURTLE NESTING BEACHES

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Direct protection of strategic nesting aggregations is critical to arresting the decline of sea turtle populations worldwide. In many areas, nesting beach protection will depend on long-term agreements with local communities.

While creating endowed funds to support such agreements and associated beach protection is a sensible strategy to ensure sustainability, in practice, few community agreements with long-term funding exist. Conservation International (CI) and its partners have been employing this approach for a number of years in the terrestrial arena and are now actively pursuing opportunities at a number of important sea turtle nesting sites. In this presentation the author will explore the basic components of a long-term community agreement, some of the obstacles to their broader adoption, and will review recent experience in the application of this approach to terrestrial and marine settings around the world. Specific examples will draw from a study of the cost and structure of existing and potential agreements at a number of important sea turtle nesting sites in the Western Pacific, including the Pacific's last remaining large nesting aggregations for the leatherback turtle, the region's largest hawksbill rookery and a number of additional sites. Legal, financial, and administrative considerations will be reviewed and recommendations made for wider and more effective use of such agreements for sea turtle conservation.

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THE PLIGHT OF SEA TURTLES AND THEIR HUNTERS IN ANGOLA

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This paper describes the results of a preliminary marine turtle study and conservation efforts in Angola during 2000 to 2004. The work was led by the Angolan Government and involved also the participation of Agostinho Neto University, the National Natural History Museum and other partners. Technical and financial support was provided by the United Nations Development Programme (UNDP) and the Norwegian Agency for Development and Cooperation (NORAD). The study focused on a general assessment of marine turtle nesting activity and exploitation. It involved interviews with fishermen, as well as the recording of nesting activity and turtle remains along most of the Angolan coast, with most effort around 50 Km south and north of Luanda and in Cabinda. The conservation efforts concentrated on public outreach to raise awareness of marine turtles and their conservation needs at all levels, with special attention paid to selected target groups including fishing communities and decision makers. A programme to support alternative livelihood projects for those fishermen currently exploiting turtles was developed, but this has yet to be elaborated and implemented. Four species of marine turtle were observed nesting on Angola's 1650km coast, including the olive ridley (*Lepidochelys olivacea* - the most commonly encountered species), leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles. Loggerhead nesting was rare and observed only on the north Angolan coast, while leatherback nesting activity was recorded on the north and central Angolan coast. Green turtle nesting activity was recorded on the southern coast, and several adult and developmental green turtle foraging sites were identified along the country's coastline. It is possible that nesting activity occurs on all sandy beaches on the Angolan coast but further surveillance is required to determine the locations of all nesting sites. Use of marine turtles is widespread and at some inhabited nesting beaches exploitation is up to 100% of both nesting females and their eggs. Use is largely for subsistence, but there is some commercial use, while sand extraction is another threat, resulting in degradation of some nesting beaches. In recent years several initiatives have been developed to protect nesting females and their eggs on privately owned beaches, but these protect no more than approximately 30kms of nesting beach. Conservation measures were taken in Cabinda Province, including the encouragement of fishermen to release captured turtles in return for support to the replacement of nets damaged by the turtle bycatch. General awareness has increased in the country, but it is clear that Angola's marine turtle populations are endangered by significant threats. A solution for the dire plight of turtles in Angola must be inextricably linked to poverty relief within the relevant fishing communities, and in particular to the development of sustainable alternative livelihoods.

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COMMUNITY-BASED CONSERVATION OF THE LEATHERBACK SEA TURTLE IN THE MEXICAN PACIFIC

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The leatherback nesting population in the Eastern Pacific has shown a dramatic decline during the last decade. The main suggested causes have been egg harvesting and slaughtering of females on the nesting beaches, as well as the incidental capture in longline and drift net fisheries. In Mexico, egg harvesting is prohibited by law. In 2003, the governments of Michoacán, Guerrero and Oaxaca States of the Mexican Pacific, where most leatherback nesting occurs, signed an agreement to reinforce the recovery actions by the Federal Government. They expressed commitment to reinforce and expand protection activities on the beaches and to make joint operations with the local communities which are considered to play an essential and determining role in conservation of leatherbacks. Important actions have been taken since the signing of this agreement, some of which are; the installation of a technical committee that discusses and develops the actions plans to be applied in the short-, medium- and long-term and workshops with the coastal communities of the three States. The workshops had the main objectives to interchange experience and results from the nesting seasons and to provide training in biology of sea turtles and field techniques to for improved conservation actions. With this project, global conservation problems are being tackled with local actions organised at a regional scale, which will hopefully reverse the drastic decline in the Eastern Pacific leatherback population.

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DEVELOPMENT OF A SPANISH MEDITERRANEAN LOGGERHEAD CONSERVATION PLAN

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In July 2002, the Spanish Cetacean Society (SEC) initiated a four year European Commission LIFE-Nature program for the conservation of sea turtles in one of Europe's most valuable marine sites, the Alboran sea and its adjacent Mediterranean and Atlantic waters. The main aim of this program has been the development of a

“Spanish Mediterranean Loggerhead Turtle Conservation Plan” (LTCP), which includes the Management Plans for the marine protected areas (SACs) designated for this species in the south of Spain within the framework of the European Union’s Habitat Directive. The objective of the LTCP is to contribute to international loggerhead turtle conservation efforts through the establishment of a national strategy of guidelines for the recovery of turtles in Spanish Mediterranean waters. Subsequently the LTCP aims to design and coordinate a series of concrete legislative, management, monitoring, research, capacity building and public awareness actions focusing on areas that have been identified as being of special relevance for the conservation of the species. A particular focus of this LTCP is the reduction of bycatch of loggerhead sea turtles by longline fleets (primarily swordfish) in the region. A series of research actions in the LIFE program have been developed towards this goal, based on active cooperation between scientists, relevant authorities and stakeholders (mainly fishermen) to obtain the essential baseline data for management and subsequent monitoring. Bycatch monitoring through a fishery observer programme has been complemented with studies focused on defining loggerhead movements and habitat use, stock identification, survival rate, etc. In order to evaluate the utility and feasibility of possible bycatch mitigation measures identified by these studies, an action for the testing of bycatch mitigation measures was initiated in August of 2005. In complement to these tests carried out onboard longliners, new technologies for releasing turtles used presently in the context of the US Loggerhead are being test for their adaptation to the Spanish fleet. Actions have been based on cooperation with the affected fishermen in order to set the ground for consensus over possible solutions that benefit both sea turtles and fishermen. Results of actions and development of the LTCP presented highlight the importance of direct involvement of fishermen in all steps of the Conservation Plan development process that has generated an extremely positive atmosphere of cooperation between scientists, relevant authorities and fishermen. This has resulted in an important acceleration of political and scientific efforts to reduce the impact of bycatch. However, the rapidly growing national and international focus on this issue requires adequate coordination in order to make sure future efforts maintain this positive input of fishermen which is certainly a key factor to solve the problem. The future implications of the LTCP development process are presented together with an outline of the main actions that will be included in the 5 year Conservation Plan that will be delivered to the Fishery and Environment Ministries in July 2006.

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PROGRAM OF CONSERVATION OF THE OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*), IN CEUTA BEACH, SINALOA, MEXICO: SEASON 2005

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Since 1976, the Universidad Autonoma de Sinaloa through the Facultad de Ciencias del Mar y Escuela de Biología, has developed activities for the conservation of the olive ridley turtle (*Lepidochelys olivacea*), in the Ecological Reserve of Ceuta Beach, Elota, Sinaloa, Mexico. This work shows the conservation effort results of the July - September 2005 season where complementary activities like environmental education and projects of marine turtle research were made. It is possible to indicate that with the support of the municipal city council of Elota and the just created patronage pro-sanctuary of Ceuta Beach to help these workings, the turtle program has entered a new stage that promises to elevate the quality of the work for marine turtles. It also has the support of the Trust for the Conservation of the Natural Patrimony of Mexico and the Company Agricola Tarriba.

HISTORICAL ASPECTS OF THE MARINE TURTLES IN THE MEXICAN PACIFIC

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In Mexico the marine turtles have played a fundamental role in the gastronomy, medicine and economy of many coastal towns. From the pre-Columbian cultures, like the Olmeca, Maya, Zapoteca and Azteca, etc. to our days, we found a variety of evidences of the relationship between marine turtles and mankind. Some prevalectic ethnic groups of the Mexican Pacific shore, among them Seris, Pómaros, CoIris, Morenos and Huaves, still maintain ancestral rites related to these reptiles. Nevertheless, at the moment the seven species that occur in our country are protected permanently since 1990 by Mexican laws. Since 1965 the capture of marine turtles was intensified and the species were pushed into the brink of extinction; in response to these matters the Mexican governments in 1968 started population recovery programs for the preservation of the species. This work, exposed and developed during several years, as conference in the “Encuentro de la niñez del Sur de Sinaloa” created and organized by Acuario Mazatlan, shows with original images such evidence, also approaching the last ways of fishing in the states of Sinaloa, Jalisco and Oaxaca.

PROGRAM OF CONSERVATION OF THE OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*), ON BEACH CAIMANERO, SINALOA, MEXICO: SEASON 2005

Fernando Enciso Saracho and Héctor Contreras Aguilar

Facultad de Ciencias del Mar de la Universidad Autónoma de Sinaloa, Mexico

Since 1986, the Universidad Autónoma de Sinaloa, through the Facultad de Ciencias del Mar, has developed conservation activities for the olive ridley turtle (*Lepidochelys olivacea*), on Beach Caimanero, Sinaloa Rosario, Mexico. This paper reports the conservation results of July to December 2005. In addition, complementary activities such as environmental education classes and research projects were conducted. With the support of the Municipal City council of the Rosario the Trust for the Conservation of the Natural Patrimony of Mexico and the Maricultura del Pacífico S.A., this project has entered a promising new stage regarding the improvement of conservation efforts, and compared to previous years, this season broke the record of the number of eggs deposited.

SPATIAL AND TEMPORAL ANALYSIS OF INCIDENTAL SEA TURTLE TAKES BY DREDGES IN THE WESTERN GULF OF MEXICO, USA

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The U.S. Army Corps of Engineers (USACE) manages dredging activities to maintain navigable depths in U.S. shipping channels. In response to incidental takes of sea turtles during hopper dredging projects in the early 1980s, the USACE, in consultation with other federal agencies, initiated a management program to mitigate the impact of hopper dredging on marine turtles. The USACE recently initiated an effort to compile data related to incidental turtle takes during hopper dredging projects between 1980 to present. Data are being collected from USACE district offices, USACE research facilities, dredging industry companies, endangered species observer companies, and NOAA. These data are a potentially valuable resource for managers. We are using mixed-effects linear models to analyze a subset of these data for shipping channels in the western Gulf of Mexico between 1995 and 2005 to inform future management decisions in that region. We used data from dredging operation records, relocation trawling records, and incidental turtle take reports for 52 dredge projects in 8 shipping channels. Study channels in Texas, USA are Brownsville, Corpus Christi, Freeport, Houston-Galveston, Matagorda, Port Mansfield, and Sabine Pass. The single study channel in Louisiana, USA is Mississippi River Gulf Outlet. We are constructing a candidate model set using multiple levels of independent variables time, location, dredging effort, and relocation trawling effort. We will use Akaike's Information Criterion (AIC) to choose best-fitting models. We will use our best models to predict the probability of take per unit of dredging effort in specific channels or groups of channels during specific time periods. Findings may assist in refining management decisions regarding better timing and location of dredging activities in the western Gulf of Mexico. Furthermore, findings may provide insight into the allocation of relocation trawling effort. The models developed should also be applicable to dredge data from channels along the southeastern U.S. Atlantic coast.

WHAT WE ALL SHOULD KNOW...! REVIEW ON A 1904 DUTCH FISHERY SURVEY IN THE CARIBBEAN REGION

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Institutions like IUCN and CITES publish lists of endangered species to optimise conservation regulations. Historical information, amongst others, is considered useful in determining the category into which a species is placed. To this end, historical non-English publications should be reviewed. Dr. J. Boeke, lecturer at the University

of Leiden around 1900, visited the wider Caribbean region between 28 December 1904 and 2 December 1905. In 1907 he published his 'Report on a provisional inquiry on the state of affairs of Fisheries and Industries of Sea products in the colony of Curacao' in the Dutch language. This review of Boeke's report contains historical data and information from the Dutch Caribbean islands and the wider Caribbean region from around 1900 on sea turtle biology, (sea turtle) fishing methods, import and export figures and proposed conservation measures, such as head-starting. I have assembled and translated these data, along with historical data on ocean currents, sea depths, sea water temperatures, salinity, chlorine contents and sea water density from the Caribbean region and compared these with current data and information. Datasets such as this can be very useful in offering better historical insight of sea turtle conservation issues, current status definitions, and listing placements.

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THE FILMING OF "TROY" AND NESTING SEA TURTLES – HOW THEY COEXISTED?

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The objective of this presentation is to describe the problems that were encountered during the development of the Program for the Protection of Sea Turtles, the solutions, and strategies adopted that had no affect on the sea turtles yet allowed the continuation of the filming of "Troy." This concerted effort between government officials and filmmakers to resolve potential problems as they related to endangered species, will hopefully serve as a role model for future film productions. During the months of April 2003 through January 2004, Los Cabos, Baja California Sur, Mexico hosted the filming of the Warner Brothers film, "Troy", which consisted of an entire cinematographic production company filming scenes on a Pacific Ocean beach in different phases, consisting of Set Design, Construction, Operation, Maintenance and Removal, and requiring a temporary change in the land use. The set construction area was located in a coastal ecosystem and the subsequent high levels of vehicular, heavy machinery, livestock and foot traffic required a fauna and flora rescue program to protect the ecosystem, which was implemented and monitored, emphasizing the identification of adverse impacts in relation to the different phases of the project. Nevertheless, these environmental impacts are not severe and affect only the area occupied temporarily by the Troy production company without damaging the surrounding environment or the adjacent population. The adverse impacts generated by the project, in the different phases, required the application of mitigating measures, which were carried out and consequently planned to achieve the viability of the project within the natural environment. The land area affected from the shore inland was 48.75 acres, with analysis of the activities in this zone, which were the construction of ships, significant livestock and continual vehicular traffic, which became problematic with the introduction of heavy machinery to modify parts of the beach. Considering that it is a natal sea turtle zone monitored by the non-governmental association ASUPMATOMA, which reports nesting sea turtle populations of olive ridley (*Lepidochelys olivacea*) and leatherback (*Dermochelys olivacea*) sea turtles, it was necessary to relocate nests away from heavy traffic and construction site areas. To protect nesting females, a program was developed and applied during eight months of the Troy filming schedule by the H. Ayuntamiento de Los Cabos, Program for the Protection of the Marine Turtle. During this time, 30 olive ridley nests were relocated and protected, releasing 2,241 hatchlings. The Troy project complied and met all requirements and obligations as set out by SEMARNAT, the Mexican Federal Government Environment Protection Agency.

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TO MANAGE OR NOT TO MANAGE: LESSONS FROM ST. CROIX FOR A LEATHERBACK NESTING BEACH IN JAMURSBAMEDI, INDONESIA

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The leatherback nesting population in St. Croix, US Virgin Islands, has shown a remarkable increase in number of nests over the past two decades. The recovery of this population has been largely attributed to a boost in hatchling production by relocation of nests that are laid close to the tideline and classified as “doomed nests”. Nest relocation is a very labor intensive process and some researchers have even questioned the long-term evolutionary consequences of relocating so-called doomed nests. Additionally, hatching success of relocated nests tends to be on average lower than in situ nests. Therefore, in this study, we develop a model that incorporates 1) processes affecting hatchling production on the St. Croix nesting beach and 2) recent survival estimates for St. Croix hatchlings to adulthood, to determine the trajectory of the nesting population if no nests or fewer doomed nests had been relocated. Outcomes of the models are used to recommend management strategies for Jamursba-Medi Beach in Papua, Indonesia, which is one of the last strongholds for leatherbacks in the Pacific and where nest inundation and predation greatly lower hatching success.

MANAGEMENT OF CARETTA CARETTA IN PRACTICE: THE IMPORTANCE OF ENVIRONMENTAL INSTITUTIONS

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Zakynthos has the most important loggerhead sea turtle (*Caretta caretta*) nesting beaches for the Mediterranean. The Presidential Decree established a private, non-profit institution to manage the National Marine Park of Zakynthos (NMPZ)- the NMPZ Management Body - and determined the strategic targets that should be accomplished in many different particular settings. Strategic targets are categorised into one of the four following categories: (a) Institutional actions aiming at the establishment and development, that is, the long-term viability of the NMPZ's Management Body; (b) Environmental actions aiming at habitat and species conservation; (c) Social actions aiming at raising stakeholders' environmental awareness; and (d) Economic actions aiming at the economical viability of the NMPZ. The aim of this paper is to present an analysis of the institutional performance of the NMPZ from 2000 to 2003 as well as to define institutional and non-institutional factors that shape Protected Area management. Therefore, three components were examined: (i) the institutional context in which the Management Body operated; (ii) the actions undertaken by the Management Body to achieve its longstanding objectives; and (iii) identification of noninstitutional and institutional parameters that proved to be crucial to the Management Body's failures and success. The issue of the Management Body's autonomy is implied by a number of findings of our research. Apart from autonomy, our study revealed the complexity inherent in the management of Protected Areas. On a theoretical level, the experience of the NMPZ study suggests that researchers and practitioners must pay closer attention to the important institutional and noninstitutional factors that shape PA governance. Moreover, the scaling-up of the local government and site-specific institutions remains a management and policy challenge that will require careful experimentation and evaluation. A lack of understanding of the

interrelations between different governance levels is likely to result in inappropriate policy recommendations and decrease the effectiveness of PA management.

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SPATIAL PATTERN OF LOGGERHEAD SEA TURTLE NESTS AS A TOOL TO REGULATE TOURIST ACTIVITIES ON NESTING BEACHES

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The Greek Island of Zakynthos has the most important loggerhead sea turtle (*Caretta caretta*) nesting beaches for the Mediterranean. Systematic monitoring over the last 20 years by ARCHELON has shown that about 1,000 to 2,000 nests, depending on the year, are recorded on the 5.5 km of sandy beaches within the Laganas Bay, located on the south coast of the island. Zakynthos, once a quiet island, catering to a few Greek visitors, has recently become a prime tourist resort and over the past 20 years has experienced a very rapid tourist growth, which is believed to exert significant pressure on turtles' nesting beaches. The aim of this study is to define the spatial pattern of the loggerhead sea turtle nests at the three main touristic beaches of Laganas Bay, named East Laganas, Gerakas and Kalamaki. ARCHELON provided the survey data of the nests recorded to the three main beaches from 2003 to 2004. The Geographic Information System (GIS) was used to define the spatial pattern of the nests. Our results showed that nests were mainly located in the transitional zone between sand and sand dunes. The definition of nesting pattern will contribute to the regulation of tourist activities on nesting beaches.

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CANCELLED

LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) NESTING ON A GEORGIA BARRIER ISLAND: EFFECTS OF NEST RELOCATION

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The nesting biology of the loggerhead sea turtle (*Caretta caretta*) was studied during the summer of 2005 on Blackbeard Island, Georgia, USA. Blackbeard Island is a National Wildlife Refuge and has an active nest relocation program designed to minimize the number of loggerhead nests lost to seawater inundation and to maximize the number of hatchlings produced. Current efforts are to relocate the minimal number of nests while maintaining high hatching success, to learn the effects of current management practices, and to improve on future management practices. Nesting activity occurred from May until August. Nest hatching occurred from July to September. All observed nesting females were measured, flipper tagged, and PIT tagged. Thirty-eight nests were monitored out of 198 total nests. Research nests were randomly assigned to two groups (in situ or relocated). In situ nests (n=19) were left where the female originally deposited the eggs, while relocated nests (n=19) were moved above the spring high tide mark and into areas that were considered optimal nesting areas. All nests were measured and all eggs were counted. Temperature dataloggers were placed in the center of all nests and temperatures were recorded every 2 hours until hatching occurred. Twenty eggs were measured from each nest and 20 hatchlings were measured from each nest if they were available. Clutch size, egg size, hatchling size, mean nest temperature, incubation duration, and hatching success were compared for all research nests. The average clutch size was 114 eggs in in-situ nests and 125 eggs in relocated nests. The average egg size was 41.99mm in diameter for in-situ nests and 42.95mm for relocated nests. The average hatchling size was 45.25mm in straight carapace length for in-situ nests and 45.77mm for relocated nests. The average nest temperature over the incubation duration was 29.33°C for in-situ nests and 29.79°C for relocated nests. The average critical period temperature was 30.27°C for in-situ nests and 30.01°C for relocated nests. The average incubation duration was 53.93 days for in-situ and 55.16 days for relocated nests. The hatchling success was 57% for in-situ nests and 81% for relocated nests. There were no statistical differences found for any mean measurements. The observed nests showed similar outcomes regardless of the nest treatment. Based on these findings from this past season we suggest that the relocation of nests has little to no effect on hatchling characteristics. More research has to be done to confirm any findings of this study. Research on this same population will continue this summer and will be compared to data from previous nesting seasons (2000-2005). Effects of nest relocation will be analyzed as well as overall seasonal nesting patterns.

INTEGRATING SEA TURTLE CONSERVATION IN THE ENVIRONMENTAL POLICY OF A TOURIST BUSINESS

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Grecotel Group is the largest hotel chain in Greece specializing in luxury hotels and services. An Environmental Department was established in 1992 to focus on the application of measures to reduce resort impact on the natural environment, while at the same time ensure the area's sustainability as a tourist destination by protecting the

local area's particular natural and cultural traits. Within this framework, Grecotel established co-operation with ARCHELON, an NGO dedicated to the protection of sea turtles, since three of its hotels in Rethymno, Crete are adjacent to one of the most important nesting sites for Loggerhead sea turtles in Europe. This co-operation is multi-leveled and has produced some encouraging results during the last thirteen years: First, Grecotel and ARCHELON collaborate in the implementation of measures aiming to improve the conditions under which sea turtles nest and to facilitate the hatchling's access to the sea. These include stacking of sunbeds at night, reducing light spillage on the beach through better light management, as well as reducing the use of heavy machinery for beach cleaning. As a result, 16.8% of the beach monitored is free for the turtles to nest at night, while the problem of hatchling disorientation has been eliminated in front of these hotels. Second, Grecotel and ARCHELON have organized activities aiming to raise awareness to the resort's clients, personnel, and local residents. Informational material is available in each hotel room, regular slide show presentations are organized by ARCHELON as part of the resort's animation programme, and the younger clients of the hotel may participate in special environmental education activities. Moreover, each hotel has a special turtle display at the front desk, providing visual cues for all clients. Many of the hotel's personnel also participate in seminars organized by ARCHELON and Grecotel, while ARCHELON members are always available for advice. Finally, several events are organized within the hotel premises which are addressed to the local residents. A highlight of these events remains a rehabilitated sea turtle release which was attended by the Patriarch, the Greek-Orthodox Church leader, local authorities, and many local people. It is estimated that more than 10.000 people are directly informed through these activities each year. Finally, Grecotel supports ARCHELON's activities financially either directly through sponsoring and accepting donation boxes or indirectly by acting as an intermediary for further co-operations with important stakeholders in the tourism industry, including tour operator companies like TUI and Hotelplan, which have become very important allies. The results of the above activities have led Grecotel to expand their co-operation into other resorts owned by the company. In 2004, a special edition of ARCHELON's publication "Sea Turtles" was distributed as a present to young children staying at the Grecotel resorts all over Greece. Grecotel's co-operation with ARCHELON has produced some fruitful results and is the living proof that the peaceful co-existence of turtles with people is a possibility.

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THE WHITE GHOSTS OF KAZANLI: SEA TURTLE CONSERVATION IN TURKEY

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Kazanli's 4.5 km long beach in Turkey, is the second most important nesting site for the critically endangered green turtle, *Chelonia mydas*, in the Mediterranean. An annual average of 74-216 green turtle nests were recorded between 1988 and 2000, in 2004 more than 350 and in 2005 only 38. In many respects, Kazanli is the most problematic green turtle nesting beach in the Mediterranean: To the rear of the beach, a Soda Chrome Factory (built between 1975-84) is situated. On the nesting beach, by-product from the factory's activities during the 1990s forms a mountain of over 1.5 million tons of hazardous toxic waste, which is covered with plastic sheeting! This poses a disturbing threat to both wildlife and humans. In 2001, the bulldozing of the factory's effluent basin wall and the subsequent release of highly toxic waste into the sea in front of the nesting beach turned the sea red. Contaminated seawater samples, which MEDASSET had analysed, were found to contain chromium concentration 13,500 times higher than natural levels. Following this incident, more than 23 green turtles were found dead on Kazanli beach. Repeated soda discharges into the sea have resulted in turtles emerging ghost-like to nest, with their carapace, limbs and head encrusted with white CaCO₃. The beach is receding about one metre a year owing to accelerated erosion, exacerbated by underwater remains of a jetty built by the Soda Chrome factory. Over the years greenhouse agriculture has encroached onto the beach. Owing to severe erosion there is no longer space for nesting between the greenhouses and the splash line. 15-20% of Kazanli's nests were destroyed through beach erosion in 2004, and

some 5-10% of the Mediterranean's green turtle nesting effort fell victim to this erosion in 2005! MEDASSET's conservation efforts have been through lobbying, media exposure, research and international campaigning, focusing on the release of toxic wastewater into the sea by the Soda Chrome factory. Annual update assessment reports by MEDASSET (since 1999) to the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) at Council of Europe, resulted in an on-the-spot appraisal mission to Kazanli by the Convention in 2002, following which a case file was opened. Case files enable the Convention to exert pressure on governments to report on and implement its conservation recommendations. Following MEDASSET's campaigning and subsequent Bern Convention activities as well as public pressure through the media, the factory has put significant effort into acting in a more transparent manner: waste water monitoring and actual discharge values are made public through the real-time publication of data on a display screen at the centre of Kazanli Municipality and new facilities for the treatment of toxic waste have been established. Nevertheless, the mountain of hazardous waste remains as a time bomb! Immediate remedial measures must be taken in order to provide a healthy environment for people and marine and terrestrial wildlife:

- Take measures to stop beach erosion;
- Rehabilitate the destroyed nesting beach;
- Remove the hazardous toxic waste time bomb.

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STRATEGIC COASTAL PLANNING OF A FLATBACK TURTLE (*NATATOR DEPRESSUS*) NESTING BEACH IN PORT HEDLAND, WESTERN AUSTRALIA

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The Pilbara coast of Western Australia provides important nesting habitat for flatback turtles (*Natator depressus*). This species is protected under the Western Australian's Wildlife Conservation Act 1950 and nationally under the Environment Protection and Biodiversity Conservation Act 1999. In Western Australia, coastal development poses a threat to marine turtles as result of artificial lighting, vehicle and pedestrian access to the beach, erosion of nesting habitat and recreational activities. These issues are becoming increasingly threatening to critical nesting areas in the Pilbara region considering the increase demand for coastal development. LandCorp (on behalf of the Western Australian government) has proposed to rezone a total of 40 hectares of land along the coast of Port Hedland within the Pilbara region, and develop a residential estate that may see houses built within 100m of a nesting beach. The problem with this type of development is that there are no existing beachfront lighting regulations or marine turtle management ordinances for new coastal developments in Australia. Nevertheless, appropriate interpretation of environmental management within the planning process encourages proactive incorporation of best practise management. Restoration of nesting habitat at developed coastal areas is often accomplished through light management, foreshore nourishment and community awareness through education and interpretation. However, the effectiveness of these management strategies often relies on local governments and residents to comply with new local ordinances. These prescriptive strategies are often difficult to implement due to limited resources and lack of compliance with ordinances. Alternatively, this reliance on voluntary compliance could be addressed prior to construction through: (1) proactive management by developers; (2) integration of environmental management during the early planning stages; and (3) use of planning policy and approvals to incorporate "design guidelines" for new coastal developments. This paper explores alternative environmental management strategies in the case of coastal development adjacent to nesting beaches in Port Hedland. These strategies are then evaluated in comparison

to existing management processes with a focus on how these strategies can assist in implementing all current Light Reduction Devices (LRD's) through compulsory design guidelines inherited by residents. This paper suggests that these alternative strategies promote conservation of sea turtle nesting habitats through landscape and building design innovation including a "Turtle-friendly" housing design.

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THE LOGGERHEAD'S HOT SPOT ON THE WEST COAST OF ARUBA

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ARUBA (12°30'N, 70° W) is an autonomous entity within the Dutch Kingdom and is located 32 km north of Venezuela. It is a small, densely populated island in the Caribbean (193 km²; 100,000 inhabitants) and is very dependent on tourism. Sea turtles (including Loggerheads) were known to nest on several beaches of the West coast. After the construction of hotels since the late fifties of the past century the loggerheads are no longer reported nesting on those beaches. Nowadays the only remaining nesting habitat is at the Fisherman's Huts - Malmok, a very small stretch of beach next to the hotel zone (\pm 1 km). Turtugaruba, the Aruban foundation for sea turtle conservation has been monitoring this area for five years. Nest data for Loggerhead Sea Turtle (*Caretta caretta*) in Fisherman's Huts, Aruba, are as follows: 2001: 19 tracks, of which 4 were nests and 15 false crawls 2002: 31 tracks, of which 9 were nests and 22 false crawls 2003: 21 tracks, of which 6 were nests and 15 false crawls 2004: none 2005: 65 tracks, of which 16 were nests and 49 false crawls Only the nests that produce hatchlings are counted. Potential successful nestings lost to high water (e.g. during tropical storms) are listed among the false crawls. The collected data describe the actual status of loggerhead activity in this delicate area. Why is this area so "delicate"? The beach is a small stretch between the coastal road and the sea. In 2001 hatchlings of 2 of 4 nests ended up on the road. The first hatchlings of 2002 were disoriented the same way. Since then the five street-lights in front of the "hot-spot" (the 350 m with the highest density of nests) have been switched off every year as soon as sea turtle activity was reported. Other artificial lighting (hotels, apartments, houses, traffic) still remain. The lights do not only disorient the hatchlings but might also be responsible for the high number of non-nesting emergences. Driving on the beach is another threat. Boulders have been placed by the department of Public Works to block access for cars. Nevertheless quad racers could pass. To prevent disoriented hatchlings from going on the road and to avoid any driving on the beach the construction of a retainer wall was started in 2005. A third threat is loss of habitat: The construction of – again – a new hotel expanding the hotel zone in the direction of the loggerhead "hot-spot" is an imminent threat. Turtugaruba tries to avoid or reduce any new habitat-loss. In December 2005 the Government of Aruba was very close to signing the contract for the new hotel project, but at the deadline of this abstract (February 15, 2006) discussions are still going on.

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A TRI-NATIONAL PARTNERSHIP TO SAVE THE WESTERN PACIFIC LEATHERBACK TURTLE IN THE BISMARCK SOLOMON SEAS ECOREGION

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This paper describes a unique partnership by the communities and Governments of Indonesia, Papua New Guinea and Solomon Islands, to protect the critically endangered Western Pacific Leatherback turtle (*Dermochelys coriacea*). The beaches of the north coast of Indonesia, Papua, Papua New Guinea and Solomon Islands, also known as the Bismarck Solomon Seas Ecoregion (BSSE), are home to the largest remaining populations of this species. Recognised as culturally, economically and nutritionally important for coastal communities and because of the far ranging migratory routes between nesting, inter-nesting and foraging areas, management strategies require national, regional and international cooperation for their survival. During the 36 Pacific Island Forum in Papua New Guinea, 2005, a commitment to develop a tri-national partnership agreement and implementation plan to the conservation and management of this species at nesting sites, feeding areas and migratory routes was announced. This partnership will cover approximately 2.5 million sq km of coastal areas and waters of the BSSE, with specific attention to inter-nesting areas of approximately 595,331.41 sq km. Community representatives from the principal nesting beaches have also willingly set aside areas of their customary areas and waters for the protection of this species, which covers an estimated 30% of all currently known leatherback beaches in the BSSE. As these turtles travel beyond these three countries, the implementation plan also addresses issues such as by-catch, technical capacity and developing community sustainable livelihood alternatives, through networking of communities and partnering with organisations such as CI, TNC, NOAA, WPRFMC, SPREP and IOSEA.

SEA TURTLE CONSERVATION IN CHINA

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Five species of sea turtle are found in China: the Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Olive or Pacific Ridley (*Lepidochelys olivacea*), and the Leatherback (*Dermochelys coriacea*). Most are documented from the South China Sea, with the greatest abundance reported from the Xisha (Paracel) and Islands, the Nansha islands and from the Hainan Island. An estimated 14,000 to 40,000 sea turtles migrate to the Xisha Islands (a group of low coral islands and reefs in the South China Sea ca. 280 km southeast of Hainan Island) and to the Nansha Islands annually, whereas about 2,300 to 5,000 migrate to Hainan Island (including Guangdong Province). These migrations involve mixed species assemblages, as follows: ca. 87% Green, 10% Hawksbill, and 3% other species (Wang, 1993). Sea turtle populations have been sharply reduced in China over the past 50 years. Fifty years ago there were several identifiable sea turtle nesting sites at Hainan Island (Qionghai, Wanning, Ya, Dongfang county) and in Guangdong Province (Nana, Huilai, Haifeng, Huidong,

Wanshan, Taishan, Yangjiang, Dianbai county). Today, only Huidong county is known to have sea turtle nesting in China. The only hope for additional populations would be the discovery of nesting on some far and desolate island. The major factors threatening our sea turtle populations are the following: fisheries bycatch; the killing of nesting females, the collection of eggs for sale and consumption; and a general lack of awareness of the declining trends in our national populations. In China, the management authority is the Bureau of Fisheries (BOF) within the Ministry of Agriculture (MOA). To protect sea turtles, China promulgated the “Law of Wildlife Protection, China [1989]”, the “Ordinance of Aquatic Wildlife Protection, China”, and the “Ordinance of Nature Reserve, China [1993]”. In addition, in 1988, China declared the sea turtle a protected species (Grade II under the Law of Wildlife Protection) Guangdong Province promulgated the “Rule of Guangdong Sea Turtle Resources Protection [1988]”. In 1992, China established the 1800 ha Huidong National Sea Turtle Nature Reserve to protect critical nesting habitat. Within the Reserve, which encompasses some 1800 ha, eggs are artificially incubated in hatcheries and released to the sea annually. Nesting occurs from June to September in the Reserve. From 1985 to 2005, a total of 1,184 sea turtles landed, including 665 successful nestings, 75,319 eggs, 62,188 total hatchlings, and 53,203 hatchlings released to the sea. To secure the future of sea turtles in China, the following recommendations are offered: surveys to identify critical habitat and better document population trends; the development of a national Action Plan to guide conservation and management efforts; enhanced international, regional and national co-operation; improved public awareness and participation; stronger measures to protect habitat; a science-based plan to restore populations, effectively mitigating major threats; and the reduction, in particular, of wasteful fisheries bycatch.

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SUSTAINABLE FISHERIES POLICIES FROM AN ECOSYSTEM PERSPECTIVE: FAO'S WORK, WITH SPECIAL EMPHASIS ON REDUCING INTERACTIONS BETWEEN SEA TURTLES AND FISHERIES

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The FAO Code of Conduct for Responsible Fisheries (CCRF) is the reference framework for sustainable development of the fisheries sector. The CCRF explicitly addresses biodiversity issues and endangered species conservation. Its operation is facilitated by a series of guidelines for responsible fisheries, including those on the implementation of an ecosystem approach to fisheries, one of particular interest to biodiversity and conservation issues. These developments are evidence of how the scope of fisheries management is broadening to also include conservation concerns. Humans are also considered as part of the ecosystem and the challenge is to find solutions that make sustainable livelihoods and sustainable environments compatible.

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MODELING THE ROLES OF SEA TURTLES IN MARINE ECOSYSTEMS

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To maintain healthy marine ecosystems, sea turtle populations need to be restored to a level where they can fulfill their ecological roles as keystone species. To understand how sea turtles function in their ecosystems, we can use ecological models to simplify complex ecological systems and to focus on the key parameters of those systems. Descriptive or conceptual models identify the variables and the interactions of these variables based on a set of hypotheses. These interactions can be quantified with field and laboratory data or the parameters can be simulated. These quantitative models can then be used to predict how the system will function under various “what if” scenarios. We review examples of ecological models in sea turtle biology. Developing ecological models for sea turtle biology allows us to focus our research efforts on data deficient ecological processes.

THE ROLE OF MARINE TURTLES IN HUMAN ECOLOGY: RELATIVE MERITS OF FLAGSHIPS AND KEYSTONES

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There is growing interest in the ecological roles of marine turtles. Ongoing studies will provide not only a better understanding of the ecology of marine turtles in particular and marine ecology in general, but also basic information essential for formulating and evaluating more effective conservation objectives and actions. Recent research indicates that these marine reptiles can play critical ecological roles such as critical marine plant grazers and sponge predators, as well as nutrient and energy transporters between different trophic levels, between terrestrial and marine environments, and between different parts of the oceans. Hence, marine turtles may serve as “keystone species,” with roles that are decisive to the structure and function of certain ecological networks, or ecosystems. Yet, a clear understanding of the ecological roles of different life stages, populations, and species requires much more detailed study over much longer periods; to deal adequately with the slow maturation, long life spans, and dramatic fluctuations from year to year in both turtle population parameters and their environments, it is essential to conduct long-term studies and monitoring on issues related to ecological roles. Independent of the myriad ways that marine turtles interact with their environments and other species, it is clear that these reptiles play critical roles in diverse relationships with peoples of different societies: they are classical “flagship species.” Their flagship role is based on the cultural and social values attributed to the animals by members of the societies with which they interact, and archaeological evidence shows that humans have attributed special importance to marine turtles for millennia. In addition to the great antiquity of human-turtle interactions, there is tremendous diversity, with cultural manifestations occurring around the world in multiple forms. During contemporary times marine turtles have been widely and actively used, either explicitly or implicitly, as icons to promote biological conservation, for numerous programs which show clear indicators of success. On the other hand, marine turtles also serve as flagships for other social initiatives, such as cultural identity and preservation, marketing, and other activities that appear contradictory to the objectives of conservation. It is not uncommon to find different sectors of the same society responding in very different ways to the same marine turtle flagship, and these sorts of confusion and conflict undermine both conservation *and* socio-cultural initiatives. Hence, it is essential to understand the complexities of human ecology when designing and evaluating initiatives that employ marine turtles as flagships. Conservationists must be especially careful of this problem. While the keystone role, or ecological function, of a species is essential for understanding the organism’s natural history and relationship with its environment, the flagship role is a much more powerful tool for affecting conservation and understanding how people perceive and interact with the animals. Species with apparently little ecological significance can be of immense importance as flagships, and have been used to successfully promote major conservation initiatives with far-reaching effects. Without understanding the human-turtle relationship, no turtle conservation program can be effective – no matter how much “good science” it relies on.

CERRO VERDE: A TEMPERATE DEVELOPMENTAL HABITAT FOR JUVENILE GREEN TURTLES ALONG THE EASTERN COAST OF URUGUAY

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Cerro Verde is one of the most southerly study sites of the green turtles feeding areas along the South-western Atlantic Ocean. The area is located in the Rocha department (34° 58' S; 54° 58' W) covering over 510 km² of a marine-coastal ecosystem, which includes 140 km² of mainland and 375 km² of marine surface. The area is part of the "Eastern Wetlands and Coastal Fringe" Biosphere Reserve, and also a RAMSAR site since 1982. In Uruguay, Cerro Verde islands and adjacent waters represents the most important feeding and developmental habitat for juvenile green turtles. Moreover, rocky shores with abundant seaweed beds and forage material as those found in Cerro Verde could only be found more than 600 km north within Brazilian waters. From 2000 to 2005 a total of 161 green turtles were captured in the study area and adjacent waters between the locality of La Coronilla and Punta del Diablo. Curve carapace length (CCL) of the turtles ranged from 30.0 – 61.2 cm (mean = 41.9 cm, SE = 0.2). Samples of recently ingested food items were collected by conducting gastric lavage to 71 turtles. The diet consisted largely of seaweeds; the most abundant and frequent component of the turtle's diet from coastal areas were the green algae *Ulva* spp., while the red algae *Chondracanthus* spp. and *Grateulopia* spp. were more commonly consumed by turtles from insular areas. Turtle sightings from observatories in Cerro Verde indicated that their activity varied seasonally. Eight green turtles ranging from 38.6 to 48 cm in CCL and 6.5 to 15 kg in mass were fitted with a combination of radio and sonic transmitters and released at their captured sites. Turtles remained within the area between 2 and 6 months, four of them where detected in the area for extended periods (up to 6.5 months). Overall mean surface and submergence times were calculated as well as hourly means at dawn, day, dusk and night. Active periods of foraging (submergence < 5 min) occurred mostly during the day, morning and early dusk. Resting behavior (submergence ≥ 10 min) was observed at night, and in some occasions at dusk. The presence of lethargic individuals covered by a great diversity of unusual epibionts during winter and spring evidenced the existence of possible periods of brumation in the region and reinforced the fact that some of the turtles remain in the feeding area even with water temperatures under 15°C. However, flipper tag recoveries, including live captured individuals, support the evidence of seasonal migrations to and from subtropical latitudes. Until present, six green turtles were recaptured between Brazil and Uruguay. Four of these turtles were tagged in Uruguay and then recaptured in Brazil while the other two formerly tagged in Brazil were found in Uruguay. This presentation will detail the data gathered between 2000 and 2005 in terms of population structure, feeding habits, activity patterns, migrations and will discuss ongoing conservation activities in the region.

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USING STABLE ISOTOPES TO DESCRIBE THE ECOLOGICAL ROLES OF SEA TURTLES: THE NICHE MOSAIC CONCEPT REVISITED

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Understanding the trophic status of sea turtles is an important first step towards describing their ecological role. Despite the oft-promulgated generalities about sea turtle diet strategies (i.e. green turtles are herbivores, hawksbills are spongivores, etc), recent data have demonstrated that a sea turtle's diet may vary both spatially and temporally. Therefore, when developing conceptual models to illustrate the ecological role of sea turtles, it is important that this variability be elucidated to better describe the complex ecological interactions between sea turtles and their environment. In recent years, stable isotope tools have proven successful at determining the trophic status and consumer-prey relationships of a variety of marine species because the isotope compositions of consumer body tissues are ultimately derived from those in its diet. By providing information on nutrients assimilated over extended periods, stable isotope analyses offer an advantage over conventional dietary analyses that only provide dietary 'snapshots' of recently consumed food items. In this study we use stable isotope analyses to determine the trophic status of sea turtles in the eastern Pacific Ocean. We provide three case studies, focusing on green turtles, leatherbacks, and olive ridleys, and demonstrate how stable isotopes can be used to further our understanding of the ecological roles of sea turtles. Our results provide new insights about inter- and intra-species variability in trophic ecology and further support the Niche Mosaic Concept as applied to sea turtles.

EVALUATION OF REMIGRATION INTERVALS AS INDICATORS FOR HOW WELL SEA TURTLE POPULATIONS FULFILL THEIR ECOLOGICAL ROLES

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Sea turtles have specialized feeding habits and affect other marine species through predation/consumption and indirectly through nutrient recycling and food competition. The food web connections between sea turtles and other species mean that changes in sea turtle abundance may have effects throughout the marine ecosystems they inhabit. To restore healthy marine ecosystems, conservation goals necessarily must include sea turtles recovering to fulfill their ecosystem roles. Pristine sea turtle populations that fulfilled their ecological roles were most likely food limited whereas current populations are recruitment and survival limited. One approach to determine how well sea turtles fulfill their ecological roles is to estimate historical population size and compare it with current population size. Historical population estimates, however, are based on extrapolations from small to large scales and, hence, are prone to large errors. Alternative indicators of how well sea turtles fulfill their ecological roles are therefore highly desirable. Sea turtles are capital breeders and remigration interval depends on available food quantity and quality. Remigration intervals therefore partly reflect the strength of intraspecific competition and could potentially be used as indicators for how close populations are to fulfill their ecological roles. We use

long-term data from Tortuguero to evaluate if remigration intervals are good indicators. Green turtle remigration interval appears to have increased with nesting since 1971 but results could be confounded by variation in tag loss, encounter and annual survival probabilities as well as by variation in marine productivity on the foraging grounds. Historical declines may explain the shorter remigration intervals of Tortuguero green turtles than for less exploited populations in Hawaii and Australia but the difference could also be caused by Atlantic and Pacific climate cycles creating selection pressures that favor different life history strategies. Tortuguero hawksbill turtles have declined and remigration intervals appear to have decreased but sample size is small. The same confounding factors apply as for the green turtle population. Tortuguero leatherback turtles have shorter remigration intervals than Pacific leatherbacks, probably due to differences in available food quality and quantity, linked to differences in oceanic productivity and climate cycles. We conclude that remigration intervals may indicate how well green and hawksbill turtles fulfill ecosystem roles but they appear less useful as indicators for leatherbacks due to large environmental variation in their foraging habitats. Research of factors affecting the quality and quantity of available food and how these factors differ between ocean basins should help explain variation in remigration intervals and clarify their usefulness as indicators.

Order: 198 **Abstract ID:** 1394 **Type:** Oral **Subject:** Ecological Roles of Marine Turtles

ECOPATH WITH ECOSIM (EWE) AND THE ECOLOGICAL ROLE OF *CHELONIA MYDAS* IN THE CARIBBEAN

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The past roles of sea turtles as major consumers in many marine ecosystems have only recently been recognized. Green turtle biomass levels required to maintain “healthy” seagrass beds within the Caribbean, as well as potential changes in community structure under various densities of *Chelonia mydas*, are explored using a quantitative ecosystem model, Ecopath with Ecosim (EwE). The Ecopath model was designed as a “snapshot” estimation of turtle density for the Bahamas, and then extrapolated to the Caribbean. Thus, the Ecopath result is an estimate of turtle biomass per km² of seagrass, given a number of trophic considerations. These biomass estimates were then evaluated over a range of conditions (e.g. competitive interactions) to determine turtle biomass levels needed to maintain a productive system. The Ecosim module allowed predicting changes in community structure under varying levels of turtle impact given fine-tuning of trophic mediations built into the system. Important assumptions underlying the exploration of such interactions are that: i) shoot density is independent of blade length, thus an increase in seagrass biomass can be equated with longer blade length; and ii) an increase in biomass is coupled with a decrease in productivity:biomass ratios, which has been validated by simulated grazing experiments in the Bahamas. These explorations combined with apparent changes in community structure are used to characterize target levels of green turtle biomass needed to maintain seagrass ecosystems in a productive state - and how that biomass compares to the potential carrying capacity of green turtles for the Caribbean.

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LEATHERBACK TURTLES AS OCEANOGRAPHIC INDICATORS: STABLE ISOTOPE ANALYSES REVEAL A TROPHIC DICHOTOMY BETWEEN OCEAN BASINS

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Oceanographic sampling often is limited to local and temporally concise assessments of complex, transient and widespread phenomena. However, long-lived, migratory pelagic vertebrates such as leatherback turtles (*Dermochelys coriacea*) can provide important integrated information about broad-scale oceanographic processes. Therefore, we analyzed stable carbon and nitrogen stable isotopes ratios ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) of egg yolk and red blood cells from nesting leatherback populations from Costa Rica in the eastern Pacific in 2003-04 and 2004-05 and from St. Croix in the North Atlantic in 2004 and 2005 to establish differences between nutrient sourcing and its influence on higher trophic level consumers in both ocean basins. Whereas $\delta^{13}\text{C}$ signatures were similar between Costa Rica and St. Croix leatherbacks, reflecting the pelagic foraging strategy of the species, Costa Rica leatherback $\delta^{15}\text{N}$ signatures were significantly enriched relative to St. Croix leatherback $\delta^{15}\text{N}$ signatures. This $\delta^{15}\text{N}$ difference likely reflects inter-basin differences in nitrogen cycling regimes and their influence on primary productivity being transferred through several trophic levels. Thus, movements, habitat preferences, and stable isotope signatures of high-order marine consumers can be combined with ocean sampling to elucidate interactions between oceanographic processes and marine animal populations. Specifically, sea turtle populations and species occupying unique ecological roles can be employed to examine the relative health and function of geographically distinct marine ecosystems.

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NEW MTDNA DLOOP PRIMERS WHICH WORK FOR A VARIETY OF MARINE TURTLE SPECIES MAY INCREASE THE RESOLUTION OF MIXED STOCK ANALYSES

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Identification and monitoring of population units in marine turtle populations using molecular markers, particularly in foraging habitats where multiple stocks aggregate, has become one of the most critical aspects of conservation management at a regional level. In some regions such as the Wider Caribbean, where more than 30 countries share management responsibilities for multiple marine turtle stocks, the distinction of populations is even more crucial. The current, widely used mtDNA dloop PCR primers generate segments of about 380 to 510 bp's in length and, although effective in distinguishing major rookeries in the earlier genetic surveys, they have become too limited in their resolution as the number of candidate source rookeries increases and the amount of haplotype frequency overlap more widespread. We have increased the number of dloop bases produced by PCR with two new sets of primers (LCM15382/H950 and LTEi9/H950) which amplify about 880 bp's and have been found by various laboratories to successfully amplify hawksbill, olive ridley, loggerhead and green turtle DNA. For hawksbills, so far, we have found a significant number of additional variable sites in the extended region which may aid in resolving some of the ambiguities in mixed stock analyses. Suitability of the primers across species and the extent of variability across the entire amplified segment are presented as well as a discussion of differences among species.

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HAWKBILL TURTLES FORAGING AROUND BARBADOS, WEST INDIES, ORIGINATE FROM ROOKERIES BOTH WITHIN AND OUTSIDE OF THE WIDER CARIBBEAN

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Although it has been proposed that recruitment of sea turtles to foraging grounds is non-random, little is known about how turtle behavior may interact with ocean currents and with the distance of source stocks and their relative abundances to produce observed stock mixtures. A mtDNA dloop analysis of the hawksbill (*Eretmochelys imbricata*) foraging aggregation around Barbados revealed more distant source rookeries than previously studied foraging aggregations in the Wider Caribbean region, with animals not only originating from the insular Caribbean but also from rookeries in Mexico, Central America and, most interestingly, from West Africa as well. Given Barbados' position up-current of all other Caribbean hawksbill rookeries and at the confluence of the North and South Equatorial currents, these genetic results were used to investigate the role of ecological factors in the composition of hawksbill foraging aggregations in Barbados waters and the importance of these habitats to the conservation prospects of distant populations.

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GREEN TURTLE POPULATION HAPLOTYPING USING SSCP

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The green turtles at Ras Al-Hadd nest year-round and are thought to comprise different subpopulations originating from different regions. Preliminary data from sequencing the mitochondrial control region showed different haplotypes. The two most common haplotypes differed by 17 substitutions and indicated the presence of genetically distinct subpopulations. In order to haplotype new samples and detect novel haplotypes in a large scale project, we optimized conditions for the single-strand conformational polymorphism (SSCP) method using known haplotypes. SSCP is a simple, sensitive, and cost-effective polymorphism scanning method. The PCR product (approximately 400 base pairs) was digested into shorter fragments using MseI, a restriction enzyme, to increase the sensitivity of polymorphism detection. Running the digestion products on polyacrylamide gel showed variable banding patterns that distinguished the different haplotypes. Later, the known haplotype patterns were used successfully as controls for haplotyping unknown samples. SSCP has been used before to assess the variation present in the Arabian Gulf using samples of

unknown origin and the results indicated the presence of only two patterns (A and B). This may be due to the fact that some haplotypes differ by a single substitution, which is unlikely to be detected within a relatively large fragment.

Order: 203 **Abstract ID:** 1513 **Type:** Poster **Subject:** Ecology and Evolutionary Biology

WEATHER INFLUENCES IN *CARETTA CARETTA* AND *DERMOCHELYS CORIACEA* REPRODUCTIVE ACTIVITIES IN COMBOIO'S BIOLOGIC RESERVE, LINHARES/ ESPIRITO SANTO - BRAZIL

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Several environmental factors have been highlighted as important for sea turtles in the decision about the nesting moment. Popular belief suggests that nesting activities increase at many sea turtle nesting beach on rainy or stormy nights. For example, the villagers of Regência / Espírito Santo say “Estrovejou, poca careba” (“Have thunder, have a lot of turtles”), relating the heavy rain to the great number of turtles on the beach. On account of the dissension about the climatic factors influence over the nest timing, a study was developed to test the influence of daily rainfall and lunar phases in the nesting of *Caretta caretta* and *Dermochelys coriacea* in the Comboios' Base (Espírito Santo, Brazil) of the TAMAR/IBAMA Project in the reproductive seasons of 1998/1999, 1999/2000, 2000/2001 and 2001/2002, employing ANOVA through randomization test. The occurrence of rainfall determined more reproductive attempts in the same night ($F=89.536$ $P=0.001$), but the amount of rainfall had no influence. The lunar phases did not influence reproduction attempts when analysed in conjunction with the rainfall ($P=0.35$ $F=13.936$), but when only cloudless nights were considered, attempts of reproduction were more frequent in new and waning moons ($P=0.024$ $F=28.178$). These results stress that meteorological conditions influence the choice of the moment for nesting and suggest that the brightness of the night (perceivable only in cloudless nights) may also interfere in the process, as empirically observed by local people and researchers.

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GUT CONTENTS OF LOGGERHEADS STRANDED ALONG THE NORTHWESTERN MOROCCO COAST

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We examined the gut contents of 5 loggerhead sea turtles measuring 57-67 cm in curved carapace length that stranded along the northwestern coast of Morocco during 2004. Nine taxonomic groups, including crustaceans, fish, molluscs and annelids, were identified. Plastic and wood fragments were also found. The portunid crab *Polybius henslowii* was the predominant species in our gut analysis. The majority of the species identified in the guts of these stranded loggerheads have a benthic existence, suggesting that these loggerheads were foraging in benthic areas possibly along the Moroccan coast.

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CHARACTERIZATION OF CRITICAL FORAGING HABITAT FOR LEATHERBACK TURTLES OFF CALIFORNIA, USA

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A key element in the recovery plan for the Pacific leatherback (*Dermochelys coriacea*) is classification of critical foraging habitat. Western Pacific leatherbacks migrate from nesting beaches in West Irian Jaya, Indonesia to multiple foraging grounds, including the west coast of North America. Leatherback sightings recorded during aerial surveys off the California coast during the 1990's indicated that up to 18% of western Pacific females utilize neritic waters off California annually, with greatest abundances occurring within a few oceanographic retention areas during late summer and fall. With this understanding, we designed fine-scale aerial surveys to study habitat associations of leatherbacks and their Scyphomedusae prey off central California. Oceanographic data were obtained from remotely sensed satellite sources and targeted in-situ shipboard sampling. We also equipped leatherbacks with satellite transmitters to monitor their movements within this coastal upwelling ecosystem. Leatherbacks aggregated only in areas with moderate to dense concentrations of large *Chrysaora fuscescens*, in shallow waters (30-60m) characterized by phytoplankton blooms and elevated surface temperatures. These conditions appear to arise from a complex sequence of physical and biological processes, driven primarily by upwelling and relaxation events. Areas of suitable habitat varied interannually, but the region off San Francisco Bay consistently supported the greatest number of leatherbacks and clearly represents critical foraging habitat for the Western Pacific population. The results of this study provide insight into physical and biological processes that may be important in other foraging areas, including less studied regions off Oregon and Washington and in the Western Pacific.

THE ECOLOGY OF CARETTA CARETTA AND CHELONIA MYDAS POST-HATCHLING'S FROM EAST AUSTRALIAN POPULATIONS

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The ecology of *Chelonia mydas* and *Caretta caretta* post-hatchlings in the south west Pacific was investigated using a combination of ecological and genetic methodologies. Post-hatchlings were obtained for this study from strandings and from the stomachs of dolphin fish (*Coryphaena hippurus*) and previous records were collated from the Queensland Environmental Protection Agency's database of marine wildlife strandings and deaths. Data on the spatial and temporal distribution of post-hatchlings in relation to rookery location and oceanographic features provides evidence that *C. mydas* and *C. caretta* post-hatchlings from populations in the southwest Pacific region become entrained in oceanic currents and live a pelagic existence. Occupancy of an oceanic and pelagic habitat is supported by dietary investigations that show post-hatchlings in the southwest Pacific Ocean from both of the investigated species derive nutritional sustenance

primarily from animal matter, and that they feed on neustonic species in a non-selective manner. The spatial and temporal data on the two species of post-hatchlings, however, indicates that the two species do not take the same migratory route after departing from the same coastal waters. The data provide strong evidence that loggerhead post-hatchling undergo trans-Pacific migrations within the southern Pacific sub-tropical gyre. This is suggested by: (i) incremental size increase in direction of this current away from nesting beaches, (ii) loggerhead post-hatchlings are reported in New Zealand waters and on the eastern side of the southern Pacific, and (iii) loggerhead post-hatchlings larger than 13.7cm CCL are not documented in the southwest Pacific. Although the current resolution of the genetic stocks in the southwest Pacific does not allow differentiation between stocks on the local scale, it can provide discrimination on an oceanic scale. Analysis of the haplotypes of the loggerhead post-hatchlings shows that all specimens investigated in this study originated from southwest Pacific rookeries. Whereas the data imply that *C. caretta* post-hatchlings embark on trans-Pacific migrations, it suggests that *C. mydas* post-hatchlings do not. While this species also occupies offshore oceanic waters, it appears they remain in the southwest Pacific region. This is indicated by: (i) green post-hatchlings occupying waters around offshore seamounts (whereas *C. caretta* post-hatchlings appear absent), (ii) the absence of *C. mydas* post-hatchlings in New Zealand or south east Pacific waters, and (iii) the occurrence of larger size classes of green post-hatchlings stranded on eastern Australian coast. Mixed stock analysis (using SPAM & TURTLE) performed with haplotypic information from post-hatchlings calculated that *C. mydas* post-hatchlings originate from the SGBR (60%), Coral Sea (27%) and New Caledonia (13%) rookeries. The differences in the habitat occupied by these two species most probably arise from behavioral differences, as initially they embark upon the same route. *C. mydas* is a more tropical species in comparison to *C. caretta*. I therefore propose that green post-hatchlings respond to warmer waters where they maintain themselves within the warm water gyres that form off the coast from the EAC. In comparison, the loggerheads remain within the cooler currents that traverse the south Pacific ocean.

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COMPLEX POPULATION STRUCTURE OF THE ENDANGERED LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) IN THE MEDITERRANEAN SEA REVEALED BY NUCLEAR AND MITOCHONDRIAL DNA MARKERS

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The genetic structure of the loggerhead sea turtle (*Caretta caretta*) populations nesting in the eastern Mediterranean was assessed by means of a fragment of the control region of the D-loop of the mitochondrial DNA (n=190)

and seven microsatellites (n=112). The two types of markers revealed genetic structuring (mtDNA: γ_{ST} =0.183, $p<0.001$; nDNA F_{ST} =0.006, $p<0.001$), thus indicating that both females and males are philopatric and that gene flow between populations is restricted. However, some nuclear DNA flow was found to occur between populations. Mitochondrial DNA data suggested that the female populations nesting on the islands of Crete and Cyprus have suffered a recent bottleneck or that the colonization of the islands is recent. However, no bottleneck or founder effect was revealed by nuclear markers, thus demonstrating the existence of a male-mediated gene flow from other populations that would increase nuclear genetic variability. Crete and Cyprus are thought to play a central role in such male-mediated gene flow and, due to the existence of the flow, the negative effect of genetic drift or inbreeding on the small populations of Lebanon and Israel may be less important than their reduced population size would suggest. All nesting populations in the eastern Mediterranean must be protected independently of their size because all contribute to the overall genetic variability; however, special attention should be paid to the Crete and Cyprus populations because of their central role in ensuring gene flow within the Mediterranean.

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GENETIC STRUCTURING OF IMMATURE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN THE MEDITERRANEAN SEA AND THE ADJOINING ATLANTIC REFLECTS WATER CIRCULATION PATTERNS

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The analysis of the mitochondrial DNA of 582 loggerhead sea turtles (*Caretta caretta*) from eleven foraging grounds in the Mediterranean and the adjoining Atlantic revealed deep genetic structuring within the western Mediterranean. As a consequence, the foraging grounds off the southwestern Mediterranean and off of the Gimnesies Islands (northern Balearic Islands, Spain) are composed mainly of turtles from the Atlantic stocks,

whereas the foraging grounds off the Italian peninsula and off the northern shore of the western Mediterranean are composed mainly of turtles from the eastern Mediterranean rookeries. Finally, the contribution of the eastern Mediterranean rookeries to the foraging grounds off of Lampedusa Island (Italy), Valencia (Spain) and Pitiüses Islands (southern Balearic Islands, Spain) is higher than expected in agreement with their geographic locations. This structuring is explained by the pattern of sea surface currents and water masses and suggests that immature loggerhead sea turtles entering the western Mediterranean from the Atlantic and the eastern Mediterranean remain linked to particular water masses, with a limited exchange of turtles between water masses. As the north of the western Mediterranean is comprised almost entirely of individuals from the highly endangered eastern Mediterranean rookeries, conservation plans should make it a priority to reduce the mortality caused by incidental by-catch in these areas.

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SPORADIC NESTING IN THE WESTERN MEDITERRANEAN AS LONG DISTANCE DISPERSAL EVENTS

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Genetic and tagging studies have demonstrated the high degree of philopatry in *Caretta caretta*. This mechanism gives turtles the advantage of exploiting nesting areas that have succeeded in the past but may have strong limitations for the colonization of new, distant nesting areas. This trade-off may have important implications in future scenarios of latitudinal migrations of nesting areas related to global climate warming as actual nesting areas may exceed pivotal temperatures for egg incubation that could be offered by slightly cooler beaches. As the species is distributed worldwide and nesting areas are sometimes separated by thousands of kilometers, long dispersal mechanisms should exist to overcome the shortcomings of philopatry. The western Mediterranean has hosted a few sporadic nesting events, far from the closest nesting areas, as in Almería in 2001 or in Naples in 2002. These singletons might be relicts of ancient nesting areas or evidence of new colonizers from the Atlantic or Eastern Mediterranean nesting areas, as juveniles of these individuals share the feeding grounds in the western Mediterranean. The control region of the D-loop of the mitochondrial DNA as well as 7 microsatellites revealed the origin of these sporadic nesting events and suggested that sporadic nesting might be one mechanism of the species to colonize new, distant nesting areas. Multiple paternity was observed as at least two fathers contributed to the Almería nest, and hence, these dispersal units might start with a higher genetic diversity than expected if one single male was involved.

Acknowledgements: We gratefully acknowledge travel support from UNEP's RAC/SPA (Regional Activity Centre for Specially Protected Areas) and other donors through the Symposium Travel Committee.

DEGREE OF ISOLATION OF THE MEDITERRANEAN NESTING POPULATIONS OF THE LOGGERHEAD SEA TURTLE USING NUCLEAR MARKERS

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Previous studies have revealed that the Mediterranean nesting populations of the loggerhead turtle are genetically isolated from the Atlantic populations. However, the marker used in these studies (mitochondrial DNA) is maternally inherited and hence, the male's contribution was not considered. Juveniles of both Mediterranean and Atlantic populations are found in the feeding grounds in the western Mediterranean, and Atlantic juvenile migration is male biased. Under this scenario, it is possible for male mediated gene flow to occur from the Atlantic to the Mediterranean in these feeding grounds. To test this hypothesis, we selected 58 Atlantic individuals from a total of 168 turtles from five feeding grounds in the western Mediterranean. We then sequenced a 380bp fragment of the D-loop of the mitochondrial DNA and selected individuals with haplotype CC-A1, which is exclusive of the Atlantic feeding grounds. We genotyped 7 microsatellites of these Atlantic individuals as well as a total of 112 individuals from Mediterranean nesting beaches. Mediterranean and Atlantic populations were highly isolated ($F_{ST}=0.025$, $p<0.001$) and hence, significant male mediated gene flow between Atlantic and Mediterranean nesting areas should be excluded. Moreover, no differences were found in terms of gene diversity, heterozygosity or allele diversity (T-Student; $p>0.01$), supporting that variability is similar in both basins and that the Mediterranean nesting areas do not have a lower genetic variability than the Atlantic ones. The high degree of differentiation between the two areas suggests that microsatellites might be powerful markers for assigning individuals found in feeding grounds to their original nesting area using assignment tests.

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PHYSICAL AND CHEMICAL PARAMETERS OF THE SANDY SUBSTRATE OF CEUTA BEACH AND ITS EFFECT IN THE HATCHING PERCENTAGE OF THE MARINE TURTLE *LEPIDOCHELYS OLIVACEA*

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The physical and chemical characteristics of soil are very important since they can explain the origin of the study area as well as the possible effects that they can have on sea turtle hatchling success. We characterized the physical and chemical parameters of nesting substrates at Ceuta Beach, Sinaloa, Mexico with the purpose of obtaining a standard for better results in the artificial incubation of olive ridley turtle (*Lepidochelys olivacea*) eggs. Of the studied variables (apparent density, porous space, capacity of humidity retention, slope, penetrability, pH and organic matter) a single significant relation was discovered between the sand grain size and hatching percentage ($r = 0.30$). Other physical and chemical characteristics of the Ceuta Beach sandy substrate did not effect the period of incubation or hatching successes observed.

DESCRIPTION OF ORGANIC MATTER AND PH OF THE BEACH SAND CEUTA LIKE REFERRING FOR THE NESTING OF THE MARINE TURTLE *LEPIDOCHELYS OLIVACEA*

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The present study was conducted from 2000-2001 to determine the chemical properties of sands comprising the nesting beach for olive ridleys (*Lepidochelys olivacea*) at Ceuta Beach, Sinaloa, Mexico. We found the sand pH to be slightly alkaline in nature and values varied significantly ($p = 0.029$ and $p = 0.011$) throughout the 35 km of nesting beach. Additionally, there were not significant differences between the aforementioned values and the months that sampling was conducted ($p = 0.341$ and $p = 0.111$).

CONFIRMATION OF MARINE TURTLE HYBRIDS IN NORTHWEST ATLANTIC WATERS

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Marine turtle hybridization has been confirmed in the scientific literature since 1983 (Wood et al.) yet worldwide documentation of hybrids remains a rare phenomenon. In northwest Atlantic waters, hybrids have only been reported on two occasions: 1 Kemp's ridley (*Lepidochelys kempfi*) x loggerhead (*Caretta caretta*) hybrid was documented in 1992 in Chesapeake Bay, Virginia, U.S.A (Karl et al. 1995) and 1 loggerhead (*C. caretta*) x green (*Chelonia mydas*) hybrid stranded in Nova Scotia, Canada in 2001 (James et al. 2006). Despite the scarcity of historical reports, the U. S. Northeast Region Sea Turtle Stranding and Salvage Network (NE STSSN) documented 7 cases of apparent interspecific hybridization in stranded sea turtles from the northwest Atlantic in just 4 years. Six of the hybrids stranded alive on Cape Cod, Massachusetts during annual cold stun stranding events: 4 in 2002, 1 in 2003 and 1 in 2004. These turtles were collected by the Massachusetts Audubon Wellfleet Bay Wildlife Sanctuary and taken to the New England Aquarium for rehabilitation. One hybrid stranded twice on Long Island, New York (2000 and 2001) and was treated at the Riverhead Foundation for Marine Research and Preservation. These turtles were initially classified as hybrids because of their intermediate morphological characteristics, including carapace scute number, marginal scute serration, scute imbrication, postorbital scale number and their overall "odd" appearance. Tissue samples (N = 5) and blood samples (N = 1) were collected from 6 of the 7 putative hybrids and shipped to National Marine Fisheries Service Southwest Fisheries Science Center for genetic analysis. Preliminary genetic results from both nuclear and mtDNA markers confirmed hybridization for 5 out of the 6 turtles. Matings between *C. caretta* x *C. mydas* accounted for the majority of hybrid crosses (4 out of 6), including 3 of the Massachusetts turtles (all confirmed) and the 1 New York turtle (results pending). MtDNA results from each of the *C. caretta* x *C. mydas* crosses indicated that the female was of *C. caretta* origin. The remaining 2 Massachusetts hybrids included 1 *Eretmochelys imbricata* x *C. mydas* cross (confirmed) (*E. imbricata* female) and 1 that presented as either a *L. kempfi* x *C. mydas* or *L. kempfi* x *E. imbricata* (*L. kempfi* female). This recent increase in hybrid reports from the northwest Atlantic is surprising, given the rarity of hybrid reports worldwide. The NE STSSN has been organized and operational for over 20 years but is only now documenting hybridization in stranded turtles. Seven possible cases have turned up in just under 4 years with 6 in Massachusetts alone. These cases could simply be the result of increased attention and detection effort, however they suggest natural occurrence of interspecific hybrids may be more common in some sea turtle species than previously believed.

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GEOGRAPHIC VARIATION IN FORAGING STRATEGIES OF LEATHERBACK POPULATIONS: A HEDGE AGAINST CATASTROPHY?

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Leatherback populations in the eastern Pacific have collapsed, while populations in the western Atlantic appear to be generally increasing. I present a synthesis of data from satellite telemetry and genetic studies (mtDNA and microsatellites) to determine stock structure and foraging strategies for Pacific and Atlantic leatherback populations. Results show that the relatively large western Pacific nesting population in Irian Jaya (Indonesia) uses multiple foraging grounds in nearby and distant waters. This population is part of a genetic stock that is comprised of discrete foraging “units” that nest on the same beaches at different times of year. Similarly, Caribbean nesting populations use multiple foraging grounds extending across the entire North Atlantic. In contrast, the depleted eastern Pacific genetic stock has a more limited distribution associated with foraging areas exclusively in the southeastern Pacific. These eastern Pacific foraging areas are characterized by low productivity linked with frequent ENSO episodes. The evolutionary history gleaned from phylogenetic analysis suggests that the eastern Pacific stock is relatively new and characterized by a history of extinction and recolonization. These results taken together suggest that the evolution of multiple foraging strategies provides a greater buffer against adverse anthropogenic impacts and environmental perturbation in the marine environment, and that these stocks are more likely to respond to conservation action on the nesting beaches directed at increasing hatchling production. Genetic analysis shows that the West Africa stock is absent from North Atlantic foraging areas, and these results provide a framework for further hypothesis testing with telemetry.

CHARACTERIZATION OF MTDNA VARIATION AMONG KEMP’S RIDELYS NESTING ON PADRE ISLAND WITH REFERENCE TO RANCHO NUEVO GENETIC STOCK

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There has been an increase in nesting by Kemps ridleys at Padre Island (PI) in Texas that may in part be the result of a long-term experimental program that involved “imprinting” hatchlings on PI beaches that had been hatched from eggs relocated from the main nesting beach at Rancho Nuevo (RN), Mexico in an attempt to establish another nesting population. We examined mtDNA control region sequences obtained from 61 females that nested on PI between 2002 and 2005 and compared haplotype frequencies with those from the RN nesting population in order to test for a shift in haplotype frequencies that might indicate a possible founder event. We identified a total of 6 distinct haplotypes, with one found at high frequency at both PI and RN. There was no significant difference in haplotype frequency indicating genetic homogeneity between both populations. Conservation implications are discussed.

A PREDICTIVE HABITAT MODEL FOR LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN THE ALBORAN SEA USING SATELLITE TELEMETRY AND GEOSPATIAL ANALYSIS

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The Alboran Sea is located in the Western Mediterranean Sea and is the most biologically productive region in the Mediterranean basin. A project to determine habitat use and movements of loggerhead turtles was initiated as part of a larger program to develop conservation strategies for cetacean and sea turtle populations within the framework of the European Union's Habitat Directive. The objective of the project was to create a predictive habitat model for loggerhead turtles derived from satellite telemetry location and behavior data using geospatial analysis techniques and multivariate, nonparametric statistics. Between July 2004 and August 2005, 19 satellite transmitters were deployed on juvenile loggerhead turtles in the Alboran Sea. Fourteen of the transmitters were Wildlife Computers SPOT4s, capable of reporting location information and a frequency distribution of temperatures. The other five transmitters were Wildlife Computer's SDR-T16s which reported geographic locations, frequency distributions, dive depths, dive durations and temperature. Some turtles were tracked for more than 300 days. After filtering to improve the accuracy of the raw location data, a Geographic Information System (GIS) was used to sample environmental variables including bathymetry, sea surface temperatures (SST) and distance to SST fronts, eddies, currents, and other surface features as well as primary productivity. This data was then used to create a predictive habitat model using multivariate, nonparametric modeling techniques. Results of this study will be presented.

TEMPERATURE COMPARISON OF LOGGERHEAD SEA TURTLE NESTING BEACHES THROUGHOUT FLORIDA

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Loggerheads nesting in the southeastern U.S. represent one of the largest nesting aggregations of *Caretta caretta* in the world. The majority of this nesting occurs in Florida. Loggerheads possess temperature-dependent sex determination (TSD) which can produce a wide variety of sex ratios. Therefore, TSD has conservation and ecological implications. The current study represents a comprehensive and simultaneous comparison of nesting

beach temperatures throughout the range of major loggerhead nesting beaches in Florida. Beach temperatures were monitored at mid-nest depth (40 cm) in areas where the majority of nesting occurred. Beach temperatures were monitored for two nesting seasons using data loggers on 8 to 13 loggerhead nesting beaches throughout Florida. Although data loggers were lost on several of the nesting beaches due to the abundance of hurricanes during 2004 and 2005, data were obtained from many of the beaches. In general, beach temperatures during the nesting seasons varied relative to weather and, in particular, to precipitation. Most temperatures recorded at mid-nest depth were within a range of 26-32°C, with an approximate average of 30°C. Preliminary analysis suggests that temperatures recorded on a single beach tended to be similar. The results also indicate that some beaches may be consistently warmer or cooler than others. The findings of this study facilitate the identification of nesting beaches which may be of conservation and management interest due to their thermal characteristics.

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SOME REPRODUCTIVE ASPECTS OF THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) IN QUEREPARE BEACH, PENINSULA DE PARIA, SUCRE STATE, VENEZUELA, DURING THE 2004 NESTING SEASON

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The Peninsula de Paria, in northeastern Venezuela is the most important nesting locality for the leatherback turtle (*Dermochelys coriacea*). This undergraduate project studied some reproductive aspects of this species between April to September 2004. Curved carapace measurements (SCL and CW) were registered, each female received a metallic tag in the left fore-flipper and an AVID PIT tag in the right shoulder. The nests were transferred to a hatchery. The mean value for SCL and CW were 150.2 cm and 111.9 cm, respectively. A total of 39 turtles were observed and 35 were tagged. In addition, we observed 2 remigrants and 3 recaptures from other beaches: two from Cipara Beach and one undetermined to date. A total of 157 crawls were recorded - including 93 nesting crawls and 40 within season returns. A nesting success of 97.84 % was observed and only 2.51 % of turtles false-crawled. The observed nesting frequency was 2.1 times and the inferred nesting frequency was 2.3 times. The observed interesting interval was 12.6 days and the inferred interesting interval was 10.3 days. Eighty-five nests were relocated to a hatchery and 7 to higher locations on the beach. The hatching success of all nests was 69%, the emergence success was 40.42 % and the recruitment success was of 61 %. Over 4,000 hatchlings were released.

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SPATIO-TEMPORAL ANALYSIS OF LOGGERHEAD SEATURTLE INTERACTIONS WITH PELAGIC FISHERIES

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Loggerhead sea turtle (*Caretta caretta*) distribution and movements in offshore waters are not well understood

despite continued efforts to monitor, survey, and observe sea turtles in the Western North Atlantic. Loggerheads are listed as a threatened species and, thus, mortality associated with pelagic fisheries is of elevated interest. This study aims to quantify spatial patterns of loggerhead sea turtle distributions in an attempt to better understand the potential factors that determine their observed locations. The data examined in this study are from the NOAA fisheries pelagic observer program 1992-2003 managed by the Southeast Fisheries Science Center, Miami Laboratory (SEFSC). A modified Ripley's K analysis was employed to determine the spatial and temporal patterns of sea turtle occurrence within the areas utilized by pelagic fisheries. Different spatial resolutions and temporal scales were examined. Our current results show that loggerhead sea turtle catch distributions appear spatially random when other variables are not included in the analyses such as sea surface temperatures and currents. However, in regions of interest, the sea turtle catch distribution displays patterns of temporal patchiness. Initial analysis of sea temperatures shows a distinct relationship between water temperature at catch locations and the total number of turtles caught at these locations. This relationship was determined to vary by region. A better understanding of loggerhead distributions may result in management decisions that reduce loggerhead interactions with pelagic fisheries.

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FORAGING ECOLOGY OF LEATHERBACKS IN THE CALIFORNIA CURRENT

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A portion of Leatherback sea turtles that nest in Indonesia cross the North Pacific to forage on dense aggregations of scyphomedusae in the California Current. We have begun a long-term project to investigate the species composition and energetic quality of Leatherback prey, diving and movements of turtles associated with the vertical and horizontal distribution of jellyfishes, and the environmental setting to better understand the ecological relationships of Leatherbacks, jellyfish, and oceanographic features. In 2005, we placed suction-cup mounted tags (TDR and VHF transmitter) on three turtles in a foraging aggregation off central California. Leatherbacks dove to depths of 20-30 m (maximum 92 m), which corresponded with the vertical distribution of *Chrysaora fuscescens*, their primary prey. For two turtles, amount of time at the surface (mean = 2.20 min, SE = 0.15) after a dive was significantly related to duration of the dive (mean = 2.9 min, SE = 0.15, max. = 6.9). Tagged turtles dove immediately to depth and slowly ascended, probably using the backlighting to see prey and eating tentacles and gonads from below. Mean bell diameter ($37 \text{ cm} \pm 0.2$) and mean % carbon ($9.7 \pm 0.7 \text{ DW}$) and nitrogen (2.6 ± 0.2) were greater for *Chrysaora* than the other species of scyphomedusae. We hypothesize that Leatherbacks preferentially locate and eat *Chrysaora* off California because it occur in dense patches, is larger and more energetically suitable as prey than other species, and environmental conditions often favor this jellyfish species.

JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) FORAGING ON A HIGH-ENERGY, SHALLOW REEF ON THE EAST COAST OF FLORIDA, USA

Karen G. Holloway-Adkins

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Several studies investigating juvenile green turtle aggregations associated with oceanic habitats have been conducted on the east coast of Florida. These turtles were typically found in areas of abundant macroalgae at water depths greater than 3 m with low-wave dynamics. The nearshore hardbottom in Brevard County, Florida, represents an area approximately 14.5 km long and 100 m wide of discontinuous reef that runs parallel to shore with an average depth of 2 m or less. This coastline is characterized as a high-wave energy environment but juvenile green turtles appear to also be using it as developmental habitat. Turtles were captured along the Brevard nearshore reefs in waters 2.0 m or less. The location of capture was recorded and a foraging sample was collected from each turtle. The results of combined foraging samples revealed that 68.5% of the items ingested was red algae. The frequency of occurrence for red algae was 100.0%. There was also a high frequency of occurrence for animal material among the samples. These data were used to compare the foraging habits of juvenile green turtles with access to deeper, less dynamic reefs.

A BEHAVIOURAL POLYMORPHISM IN THE HAWKSBILL SEA TURTLE? EVIDENCE FROM A MULTI-YEAR STUDY ON MATERNAL NEST-SITE CHOICE

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Incubation induced variation in offspring phenotype is common in many egg-laying species. As a result, it is often thought that females will take advantage of this variation and will actively choose nest sites to exploit offspring reaction norms. The implicit assumption underlying this view is that nest-site choice is a plastic trait, but repeated observations of a same female are seldom carried out. If, in fact, individual females are consistent in their nest-site choice, then this could suggest that the behaviour is genetically determined with polymorphisms existing within a population. It has been shown that individual hawksbill females differ in their preferences for nest microhabitat characteristics within a nesting season, but we wanted to determine whether these polymorphisms persisted over several seasons. To do so, we characterized the nesting patterns of females that were observed nesting in 2002 and 2004. We found that over these two nesting seasons, individual preferences were maintained and this despite changes in the beach environment and in female condition. These different preferences also engendered significant differences in offspring phenotype, especially with respect to incubation duration. These data have important implications for sex ratio evolution and the maintenance of temperature-dependent sex determination.

COLOUR VARIATIONS OF THE EAST PACIFIC GREEN TURTLE: AKA THE BLACK TURTLE

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The East Pacific green turtle (a.k.a the black turtle) has long been at the centre of a debate: full species, sub-species or simply a unique subpopulation? In favour of the full species designation, Pritchard (1998 & 1999) maintains that the degree of differentiation in size, shape and colour in the black turtle is more extreme than that found in any other *Chelonia* subpopulation: in particular, the dark plastral pigment is not environmentally derived. However, mtDNA analysis (Bowen and Karl, 1999) shows little genetic variation from other green turtle populations. Kamezaki and Matsui (1995) concluded that the black turtle skull, though unique, does not warrant full species status. In 1952, Archie Carr described the East Pacific green turtle as a sub-species, *Chelonia mydas agassizii* and in 1962 Caldwell distinguished *Chelonia* from the Gulf of California as *C. mydas carrinegra*, named after his colleague A. Carr and for the dark coloration. Carr (1961) later seemed to support full species status, as he recognised the unique colouration and shape: “I would say that a complete novice in turtle study would be able to separate 95 to 98 percent of a mixed lot of *Chelonia*”. Whatever the final outcome of this debate, one fact remains: black turtles, whatever their designation, do have distinctive colourations. This poster shows the vast range of plastron pigmentation within a black turtle subpopulation from the Gulf of California, Mexico, with comparisons from the Hawaiian, Atlantic and Galapagos populations.

DIET COMPOSITION OF LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN THE ADRIATIC SEA

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We performed general necropsies on 54 loggerhead sea turtles ranging from 25.0 – 70.0 cm CCL (mean: 40.9 cm, SD: 9.1). These turtles were stranded or incidentally captured by fisheries in the eastern Adriatic Sea (Croatia and Slovenia). Digestive tract contents were isolated by rinsing through a fine-mesh sieve. Food item samples were later identified and wet weighed for each identified taxon. Total wet weight (w.w.) of individual samples ranged from 0.29 to 959.46 g (mean: 198.58, SD: 202.23). The following taxa were recorded: Porifera, Anthozoa, Scyphozoa, Sipuncula, Gastropoda, Bivalvia, Cephalopoda, Polychaeta, Crustacea, Insecta, Bryozoa, Ophiuroidea, Echinoidea, Tunicata, Pisces, Algae and Spermatophyta. Three highly ranked prey groups included Crustacea (26.6% w.w.), Anthozoa (25.7%) and Mollusca (22.3%), while all other taxa accounted for 25.4% w.w. These three taxa also had the highest occurrence (92.6, 61.1 and 94.4%, respectively), and seem to present the most important prey in the diet of loggerheads in the Adriatic Sea.

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FACTORS INFLUENCING INSECT INFESTATION OF LOGGERHEAD (*CARETTA CARETTA*) SEA TURTLE NESTS ON ZAKYNTHOS, GREECE

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Insect infestation of loggerhead sea turtle nests was examined in Laganas Bay on the island of Zakynthos, Greece, during 2004 on the East Laganas and Kalamaki beaches. Beach surveys and nest excavations were performed in the course of the standard ARCHELON monitoring project. Different parameters such as nest distance to the sea and distance to the vegetation, hatching duration, presence of infestation, nest depth, number of dead hatchlings and embryos, and clutch size were recorded in an attempt to assess whether or not they predispose nests to infestation. Insect infestation occurred only on East Laganas Beach. Insect larvae were encountered in 22 clutches out of the 79 nests (27.8%) that were excavated on this beach. Two kinds of insects were found in the nests: fly larvae belonging to *Sarcophila latifrons* (Fam. Sarcophagidae, Ord. Diptera) and beetle larvae (Fam. Elateridae, Ord. Coleoptera). For the sarcophagid larvae, the factors that seemed to determine their presence are: the depth to top of the egg chamber and number of dead embryos and hatchlings in the nests. A significant negative correlation was found between nest depth and sarcophagid infestation; meaning that shallow nests showed a higher level of infestation. The number of dead hatchlings and embryos was also found to be an important factor as an increasing number of dead embryos and hatchlings coincided with a high level of fly infestation. The variable that seemed to play an important role in the presence of the elaterid infestation was the position of the nests in relation to vegetation. Specifically, a significant relation was found between this variable and the presence of the coleoptera. An interesting result of this study was that no infestation was encountered on Kalamaki Beach. The most important factor preventing the insects to infest the clutches on Kalamaki was the physical structure of the beach and more specifically the clay cliffs at the back. The vegetation is restricted away from the beach on top of or behind clay cliffs. Therefore, the so called "refuge" of the adults, is practically nonexistent and where it does exist, the clay cliffs act as barriers between the "refuge" and the sand, hindering the adult insects to move and detect the nests. However, the explanation should not be attributed to a single factor. On Kalamaki, apart from the clay cliffs, there are other parameters such as deeper nest depths, clay over the nests, high risk of inundation and predation by larger animals that when combined create an inappropriate environment for the larvae. Apparently, insect infestation does not have any adverse effects on loggerhead nests on Laganas Beach, due to the low percentage of eggs that were affected. The results of this study suggest that the infestation only occurs to eggs that have failed to hatch and contain decaying tissue matter. Acknowledgements:

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EVALUATION OF PREDATION OF KEMP'S RIDLEY *IN SITU* NESTS AT RANCHO NUEVO, MEXICO

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The Kemp's Ridley Conservation Program has historically relocated the majority of nests into protected "egg corrals" at the main nesting beach of the Kemp's ridley near Rancho Nuevo, Mexico. This species is showing a gradual recovery and in the near future it may be necessary to leave nests in their natural location on the beach (i.e. *in situ*). The current study examined predation associated with *in situ* nests. For this study, *in situ* nests (n=26) and control nests laid in close proximity to one another during an arribada were observed at the time of hatchling emergence. Also, control nests (n=5) from the same arribada, but located outside the study area were also observed. All of the nests received protective covers. Hatchling and predator tracks were documented around each nest in the morning, early afternoon and just before dusk. Additionally, observations were made from an elevated platform located in the middle of the study area for 7 nights, using a night vision monocular and infrared camcorder. Animals were observed at night as they visited nearly every nest on the beach. The results suggest that a limited number of predators frequented the study area. However, all nests in the study area were frequented by multiple predators (especially nocturnal predators) during each 24-hour period. Nocturnal predators included coyotes, raccoons, and skunks whereas diurnal/nocturnal predators included ghost crabs, vultures, ants, and flies. The results suggest that leaving a dense aggregation of *in situ* nests could enhance hatchling survival via predator satiation.

NEW RECORD OF A NUDIBRANCHIA, *FIONNA PINNATA*, LIVING ON JUVENILE LOGGERHEADS IN THE CANARY ISLANDS

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Sea turtles are suitable platforms for the opportunistic colonization of various species of marine flora and fauna. Therefore they commonly carry diverse and numerous biological forms on their shells. The occurrence of a particular epibiont species may ultimately help to clarify certain questions about sea turtle movements, habitat preferences, juvenile and subadult activities and many other aspects of their life history. More than 100 species (pertaining to 13 Phyla and 37 Class) of epibionts have been described living on the carapace of loggerhead turtles around the world. Actually, each year new species of epibionts are discovered living on sea turtles. Each population of sea turtles living in one place or region may carry the same kind of epibionts on their shells, but it is not unusual to sometimes find new additions. Our research has sampled annually more than 100 pelagic loggerheads living around the Canary Islands, and has found a high numbers of epibionts species. Some of these are algae, such as *Polysiphonia*, *Hincksia*, *Ceramium* spp., etc.; Hidroidea like *Obelia geniculata* or Crustaceans such as Isopodes, Amphipodes, Cirripedians (*Lepas anatifera* and *Conchoderma virgatum*) and Balanidae (*Chelonibia testudinaria*).

However, throughout this research we emphasized on one particular epibiont species living on marine turtles which has never been described before. This new record is *Fionna pinnata* (Gastropoda, Nudibranchia). *Fionna pinnata* is often described as pelagic because they live exclusively on floating objects in the sea, usually feeding on goose barnacles (*Lepas* spp.). However, it has also been reported that *Fionna pinnata* feed on floating cnidarians such as *Physalia* and *Veleva*. Large populations and their egg masses can often be found associated with colonies of goose barnacles on driftwood, fishing floats, etc and have also been found for us also on the carapace of the juvenile loggerhead turtles.

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Order: 228 **Abstract ID:** 1491 **Type:** Poster Reserve **Subject:** Ecology and Evolutionary Biology

THE PANMIXIA PARADIGM OF EASTERN PACIFIC OLIVE RIDLEY TURTLES REVISITED: EVIDENCE OF GENETIC STRUCTURE

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Previous studies of the olive ridley *Lepidochelys olivacea* population structure in the tropical eastern Pacific have indicated the existence of a single panmictic population ranging from Costa Rica to Mexico. This information has been used to design specific management measures to conserve primary nesting beaches in Mexico. However, little is known about olive ridleys in the Baja California Peninsula, their northernmost reproductive limit - where recent observations have shown differences in nesting female behaviour and the size of hatchlings relative to other continental rookeries. We used mtDNA control region sequences from 137 turtles from five continental and four peninsular nesting sites to determine whether such differences correspond to a genetic distinction of Baja California olive ridleys or to phenotypic plasticity associated with the extreme environmental nesting conditions of this region. We found that genetic diversity in peninsular turtles was significantly lower than in continental nesting

colonies. Analysis of molecular variance revealed a significant population structure ($\Phi_{ST} = 0.048$, $P = 0.006$) with the inclusion of peninsular samples. Our results: (i) suggest that the observed phenotypic variation may be associated with genetic differentiation and reproductive isolation; and (ii) significantly challenge the notion of a single genetic and conservation unit of olive ridleys in the eastern Pacific. We conclude that conservation measures for olive ridleys in Mexico should be revised to grant peninsular beaches special attention.

Order: 229 **Abstract ID:** 1492 **Type:** Poster **Subject:** Ecology and Evolutionary Biology

PHYLOGEOGRAPHY OF EASTERN PACIFIC OLIVE RIDLEY TURTLES BASED ON MITOCHONDRIAL DNA

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Previous phylogeographic studies of olive ridleys in the Pacific have shown that the lineages in the eastern Pacific originated from those in the Indian Ocean and that this invasion occurred only 300,000 years ago. However, little is known about the evolutionary history of olive ridleys in the eastern Pacific. Therefore, we used mtDNA control region sequences from 137 turtles from five continental and four peninsular nesting sites to determine population structure. A Nested Clade Analysis (NCA) was conducted to determine if the association of the haplotypes of this species in the eastern Pacific was caused by restricted gene flow or historical events of the population. A Mismatch Distribution Analysis was performed to determine the demographic history of the colonies and to elucidate any signs of colonization or bottleneck events. Analysis of molecular variance revealed a significant population structure ($\Phi_{ST} = 0.048$, $P = 0.006$) among the colonies, while NCA showed geographic association due to restricted gene flow and isolation by distance among the colonies. Mismatch Distribution supported expansion events in all the colonies sampled. Our results: (i) support the recent colonization of the eastern Pacific by *Lepidochelys*; (ii) reveal genetic signatures of historical expansion and colonization events in the eastern Pacific, and (iii) show evidence of restricted gene flow between continental and peninsular colonies. We conclude that the center for dispersal in the eastern Pacific originated in the tropical region (Costa Rica) and that peninsular colonies are the youngest in this region.

Order: 230 **Abstract ID:** 1846 **Type:** Poster **Subject:** Ecology and Evolutionary Biology

ESTIMATION OF OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*) HATCHLING PREDATION BY THE BLACK VULTURE (*CORAGYPS ATRATUS*) IN OSTIONAL NATIONAL WILDLIFE REFUGE (ONWR), COSTA RICA

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The town of Ostional, adjacent to ONWR has a legal olive ridley (*Lepidochelys olivacea*) sea turtle egg harvest program. There are several conservation practices that take place, which involve the protection of the olive ridley hatchlings from predatory birds. Even though black vultures (*Coragyps atratus*) are commonly known as scavengers they are the most frequent predators of the hatchlings. To measure the value of this conservation

practice, the predated rate of hatchlings were estimated using a line transect (900 meters) in the principal arribada area. Each hour the number of black vultures was recorded, along with the predated and live hatchlings. Days without hatchlings presence, the mean of black vultures per day was 526.36 ± 434.17 , but increase to 612.47 ± 406.79 when hatchlings were present. Consistently, the peak was between 5:00 am to 7:00 am with no significant statistical difference between the means. The hatchling emergence cycle starts at 20:00 and ends at 8:00 am, peaking from 23:00 to 1:00 am. During the day only 16% of hatchlings appeared. Predation rates per day without protection from people was 37.83 ± 41.27 , and with protection 27.00 ± 38.83 . When the frequency of hatchlings increased, the predation rate increased when no protection from humans was initiated, this trend would change with human protection. In conclusion, the human protection of the hatchlings increases their survival rate. This conservation strategy has been implemented in Ostional for 23 years. Presently, this activity is a tradition and was first initiated by local women and children.

Order: 231 **Abstract ID:** 1448 **Type:** Poster **Subject:** Ecology and Evolutionary Biology

ANALYZING THE PROFILES OF NEST SITE SELECTION OF LOGGERHEAD SEA TURTLES: A CASE STUDY OF THE ISLAND OF ZAKYNTHOS, WESTERN GREECE

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The Bay of Laganas at the southern part of Zakynthos Island, western Greece, is the most important nesting area for loggerhead turtles (*Caretta caretta*) in the Mediterranean region. However, no comprehensive study has been undertaken so far to examine factors that are likely to influence nest site selection at this nesting area. In the present study a series of biotic and abiotic variables has been recorded for all six nesting beaches that comprise the nesting habitat. Each nesting beach was subdivided along its length into sections and a total of 16 variables were recorded for each one of these sections. These variables included both physical characteristics but also variables that are associated with human presence and coast development. Relative abundances of nesting and non nesting emergences were examined with response to the collected variables. Of the sixteen factors evaluated, topographic features of the beach (i.e. width and length) were recognized to have a significant influence on nest site selection.

Order: 232 **Abstract ID:** 1557 **Type:** Oral **Subject:** Ecology and Evolutionary Biology

CONNECTIVITY AND STRUCTURE OF ATLANTIC GREEN SEA TURTLES (*CHELONIA MYDAS*)

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Elucidating relationships among marine chelonian aggregations is a global research priority. The present study characterizes *Chelonia mydas* breeding and foraging groups in the Atlantic Ocean basin, employing population

genetic methods. In this approach major objectives are to: 1) determine natal origins of Western South Atlantic foraging groups; 2) elucidate connectivity among feeding aggregations; 3) assess subdivision among key rookeries as revealed by nuclear genetic markers; 4) examine rarely addressed aspects of intra-population genetic structure; and 5) consider processes impacting connectivity in Atlantic *C. mydas*. The study revealed that feeding aggregations in Brazil are mixed stocks, drawn primarily from Ascension Island (UK) as well as Suriname and Aves, Venezuela combined. Tortuguero, Costa Rica was an additional contributor at one study site. The Almofala and Ubatuba foraging grounds are distinct from each other, and from most other Atlantic aggregations, at mitochondrial loci. Temporal and demographic structure in mitochondrial DNA was not detected at Ubatuba or Almofala. Weak to intermediate subdivision among Atlantic rookery groups was indicated by microsatellite analysis. The research enhances basic biological knowledge of marine vertebrate population structure with applications to migratory species worldwide.

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Order: 233 **Abstract ID:** 1731 **Type:** Poster **Subject:** Ecology and Evolutionary Biology

THE INFLUENCE OF HIGH TEMPERATURE AND TWO HURRICANES ON THE SUCCESS OF LATE SEASON LOGGERHEAD NESTS IN BROWARD COUNTY, FLORIDA, IN 2005

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The success of loggerhead nests, defined as the percentage of the eggs per nest resulting in live released hatchlings, declined to unusually low levels during the latter part of the 2005 season. The mean successes were 81.1, 61.1, 32.8 and 13.4 percent for nests deposited in May, June, July and August, respectively. Many eggs from the August nests appeared to be unusually dried. There was a significant inverse relationship ($P < .0001$) between the daily air temperature anomaly on the day of nest deposition and the average daily success rate of loggerhead nests in 2005. The daily temperature anomaly is the deviation of the average air temperature each day from the daily climatological average values. There was also a highly significant inverse relationship between maximum daily air temperature and nest success rate in 2005. These relationships were not found in the previous two years. The actual average temperature during August in 2005 was 29.7°C, compared to 28.9 and 29.2°C in 2004 and 2003, respectively. The 2005 average was statistically different from the other two years (one way ANOVA, $P < .001$) and also from the climatological average temperature of 28.6°C. Mean daily success rates were less than 50 percent for nests deposited during the 50 days preceding the impact of Hurricane Katrina on August 25. Nests deposited in the first two weeks of August were also impacted by Hurricane Rita. Mean daily success rates were less than 10 percent on 7 days during this period.

EVALUATION OF SQUID MEAL IN DIETS OF JUVENILE HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*)

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A completely randomized experimental design was performed under controlled laboratory conditions for 89 days to determine the effect of the squid meal diet on the growth and other nutritional parameters of juvenile hawksbill turtles (*Eretmochelys imbricate*). Study animals initially weighed an average of 28.7 ± 5.28 g and measured an average of 6.5 ± 0.43 cm (carapace length). Four practical diets containing 0, 5, 10 and 15% squid meal were evaluated. There were no significant differences in the total increase in weight and length between all treatments ($P > 0.05$). However, there were significant differences in these parameters when the ingredient was lacking. The best daily growth index in weight was between 1.8 - 2.3 g/day and in length of 0.58 to 0.69 mm/day. Feed conversion ratio varied between 1.8 and 3.0. Protein efficiency ranged from 0.66 to 1.1 and the survival of juveniles varied between 80 and 90 %. We recommend that juveniles of this species (less than 1 year of age) are fed artificial diets containing at least 5% squid meal.

ONTOGENETIC SHIFTS IN JUVENILE GREEN TURTLES FROM OCEANIC TO NERITIC HABITATS: EVIDENCE FROM STABLE ISOTOPES

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Stable ^{13}C and ^{15}N isotope analyses of scutes were used to investigate diet and trophic position of North Atlantic green turtles (*Chelonia mydas*) prior to their recruitment to neritic waters in Florida and the Bahamas. Scute samples were collected between 2001 and 2005 from green turtles that stranded dead on Florida beaches and from green turtles on foraging grounds in the southern Bahamas. We confirmed that the scute carries a record of previous diet and habitat use by comparing samples of old and new scutes from green turtles that had recently recruited to seagrass meadows in the Bahamas. To establish a baseline isotope signature for sea turtles feeding in the oceanic habitat, we analyzed samples from juvenile loggerheads (*Caretta caretta*) residing in the waters over the mid-Atlantic Ridge for ^{13}C and ^{15}N . Results indicate that juvenile loggerheads and green turtles occupy the same type of habitat and feed at a similar trophic level during the first years of life. Our analyses of ^{13}C and ^{15}N signatures of green turtles provide evidence of a shift from a primarily carnivorous diet in oceanic habitats to an herbivorous diet in neritic habitats. Stable isotope analysis is a powerful tool in evaluations of ontogenetic shifts in diet and habitat of juvenile sea turtles.

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IS THE GIBRALTAR STRAIT A BARRIER FOR THE DISPERSAL OF MEDITERRANEAN LOGGERHEAD SEA TURTLES?

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Surface water flows eastward along the Strait of Gibraltar (velocity range: 39.9 cm s⁻¹ at Algeciras, 48.7 cm s⁻¹ at Tarifa), which facilitates the entrance of immature Atlantic loggerhead sea turtles into the western Mediterranean, but may restrict the westward movements of turtles from the Mediterranean to the Atlantic. In order to assess the minimal size that loggerhead sea turtles should attain before they may travel against the surface currents of the Strait of Gibraltar, swimming performance of 11 loggerhead sea turtles ranging in size (straight carapace length) from 25.8 cm to 47.5 cm was tested in the laboratory. The average critical velocity was 1.01 body length s⁻¹, thus suggesting that the Strait of Gibraltar is not a barrier for turtles longer than 48.2 cm (SCL) and that even some turtles as small as 39.5 cm (SCL) may manage to cross it. To determine whether Mediterranean loggerhead sea turtles migrate westward to the Atlantic, 71 turtles were collected from both sides of the Strait of Gibraltar and the D-loop of the mitochondrial DNA and 7 microsatellites were analyzed. No statistically significant differences were revealed between the two groups for either the mitochondrial DNA ($\gamma_{ST} = 0.0015$, $p > 0.05$) or for the nuclear DNA ($F_{ST} = 0.0041$, $p > 0.05$). However, a few Mediterranean individuals were detected in both groups using assignment tests. The overall conclusion is that the Strait of Gibraltar is a barrier only for the westward movements of early immature turtles and that some Mediterranean loggerhead sea turtles migrate to the Atlantic.

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POPULATION GENETICS OF GREEN TURTLE ROOKERIES IN THE WEST CUBAN ARCHIPELAGO USING A MTDNA MARKER

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Taking into account the significant contribution of each rookery to green turtle metapopulation genetic background, we intended to characterize and compare Cuban rookeries with the rest of the studied rookeries that share at least

one haplotype, in terms of population structure, diversity indexes, and phylogenetic relationships, inferred from partial sequences of mtDNA control region. In western rookeries of Cuba, haplotypes are of the same lineage and the differences between them are of one or two changes, which determines low nucleotide diversity. The 71.4% of these is endemic. There is not a significant genetic structure among Cuban rookeries. However, when they are compared with the rest of the region, structuring is found, showing a four fold percentage of variation higher inside than among other rookeries. Consequently, the Cuban rookeries constitute a nesting population that exchanges migrants limitedly with the remaining populations of the region (metapopulation). Nevertheless, in spite of the lack of genetic structuring among Cuban rookeries, the Guanahacabibes Peninsula rookery has a genetic diversity that duplicates that of San Felipe where only two haplotypes were found. The index of genetic differentiation by pair of rookeries is positively correlated with the geographical distance among the rookeries, evidencing isolation by distance among them. In the Cuban population the pattern of sudden expansion is accomplished according to mismatch distribution analysis, being a unimodal curve with mode in zero differences. Nevertheless, this result doesn't match with Fu' test, sensitive to the demographic expansion, probably as consequence of the effect of recent migrations. Starting from nested clade analysis a restricted genetic flow by isolation by distance is inferred for the clade that involves most of Cuban haplotypes. Among the totally nested cladodes a past fragmentation and/or long distance colonization are inferred. Finally, the nesting population of green turtles in western Cuba, although it shares a historical past common with the remaining populations of the region, constitutes a genetic identity that should be managed carefully to avoid its extirpation.

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INFLUENCE OF THE SEASIDE VEGETATION ON THE NESTING OF MARINE TURTLES IN TOGO

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Togo is a coastal country situated in the Gulf of Guinea whose sandy beaches represent potential sea turtle nesting sites. The vegetation related to this nesting habitat has been characterized. Four species of sea turtles have been identified along the Togolese coast: the green turtle (*Chelonia mydas*), the hawksbill (*Eretmochelys imbricata*), the olive ridley (*Lepidochelys olivacea*) and the leatherback (*Dermochelys coriacea*). The females of *C. mydas*, *L. olivacea* and *D. coriacea* are known to nest in Togo, while nesting of *E. imbricata* has not been confirmed. The relationship between the various beach vegetation and the distribution of marine turtles nests is discussed. Other physical factors identified as threats to marine turtles are also noted.

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MATING SYSTEM IN FLATBACK TURTLES - A MICROSATELLITE ANALYSES

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In recent years, genetic studies have been used to investigate mating systems of marine turtles, providing information relating to the breeding behavior and genetic effective population size of small populations, which is of importance in conservation. To date, no such research has been conducted on the flatback turtle (*Natator depressus*), which is endemic to Australia. There is only limited knowledge available about *N. depressus* mating behavior due to its preference for muddy inshore courtship areas where observational data are difficult to obtain. This study investigates paternity of flatback clutches in two populations in Queensland: Peak Island, Keppel Bay, and Mon Repos, Bundaberg. In the 2004-2005 nesting season, tissue samples were taken from nesting females (n = 9) and their hatchlings in one or more clutches (n = 16), representing 25–57% of offspring per nest. Genotypes were determined at four variable microsatellite loci: OR-3, OR-4, D108 and C102 (Aggarwal *et al.* 2004, P. Dutton, pers. com). The number of fathers contributing to each clutch was estimated using Chi Square tests of Mendelian expectations and the programs PARENTAGE1.0, GERUD1.0 and MER3.0. To determine if these rookeries were part of the same population, and to establish baseline allele frequencies for the paternity analysis, 30 females from Mon Repos and nearby Curtis Island and 34 females from the Peak Island rookery were genotyped. A high level of genetic diversity was found in both populations, more than previously observed (FitzSimmons *et al.* 1996). Allele frequencies were significantly different between the two rookeries ($p < 0.05$) and the extent of genetic structure ($F_{st} = 0.058$, $p < 0.01$) was greater than zero. This indicates that the two rookeries represent different breeding populations off the coast of Queensland. Results of the paternity analyses varied with the different approaches, but by calculating a mean value of the output from these different methods, the null hypothesis of single paternity could be rejected in at least 11 of the 16 clutches. Multiple paternity was thus observed in the clutches of five of nine females, and 68.8% of the clutches sampled. Analyses of successive clutches illustrated that paternal contribution to clutch fertilization can vary through time, as observed for two females. These results represents successful multiple mating by 55.6% of females, resulting in a greater than expected effective population size. This is the first evidence regarding the mating system of flatback turtles. The observed frequency of multiple paternity is among the highest reported in comparison to other marine turtle species. Few studies of mating systems in turtles have documented paternity over successive clutches, and fewer have demonstrated differences in paternity as observed in this study. Even though the sample size was relatively restricted, this study provided sufficient data to conclude that multiple paternity in flatback turtles is common, with two fathers being more likely than three.

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PRELIMINARY OBSERVATIONS ON DIETARY HABITS OF LEATHERBACK TURTLES FOUND IN THE MID-SOUTHERN TYRRHENIAN SEA, ITALY

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The leatherback turtle (*Dermochelys coriacea*) has a worldwide distribution including the Mediterranean Sea, where it enters through the Gibraltar Channel. Primarily pelagic, it eats soft-bodied animals such as scyphomedusae, tunicates, and small crustaceans and fishes found in association with the jellyfish. Besides the accidental encounters with fishing nets, these feeding habits themselves contribute towards their mortality as leatherback sea turtles are attracted by floating pieces of plastic which it confuses with food and they often suffocate. We collected and examined the digestive tract contents of four dead adult leatherback turtles found between 1995 and 2005 in the mid-southern Tyrrhenian Sea (Italy). Our goal was to identify the organic remains and verify whether or not plastic had been ingested. This was to increase our limited knowledge of the diet of *Dermochelys coriacea* in the Mediterranean and also to evaluate the level of man-made debris in our waters. In our poster we describe the identified items, specifying in which part of the digestive tract (oesophagus, stomach or intestine) they were found. If organic, we tried to assess the lowest taxon. In general, we have recognized the following organic items such as *Posidonia oceanica*, cephalopod beaks, ascidians, sponges and worms with inorganic debris such as plastic, fishing lines and pieces of nets. The presence of benthic organisms together with the floating debris tells us that the leatherbacks had foraged both at the bottom as well as at the surface of the water column.

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A STUDY ON THE ECOLOGY AND CONSERVATION OF OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) AT THE RUSHIKULYA ROOKERY OF ORISSA COAST, INDIA

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A study was carried out at the Rushikulya rookery of Orissa between 2003 – 2005, which critically analyzed the offshore and onshore biology and behaviour of olive ridley sea turtles at the rookery. The at-sea distribution of olive ridley sea turtles off the coast of the Rushikulya rookery, Orissa, was studied during the breeding season. The estimated surface density of olive ridleys in the water was 35.067 per sq. km and the encounter rate was 3.68/km. The area of maximum utilization for mating pairs was 57.92 km². Sporadic nesting was documented throughout the season and arribada was observed for both seasons. This study found the mean IP (internesting period) to be ~19 days. Emergence success of hatchlings was recorded higher than that of the Gahirmatha rookery. Data collected on abiotic and biotic factors influencing adult turtles and hatchlings shows that non-human predation, beach erosion and egg loss, artificial illumination, casuarina plantation and anthropogenic activities influence both habitat and the species. An effective protection of reproductive patch would be the best solution for protecting the breeding turtles in the offshore waters of the Rushikulya rookery. Continuous beach monitoring, accurate counting of nesting turtles for population estimation, protecting nests from mammalian predators and checking the artificial illumination on

the beach are urgently necessary for the rookery. Along with this, strict implementation of the various protection acts will be effective measures for the conservation and management of the olive ridley sea turtles of the Rushikulya rookery of Orissa coast.

Order: 242 **Abstract ID:** 1606 **Type:** Oral **Subject:** Ecology and Evolutionary Biology

A HURDLES RACE WITH THE CARIBBEAN HAWKSBILL: WHEN OBSTACLES ANALYZING MTDNA DATA BECOME HIGHER AND HIGHER

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Choosing the right molecular marker depends very much on the research question, time, budget, and the availability of samples. Furthermore, individual studies are much more powerful when analyzed in the context of previous data. This is especially true for endangered Hawksbill turtle populations where rookeries are distributed widely and without regard to international boundaries. The first genetic study on the nesting aggregations of the hawksbill sea turtle in the Caribbean was published in 1996, using a 380bp fragment of the mtDNA control region. This research confirmed the natal homing behavior of nesting females but failed to distinguish between major phylogeographic areas within the Caribbean. Subsequent studies continued to use the 380bp fragment of the control region and used the combined data for mixed stock analysis of foraging aggregations and breeding males. Improved technology makes it far easier and cheaper to collect longer sequences and higher resolution molecular data promise better insight into longstanding issues in hawksbill populations. Currently, there are isolated efforts to double the number of base pairs of control region collected from individuals at particular rookeries; however, answers to major phylogeographic questions will remain elusive without a community effort to update the genetic profile of each main rookery. Higher temporal and spatial resolution is critical as haplotype frequencies overlap and spatio-temporal variance remains largely unknown. We will discuss the main challenges we have faced in our analysis of the genetic composition of a Caribbean hawksbill aggregation and numerous caveats due to discrepancies in the different sources of information.

Order: 243 **Abstract ID:** 1735 **Type:** Poster **Subject:** Ecology and Evolutionary Biology

REPRODUCTIVE STRATEGIES OF HAWKSBILL SEA TURTLES INFERRED WITH MICROSATELLITES ANALYSIS

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Turtles display multiple reproductive strategies to assure itself individual fitness. Multiple mating is one of the

strategies exhibited by sea turtles, and often observed in the field. However, the outcome and benefits that females may obtain mating with multiple males has been recently questioned. The mating system exhibited by turtles has been assessed since the early eighties and the studies included five of the seven extant species of marine turtles. However, the mating system of the hawksbill sea turtle has remained unstudied for non-specific reasons. We investigated if multiple paternity exists on hawksbills, breeding and nesting at Mona Island, Puerto Rico. During the 2003 nesting season, nests were marked and monitored on the beaches of Mona Island. Tissue samples were obtained from the mother during oviposition, and samples (n=30-60) of her hatchlings were collected right after emergence. Amplifications and subsequent scoring of alleles were made for five microsatellite loci (Cm84, Cc117, Cm58, Cm72 and Ei8). Most of the nests were collected from the same mother (from 2 up to 4 nests) in our attempt to also observe changes in nest siring as the breeding season progressed. In addition, genotype profiles from potential fathers (n=74) were obtained to compare and match, when possible, with the genotype of the fathers identified for hatchlings out of each nest. This study presents the results of the DNA fingerprinting analysis and comments about the strategies exhibited by male and female hawksbills in our intent to understand the evolution of reproductive behavior of this endangered species.

Order: 244 **Abstract ID:** 1752 **Type:** Poster **Subject:** Ecology and Evolutionary Biology

GENETIC COMPOSITION OF SEA TURTLES BYCATCH FROM PERUVIAN FISHERIES INFERRED THROUGH MTDNA ANALYSIS

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The incidental capture of non-target species during fishing activities is a worldwide threat in marine environments and compromise local, regional and global conservation efforts. The impact is more critical when it includes endangered species, like sea turtles. The Peruvian commercial fishery, unfortunately, contributes to this threat. During the last three years a local research-conservation project has been monitoring the impact by conducting on-board observations of the bycatch. The purpose of the project included to investigate the genetic composition and diversity of the bycatch during the duration of the study. In addition, a mixed stock analysis (MSA) was conducted to estimate the most likely origin of each individual. Since 2003, samples from 92 individuals of three different species (*Chelonia mydas*, *Lepidochelys olivacea* and *Caretta caretta*) have been collected and preserved. In addition, morphometric information, geographic position and individual's pictures were obtained. Amplifications of a target fragment of the control region d-loop were conducted using the primers LTEi9 and H950, and sequences of 740bp fragments were analyzed for haplotype identification. We used previously published data on Pacific nesting rookeries for each sea turtle species as baseline information for the MSA. We will present the preliminary results of this analyzes and the relevance of this information for future conservation initiatives of migratory species on the East Pacific Ocean.

LIFE HISTORY VARIATION IN HABITAT USE BY LOGGERHEAD SEA TURTLES, NERITIC OR OCEANIC: A RESULT OF POPULATION SUBDIVISION?

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A size-related variation in feeding habitat use of neritic or oceanic areas by adult female loggerhead sea turtles (*Caretta caretta*) has been reported in Japanese populations. Some females stay along the continental shelf of the East China Sea and coastal waters of Japan, while others migrate offshore, into the Pacific (Hatase *et al.* 2002). These two behaviors were observed from females from one nesting beach, and the existence of a population subdivision was suspected. We investigated whether this variation corresponds to different genetic populations. A total of 48 nesting females on Yakushima Island were classified into 8 females (SCL: 826±45 mm : mean±SE) with stable isotope ratio of egg yolk of $\delta^{15}\text{N} < 12$, $\delta^{13}\text{C} < -18$ as an oceanic group and the other 40 females (SCL: 854±43 mm) as a neritic group. They were examined by five microsatellite markers (Cc7, Cc117, Cc141, Cm84 and Ei8). Deviation from Hardy-Weinberg equilibrium was not detected for any loci or groups, with exception of combinations of the Cc141 loci within the neritic group. There was no genotypic difference between any two groups at each locus ($P = 0.40-0.79$, G test in FSTAT ver.2.9.3.2; Goudet *et al.* 2002). Haplotype frequencies of the mtDNA control region (type B, type C; Bowen *et al.* 1995) in the neritic (0.875, 0.125) were same with those of the oceanic groups. Assignment test using *Structure 2.0* (Pritchard *et al.* 2000) also did not show any sign of population subdivision. Our results suggest that both neritic and oceanic individuals belong to the same genetic population. Although actual behavioral mechanisms are unknown, individuals of the two groups appear to share a common mating habitat both temporally and spatially.

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SEA TURTLES OF THE EPI-PELAGIC SARGASSUM DRIFT COMMUNITY

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This presentation summarizes studies of post-hatchling and small-juvenile sea turtles found near Florida, USA. The turtles were discovered within surface drift-lines located in the eastern Gulf of Mexico and near the western Gulf Stream front off Florida. Turtles were observed and captured during linear transects through oceanic fronts, slicks, windrows, Sargassum patches, and other drift material. Transects took place seasonally, principally July-October, during periods of calm sea state (Beaufort force 0-3). In nine seasons, 1992-2005, transect observations have included 1301 post-hatchling loggerheads (4-8 cm straight carapace-length, SCL), and 12 post-hatchling green turtles (5-6 cm SCL). Observations of turtles in the small-juvenile range (15-25 cm SCL) have included nine Kemp's ridleys, five green turtles, three hawksbills, and one loggerhead. Capture rates of post-hatchling turtles were highest for transects in Atlantic shelf waters near the Gulf Stream. Capture rates of small juveniles were highest for transects in the Gulf of Mexico 40-70 NM from Florida. All Kemp's ridleys were from the Gulf of Mexico. Behavioral measurements suggest important differences between species. As part of this study, we predict locations of important epi-pelagic developmental habitat as defined by oceanographic features. We also note the first records of Kemp's ridley directly observed in and captured from the pelagic Sargassum community.

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MULTIPLE PATERNITY IN MEDITERRANEAN LOGGERHEAD SEA TURTLES

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Due to temperature-dependent sex determination, climate change is likely affecting sex ratios in most sea turtle populations, but possible effects on population dynamics remain highly speculative. What is the threshold operational sex ratio (the ratio of reproductively active males to females at any one time) necessary to fertilize all eggs in a population? How frequent is multiple paternity and what is the effect of multiple paternity on individual female fitness? Understanding these issues would allow scientists to more accurately predict the effect of climate change on sea turtle populations. For example, is a decreased rate of female multiple matings likely to result in a reduced clutch hatching success? Moreover, these questions are intriguing from an evolutionary ecology perspective. The availability of adequate molecular techniques has opened new opportunities to indirectly study aspects of mating behavior. We investigated patterns of multiple paternity in clutches of 16 individual female loggerheads of Zakynthos (Greece), using four highly variable microsatellite loci. We tested for a relationship of clutch hatching success, proportion of eggs with no visible embryos and proportion of hatchlings with abnormal carapacial scute patterns versus the number of males involved in a clutch. We detected fertilizations of more than one male in all but one of the investigated clutches, with some females having apparently mated with at least five males. Given the probable different remigration patterns in male and female sea turtles, we hypothesize that the frequency of multiple paternity in a population may be subject to year-to-year fluctuations. Since overall nest

numbers were average in the two seasons of our study, we conclude that female multiple mating is widespread in this largest known Mediterranean sea turtle population. Although no clear relationship was detected between hatching success and the rate of multiple paternity, considering the high impact of the incubation environment on hatching success, our relatively small sample size and the fact that we could not test for success in singly versus multiply fathered clutches, we feel that no strong conclusions can be drawn from this result. Even if multiple paternity is indeed not affecting hatching success, multiple matings of females might be an adaptive strategy under conditions of low male-female encounter rates. Multiple matings might be crucial for the long-term dynamics of sea turtle metapopulations by reducing the founder effect when few females colonize new nesting areas. Interestingly, and to our knowledge not previously shown in sea turtles, the number of detected fathers was positively correlated with the size of the mother. Although there are plausible explanations for male preference of large females, this result is not necessarily proof of male control over matings. Because size is indicative of age in sea turtles and females can store viable sperm from previous years, larger females may have more sperm available from previous seasons than smaller females and may not actually mate more frequently within a given season.

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Order: 248 **Abstract ID:** 1652 **Type:** Poster **Subject:** Education, Outreach and Advocacy

ADRIA-WATCH: AN OBSERVATORY FOR SEA TURTLES AND OTHER GREAT VERTEBRATES OF THE NORTHERN ADRIATIC SEA

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A considerable number of large vertebrates as cetaceans, marine turtles and sharks inhabit the northern Adriatic Sea but few people are aware of this biological wealth. In 2004 an INTERREG III project was established in order to collect metadata and promote knowledge about these taxa. Although the Adriatic Sea represents a relatively small area, various institutions and associations carry out scientific research, collect data and record sightings and strandings along its coasts. Several partners belonging to Italian, Slovenian and Croatian coasts are working on the project. The co-operation and co-ordination among these institutions is an extremely important tool to reach fundamental scientific and educational goals. The ADRIA WATCH project scientific observatory collects data on large marine vertebrates and enters it all into a single database. Besides collecting data on sightings and strandings of marine turtles, cetaceans and sharks along those coasts a strong effort is also dedicated on promoting public awareness for fishermen and local authorities. Thousands of leaflets (in four different languages: Italian, English, Croatian and Slovenian), posters and sightings data forms have been distributed all over the region. The project also contributes to sharing knowledge, through a web site, public conferences, scientific seminars, didactic material and educational projects. The web address will be soon available. In particular for turtles a satellite tracking project is about to start in 2006.

Order: 249 **Abstract ID:** 1533 **Type:** Oral **Subject:** Education, Outreach and Advocacy

ECOTOURISM AND NATURAL RESOURCES (CASE STUDY OF SEA TURTLES IN CAMPO-MA'AN NATIONAL PARK IN CAMEROON)

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In Cameroon, sea turtles have faced threats from humans for many years. After the Ekwata resolution in 1997, efforts were initiated to save sea turtles. This study was carried out around Ebodjé in Campo-Ma'an UTO in Cameroon. The study was done by identifying and describing nesting sites, carrying out night patrols to determine nesting intensity in relation to tides, evaluating human impacts through fishermen surveys, conducting educational campaigns for fishermen, and getting tourists to sponsor the release of turtles. There are 9 principal nesting beaches and nesting frequency varies among them. We identified four sea turtle species: leatherbacks, green

turtles, hawksbills, and olive ridleys. These turtles are being killed for their meat, carapace (for tourists) and for the medicinal use of turtle fat and their eggs, which undoubtedly reduces their population. Between 1999 and 2001, 294 turtles have been tagged and released by 126 tourists: 122 green turtles (41.5%), 61 hawksbills (20.7%), 103 olive ridleys (35%), and 8 leatherbacks (2.7%). In 1999, 21 turtles were released (7.14%) while 156 turtles were released in 2000 (53.06%) and 117 turtles in 2001 (39.79%). During the study 18 individuals were tagged twice. For each individual 10,000 FCFA (15.25 euros) was given by a tourist; the total amount was 2,940,000 FCFA (4,482 euros) for 3 years with 210,000 FCFA (320.25 euros) in 1999, 1,560,000 FCFA (2,379.02 euros) in 2000 and 1,170,000 FCFA (1,784.27 euros) in 2001. To improve captive conditions for accidentally captured turtles that were held for later release, a big sea water tank was constructed in the town of Kribi, the Programme Kudu base; 8 educational boards were also placed around the tank. In 2001, an ecotourism project was developed in the village of Ebodjé (ethnicity Iyassa). A committee of villagers manages this project. Huts were constructed to house western tourists. A sea turtle museum funded by the European Union is being built. The project would greatly benefit from a bigger construction that could house the school and the dispensary. This pilot village has accepted to reduce its exploitation of sea turtles. An ecotourism program is being planned with WWF-Cameroon that will take tourists to the coast at Ebodjé and then into the forest of the National Park of Campo-Ma'an. The main nesting sites should be placed within a Marine National Park to better protect and conserve the area. In conclusion, this study suggests that ecotourism can be used in this area to support the protection of sea turtles. To be successful, efforts should encourage the education and training of all stakeholders involved.

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Order: 250 **Abstract ID:** 1674 **Type:** Poster **Subject:** Education, Outreach and Advocacy

KELONIA: THE MARINE TURTLES OBSERVATORY

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Property of Région Reunion Council, "KELONIA, the marine turtles observatory" is built on the old site of the marine turtles ranch in Saint, Réunion Island (french territory of Indian Ocean). The aims of KELONIA are: - to raise awareness to conservation of the natural and cultural heritage associated with marine turtles, - to develop and participate in scientific programs for survey and conservation of marine turtles and their habitats. The poster presents the infrastructures that will help the centre to achieve its objectives, the awareness and scientific programs (including social science) developed with national and regional (SWIO) teams.

FATE OF LIVE STRANDED TURTLES IN NORTH CAROLINA, USA, AND THEIR ROLE IN CONSERVATION

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Each year, approximately 480 stranded turtles are observed in North Carolina, USA. Of these, <8% are found alive and survive long enough to be candidates for rehabilitation. Live stranded turtles suffer from cold stunning (49.5%), disease (22.9%), boat strike wounds (14.0%), and entanglements with fishing gear (4.2%). The remaining 9.4% of turtles suffer from illness or wounds of unknown origin. The Karen Beasley Sea Turtle Rescue and Rehabilitation Center (KBSTRRC) in Topsail Beach and the NEST rehabilitation facility in Manteo are volunteer-run facilities that exclusively treat sick and injured turtles in North Carolina. Since 1996, 153 rehabilitated turtles have been released and their length of stay in rehab has ranged from 2 days to 35 months (average = 5.8 months). A large network of rescuers, veterinarians, aquarium staff, and volunteers contribute towards rehabilitating these turtles. For example, Sea Turtle Stranding and Salvage Network (STSSN) members often drive over 50 miles to deliver sick and injured turtles to the rehabilitation facilities, where in turn endless hours are spent feeding, cleaning, and treating ailments, as well as raising funds to maintain the centers. Although it is commonly suggested that the time, money, and energy devoted to rehabilitation would be better spent on other conservation efforts that target larger numbers of turtles, there are several additional advantages related to rehabilitation beyond returning turtles back to the wild. First, the response to and recovery of live strandings is an opportunity to educate the public on the threats turtles face, the stranding program, and the rehab centers. Many individuals who see the stranded turtle on the beach take a vested interest in the turtle's recovery that over time extends beyond the individual turtle. Tours given at KBSTRRC provide a rare opportunity for the public to get "up close and personal" with live sea turtles. Turtle release days often attract over 1,000 people. These opportunities generate in the public a piqued sense of respect and understanding of the injured animals and for sea turtles in general. Second, veterinarians and veterinary students have benefited from hands-on experience with turtles, learning and perfecting the science of marine veterinary medicine. These interactions also occasionally result in cutting-edge techniques that have greatly reduced healing time. Third, many rehabilitated turtles from NC have been given satellite tags at release and their subsequent in-water tracks are freely available on-line. The data collected are invaluable for building up our knowledge of the at-sea behavior of sea turtles, in addition to providing educational opportunities to interested students and others. In addition, the many relationships that are created with various institutions like the US Coast Guard, Duke University, and the NC Aquariums are invaluable to the success of the sea turtle monitoring program in North Carolina. Thus, rehabilitation can have a much greater impact on conservation, reaching beyond the benefits for a few turtles, by fostering many opportunities to engage the public, encouraging the study of sea turtle health, migration, and behavior, and increasing partnerships that strengthen our efforts.

MWOAKILLOA COMMUNITY-BASED MARINE TURTLE PROJECT RAISING AWARENESS AND MANAGEMENT

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Mwoakilloa is one the small outer island of Pohnpei State in the Federated States of Micronesia. It is located at the coordinate of 6 degree and 39 minute North and 159 degree and 53 minute East. It has a population of 500 with small three islets on its circular shaped reef with two lagoons separated by a reef cutting through the lagoon. One of the islands (Kahlap) is inhabited by people where all the dwellings and establishments are situated. The other two are still intact from development which provides copra, breadfruit and other farm produce for the islanders. Mwoakilloa among all the other outer islands of Pohnpei, has been taking initiatives in establishing part of its marine ecosystem under protection status for resource management purposes. In the past, Mwoakilloa beaches are known to have been very active nesting sites for marine turtles, greens and hawksbills. At present, nesting has declined due to loss in culture practices that led to resource conservation. The Marine Development and Conservation then worked closely with the Mwoakilloa Local Government and the community to revitalize those nesting beaches and started awareness in the community. The project turned successful with a lot of support from the community who are interested in getting an ordinance pass from the local government leaders to preserve all potential nesting beaches, sea grass beds and resting areas for conservation and management of Mwoakilloa turtles.

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SEA TURTLES DAY IN BENIN: AN INITIATIVE TO PROMOTE

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Benin is a small country of West Africa situated on the Gulf of Guinea, with approximately 125 km of coastline. Benin is located between the longitudes 0°40 and 3°50 East and the latitudes 6°10 and 12°30 North, covering an area of about 114,763 km². Its population was estimated in 1995 at 5,422 million inhabitants, representing a density of 45.9 inhabitants by km². The population growth rate was 3.2% in 1994. Along its coastline, made of low sandy coast, four (4) out of the six (6) species of sea turtles present in the Atlantic Ocean are known to exist. In order of importance, we have *Lepidochelys olivacea* (Olive ridley) and *Dermochelys coriacea* (Leatherback) whose nesting was confirmed; *Chelonia mydas* (Green turtle) and *Eretmochelys imbricata* (Hawksbill) which are often captured in fishing gear. (Dossou-Bodjrenou and al. (1999), Formia (2000), Fretey (2001)). Most of the main threats on sea turtles in the West African region were recorded in varying degrees on the coast of Benin. Poaching by humans remains the most worrying. Some actions have been undertaken since 1999 following the Abidjan Memorandum of Understanding concerning conservation measures for marine turtles of the Atlantic

coast of Africa. The collaboration with administrative and political authorities is positive for the sensitization of local communities and their empowerment (Committees of Protection). The development of a participative Action Plan that put emphasis on the responsibility of local communities and on support to generating incomes through alternative activities was determined. A progressive realization of the authorities is making the implementation of Rio's Conventions in our country easier. In order to give more visibility to the actions, January 8 is appointed as a National Day for sea turtles in Benin by the members of the Sea Turtle Conservation Committees (Ecoguards). The first edition in 2005 and the second in 2006 were furnished by a caravan through the town of Grand-Popo followed by cultural events, films projections on sea turtles and the hatchling releases with the local authorities, populations and tourists. It was a special occasion for information, communication and awareness for the general public that was strongly supported by the Media. This day is appointed in prelude to the yearly celebration of the National Official Day for the traditional religions in Benin (January 10). An opportunity that attracts many Voodoo's cult adepts from the South-Benin, tourists from the African Diaspora, curious and many media from Benin and Togo on the Voodoo sites of Grand-Popo. The official events ended with the release of hatchlings as a sign of the traditional religion's outstanding contribution to the protection of biodiversity. This experience that has started to be integrated in the local Development Plan has to be encouraged in order to promote the activities and the encouraging results obtained by the Beninese experiences in the conservation of sea turtles in the region. A particular attention from all the players is wishing to give a chance of survival to sea turtles in the precariousness' context of the local communities in African countries on the Atlantic coastline.

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Order: 254 **Abstract ID:** 1828 **Type:** Poster **Subject:** Education, Outreach and Advocacy

SEA TURTLE CSI: A TEACHING MODULE IN SEA TURTLE GENETICS

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A teaching module was developed for high school level students based on sea turtle conservation and genetics. This module is targeted to teach students concepts of wildlife conservation and management through the application of state-of-the-art genetic techniques. Students are initially given a series of multimedia presentations to provide a background in sea turtle biology, conservation, and molecular genetics. The module is designed a portable experiment that can be conducted in the classroom. Students are given a scenario in which they are wildlife conservation agents in charge of identifying sea turtle tissue samples that have been confiscated by customs officials. Students are assigned unknown samples of loggerhead DNA. Their goal is to identify the haplotype (and potential origin) of their unknown sample via PCR, gel electrophoresis, and DNA sequencing. The goal of the module is to give the students a basic understanding of molecular biology and its applications to conservation. This module is currently being implemented for high school students through the UAB Center for Community Outreach Development (CORD).

A PROPOSED MODEL FOR IMPLEMENTING THE TCOT PROJECT RECOMMENDATIONS ON MARINE TURTLE EDUCATION IN THE TURKS & CAICOS ISLANDS

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The Turks & Caicos Islands like other United Kingdom Overseas Territories, signed an Environment Charter in September, 2001, within the Charter's Commitments 9 and 10. As a result The Turtle Conservation in UK Overseas Territories, funded by OTEP and DEFRA engaged a research project analysing primarily Conservation and Sustainable Use of Marine Turtles. A key recommendation of this research was the implementation of general awareness programmes for Marine Turtle conservation in the Turks & Caicos Islands. This poster presents a model for implementing those TCOT project recommendations which relate specifically to educational activities.

MARINE TURTLE EDUCATIONAL PROGRAMMING AT THE LOGGERHEAD MARINELIFE CENTER OF JUNO BEACH, FLORIDA, USA

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All species of sea turtles are either threatened or endangered worldwide, and require careful management help to sustain their populations. It is well documented that public education is a key component of any recovery strategy, and has proven to be universally effective where applied. The Loggerhead Marinelife Center (LMLC) is located in Juno Beach, Florida (USA), a major rookery for Atlantic loggerhead turtles as well as important nesting grounds for Atlantic green and leatherback turtles. The Loggerhead Marinelife Center's twenty-year focus has been on public education, sea turtle rehabilitation, and research. We strongly believe that public education, especially for children, is the key to securing the long-term health of sea turtle populations. The LMLC'S educational programming is focused in five major areas: school group field trips and tours that focus on sea turtle conservation and ecology, age appropriate hands-on sea turtle conservation training camps that let students gain experience with sea turtles, guided turtle walks that permit the general public to view a nesting turtle in a controlled environment, volunteer training programs that focus on individual strengths that benefit the LMLC, and themed birthday parties that include a guided tour and fun turtle-related activities. Our goals are to help the general public develop an appreciation for Florida's marine turtles, to better understand current issues regarding marine turtles, and to gain sufficient knowledge to pass that information on to others.

EVALUATION OF NEW TURTLE-TOUR VISITATION SYSTEM AT TORTUGUERO, COSTA RICA

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Introduction Tortuguero National Park in Costa Rica is a popular site for tourism, with green turtles representing the main attraction during the June-October period. The number of visitors has increased since the 1980s, with 31,655 and 36,104 tourists participating in turtle tours in 2004 and 2005. Sea turtle tourism generates considerable income and employment opportunities for Tortuguero villagers and business owners (Troëng & Drews 2004). Tours to observe sea turtles are limited to 8.4 km of the 29.4 km beach and to four hours (20:00-24:00 hr) each night. Tours are predominantly lead by local guides (Peskin 2002). In 2004, a new visitation system was implemented along the public beach section (5.6 km). In 2005, the new system was expanded to the entire 8.4 km for part of the nesting season. Instead of guides looking for turtles, the new system involves “spotters” who look for turtles and inform guides waiting at pre-determined locations. Tourists approach turtles using paths behind the beach. The system minimizes the time tourists spend on the beach and aspire to reduce disturbance. Our study aimed to evaluate this new system. Methods Tortuguero Conservation Area staff recorded the number of tour permits issued. Caribbean Conservation Corporation staff recorded the number of nests and ‘half-moon’ crawls each morning. ‘Half-moon’ crawls are events where no eggs were laid and can be related to human disturbance. We analyzed visitation and track data using a generalized additive model (GAM) with nests as the response variable and year, Julian date, half-moons, site (public beach/ national park), system (old/new), and visitor numbers as covariates. Results Year, Julian date, half-moon crawls, site, and system had significant effects on nest numbers; the number of visitors did not have a significant effect. The number of nests was greater during nights and along sections where the new system was implemented, even when other covariates were considered. For this reason, we believe that the increased nesting is the consequence of the new system’s reduced impacts. The GAM model accounted for 82% of the variance. Discussion It appears the new system has reduced disturbance to turtles and has resulted in increased nesting. To ensure that increased visitation, under the new system, does not have a negative impact on nesting, we recommend continued monitoring of visitor and nest numbers. The new system created 13 jobs as “turtle-spotters” for Tortuguero villagers. These positions are supported with funds raised from business owners, and administered by the CCC. To consolidate the new system, we recommend the establishment of a permanent funding mechanism (visitation fees or business owner contributions) to pay salaries, equipment, and path maintenance. We believe the new system may be successfully implemented on other beaches where tourists come to observe turtle nesting.

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THE TURTLE GUIDE: DEFINING THE POSSIBLE?

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At the 25th Sea Turtle Symposium a conceptual presentation was given outlining the creation of an online interactive turtle guide. It was suggested that an opportunity exists to centralise the sharing of practical information through an online guide for turtle research and conservation. However, more importantly, it would provide an online toolbox to enable users to identify or characterise their turtle-related issues/problems and then advise on a solution(s) based on existing practices and methodologies. A pivotal aspect of the toolbox approach is the construction of a comprehensive list covering the range of methodologies currently in use on turtle research, conservation and sustainable management. This will not only endeavour to cover the more traditional methods in practise, but also include newer emerging approaches from a round the world. The type of information that will be collected will include an overview of the method; relevant contact details and recommended further reading/links. Once an initial list of acceptable methods/techniques has been established in collaboration with the turtle community, then the proposed Turtle Guide can start moving forward towards the development phase.

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TWENTY YEARS OF CREATING EDUCATIONAL MATERIAL FOR SEA TURTLES IN GREECE

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It is well known that education plays an important role in Nature conservation and specifically of threatened species. Education is greatly facilitated by using attractive tools. Sea turtles, privileged to mystified life-cycles, long-range migrations, and universal myths, provide a powerful source of inspiration in creating such tools. ARCHELON, founded in 1983, has the main objectives of studying and protecting sea turtles in Greece. A major instrument to fulfill the Society's conservation role is by raising public awareness and by educating people. In the course of its conservation programs, ARCHELON has created a diversity of educational material since 1985, with the aim to sensitize various target groups but mostly the young generation. This material includes: - Three portable educational kits to be borrowed by schools: "The Turtle Briefcase" (created in 1990), "Life on the Coast" (created in 1992) and "Fishermen and Turtles" (created in 2000). "The Turtle Briefcase" was the first environmental kit to be offered to the then newly established Environmental Education Departments all over Greece by the Ministry of Education. - A mobile exhibition, transported in a van, with the triple subject "Mediterranean – Fisheries - Sea turtles", addressed to the general public and fishermen. This was created in the course of an EU co-funded LIFE-Nature project "Reduction of mortality of *Caretta caretta* in Greek seas". - Permanent displays in ARCHELON's Information Centers in Lakonikos Bay (southern Peloponnesus), Kyparissia Bay (western Peloponnesus), Pangalochori (Rethymno, Crete), and at ARCHELON's Rescue Centre (Glyfada, Attica). - Two table games "On the Turtle's Back", created in 2001, and "Selected Marine Voyages", created in 2006. Both emphasize the

need to offer for the common good. Sea turtles, used extensively in the above material, play only the role of an example; through their impressive life-cycles, the value of Nature is appreciated and its importance in Man's life emphasized. Moreover, as this material is usually presented by field researchers, who can provide first-hand answers and additional explanations, its messages are well absorbed by the various target groups. The motivation to create this material was an internal need to participate in the protection of life on earth and share the charming information of sea turtle's life-cycle with children, young people and the general public. Although we have not evaluated statistically the results of our 23 years of work, we can tell that the loggerhead turtle is, at least amongst the schoolchildren, the most well known threatened animal in Greece.

Acknowledgments: I thank the many collaborators and ARCHELON volunteers who provided inspiration, scientific knowledge, and technical assistance.

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Order: 260 **Abstract ID:** 1825 **Type:** Oral **Subject:** Education, Outreach and Advocacy

**PUERTO ADOLFO LÓPEZ MATEOS BAJA CALIFORNIA SUR, MÉXICO:
A LESSON IN OWNERSHIP OF NATURAL RESOURCES THROUGH PRIDE**

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Environmental degradation resulting from overfishing, bycatch, and garbage accumulation are common to many coastal communities. This degradation directly damages important coastal ecosystems, jeopardizing citizens' wellbeing, yet people rarely understand the impacts of their pollution and fishing. Because the effects of environmental degradation are experienced by all, coastal inhabitants can grow to appreciate, respect and care for the places in which they live. The Bahía Magdalena-Almejas (BMA) estuarine ecosystem in Baja California Sur, Mexico boasts a diversity of habitats and is an important feeding area for five sea turtle species. A substantial human population across 15 settlements produces an average of 1.5 kg of solid waste per person per day, but there are no disposal or sewage treatment facilities in the region. Assorted fisheries are overexploited, and turtle bycatch and poaching is substantial. From spring 2004 to the present we carried out a natural history pride campaign to empower the citizens of BMA to better manage their waste and fishing by celebrating the area's rich natural heritage. We integrated 1) festivals, parades, puppet shows, comic books, and local music to engage people; 2)

educational enrichment in schools plus community outreach programs both for and by women's and youth groups to inform people of alternatives and to involve them in developing solutions; 4) Promotion of sea turtle ecotourism and generation of legal regulations. 18 months into our 3 year initiative we are approaching our goals: garbage separation in a majority of households and reduction of both bycatch and poaching of sea turtles.

Order: 261 **Abstract ID:** 1790 **Type:** Poster **Subject:** Education, Outreach and Advocacy

GROWING SEA TURTLE BIOLOGISTS: THE RESULTS OF A SEA TURTLE SEMINAR FOR HIGH SCHOOL STUDENTS ON ST. CROIX, USVI

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Savannah State University, USA

The first Annual Junior Sea Turtle Biologist Seminar was held from July 11 to 15, 2005 on St. Croix, United States Virgin Islands (USVI). The purpose of the seminar was to educate the community and encourage awareness of sea turtles as well as to promote participation in local conservation efforts. Funded by the NOAA Living Marine Resources Cooperative Science Center at Savannah State University, the seminar was developed and taught in collaboration with the USVI Division of Fish and Wildlife (DFW) and the West Indies Marine Animal Research and Conservation Service, Inc. (WIMARCS). Each session of the seminar was taught by sea turtle biologists local to St. Croix and consisted of lectures and other interactive learning activities as well as hands-on experience with local sea turtle projects. Three students participated in the 2005 seminar: John Syndey, Jr. (15), K'Neale Francis (14), and Aaron Francis (11). They were tested before and after the seminar as a measure of the seminar's success. John scored 35% on the pretest and 85% on the post test. K'Neale scored 50% on the pretest and 100% on the post test. Aaron scored 10% on the pretest and 85% on the post test. Overall, it is safe to say that the seminar was successful in educating these young students on sea turtle biology and conservation issues.

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Order: 262 **Abstract ID:** 1753 **Type:** Poster **Subject:** Education, Outreach and Advocacy

A MOBILE EXHIBITION FOR EXTENDING THE RANGE OF PUBLIC AWARENESS IN SEA TURTLE CONSERVATION PROJECTS

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It is common knowledge that public awareness projects regarding sea turtles are usually limited around areas where there are permanent or semi-permanent monitoring and conservation projects, and are usually carried out by the same people who are working in the field, thus limiting the geographical range. This creates, inevitably, an uneven pattern of well informed people in specific sites whereas people in neighboring areas might be misinformed, if not informed at all! To offset this drawback, a mobile exhibition was designed and constructed by ARCHELON in the course of LIFE-Nature project co-funded by the EU "Reduction of mortality of *Caretta caretta* in the Greek seas".

The exhibition itself is an aluminum construction and when put up is in the shape of three hexagons, the sides of which are 1m in length and 1.8m in height. On top of these hexagons, flagpoles and sunshades can be attached raising the total height to 3m. The whole construction has its own electric lighting, either through a mains supply or generator, rendering the exhibition operable during the evenings. The displays are circular, made of a very light plastic material, and can be replaced by others showing different themes. The current theme of the display is “Mediterranean Sea – Fisheries – Sea turtles”. The exhibition can be mounted or dismounted in a few hours and fits in a “Ford Transit” van, kindly donated by the Ford Group. From May 2003 through October 2005, 20 trips of the mobile exhibition were done in 14 areas of interest around Greece. It is estimated that a total of 15,000 people have visited the exhibition and were informed on various aspects of sea turtle conservation. The exhibition visits are planned following arrangements with local communities, usually on the occasion of a local festivity which guarantees increased attendance. As in many pioneering applications the exhibition doesn’t go without a few problems. The largest is the rather high fuel consumption of the van, which runs on gasoline and not on petrol. This problem was solved by planning of the visits’ schedule and the routes followed by the van, so more trips could be done with less mileage. Another problem was that at first it took about four hours to put the exhibition up, a shortcoming which we overcame by repeated practice; now this is reduced to about two hours. Overall, the mobile exhibition is ranked as a valuable tool because (1) it extends the spatial and temporal range of public awareness activities by visiting either remote areas or areas with a highly seasonal interest, (2) it is a “quick action” tool, transported and mounted easily in cases where immediate action is necessary, and (3) it has the advantage of being easily stored and protected from adverse outdoor conditions which lower the life duration and create high maintenance cost if it were a permanent outdoor exhibition. The above advantages offset the relatively high transportation costs and the extra work needed for mounting and dismounting it.

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THE STATE OF THE WORLD’S SEA TURTLES (SWOT): COLLABORATING FOR CONSERVATION - THE LEATHERBACK NESTING BEACHES OF THE WORLD

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Over the past two years researchers around the world have contributed their time, energy and scientific data to the State of the World’s Sea Turtles (SWoT) effort, in order to collaboratively map the leatherback nesting beaches of the world with the best available information from the last complete nesting season in 2004. Published in the first SWoT Report, this network of data providers – the “SWoT Team” – documented 203 leatherback nesting sites in 46 countries. Nesting data from the last complete nesting season in 2004 were contributed from 89 of these sites, and the remaining 114 either did not participate or do not have beach monitoring programs. In creating a global picture we faced many challenges relating to data deficiencies and incompatibilities. Firstly, there are likely a number of leatherback nesting sites that have not been discovered, and even among the sites that we know exist, many have incomplete data or none at all. Furthermore, with information from nearly 100 sources and 46 countries, we are faced with the tremendous challenge of creating uniformity among diverse data sets. Under the guidance of a Scientific Advisory Board, we have made a concerted effort to develop solutions that are scientifically credible and transparent. These are explained in detail in the SWoT Report. Ultimately, presenting a uniform global picture that is easy to interpret is a critical step in our ability to communicate the SWoT Team’s results to the public, and ultimately to promote the human behavior changes that are needed to conserve sea turtles. The SWoT Report aims

not to be “just another report”, but rather a strategic tool for promoting conservation action. As such, leaders in the sea turtle conservation movement were invited to write strategic articles on key themes, in order to set examples for global conservation practice. These themes include environmental policy, business practice, coastal development, protected areas, economics, fisheries, and community-based conservation, among others, intending to address every major threat to sea turtles today. As the first SWoT Report is released at the 26th Sea Turtle Symposium, we will use its contents and messages to guide a global media campaign that promotes human behavior change on many levels. Through the network created during two-years of data gathering (the SWoT Team) we have a unique ability to disseminate information to nearly all sites where the leatherbacks are found – almost every nesting beach in the world, and in many at-sea areas. Each member of the SWoT Team will receive multiple copies of the report, as well as an accompanying outreach and education toolkit, with boilerplate materials for local adaptation, such as press releases, lesson plans, techniques for engaging donors, and more. These materials will derive directly from the report’s content, and aim to give a more powerful whole back to the many contributing parts. The SWoT Report and all of its parts – the database, the “SWoT Team” network, and the communications strategy – are dynamic and evolving, and it is our intention that these will grow and strengthen through experience and time.

Order: 264 **Abstract ID:** 1538 **Type:** Poster **Subject:** Education, Outreach and Advocacy

STATUS AND CONSERVATION OF MARINE TURTLES IN MALTA

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Five species of marine turtles are recorded in the Maltese Islands, with the Loggerhead Turtle being the most common. *Caretta caretta* is recorded to have formerly nested in very small numbers and irregular episodes, prior to 1940s. Although nesting or at least nesting attempts cannot be completely ruled out, no more records exist after this date. The chief threat for the Loggerhead turtle in the Maltese waters is accidental capture through long-line fishing, however an increase in public awareness, with a joint conservation effort by fishermen and the general public is fostering an increase in landings by fishermen and a possible decrease in mortality at sea. Malta has also embarked on a tagging and data gathering practice since 1991, with the greatest efforts in the past 3-4 years, through concurrent public awareness activities. Tagging and the related data conveyed from turtle networks, is accruing our knowledge on possible migration routes and behaviour. Malta has also embarked upon a rehabilitation and rescue project, to sustain the safe release of a number of rehabilitated turtles every year. Malta is also contributing to the conservation of these reptiles through the establishment of a data-base, a national action plan for protecting turtles and additional planned educational material. An efficient stranding network, established also with the help of NGOs, is also helping in an efficient, effective and rapid scheme to attend such episodes. Timely and effective response combined with rehabilitation measures and possible surgical intervention thence helps to save these reptiles.

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SEATURTLE CONSERVATION THROUGH CAPACITY BUILDING IN NORTH WEST PACIFIC COAST OF NICARAGUA

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The northwest pacific coast of Nicaragua consists of three nature reserves; Isla Juan Venado, Estero Padre Ramos and Volcano Cosigüina, whose coastal perimeters harbor numerous unprotected nesting beaches for five species of sea turtles. For the past two years, Frontier-Nicaragua's field research teams have recorded numbers of nests in these Reserves and have investigated supply and demand linkages in areas where turtle eggs and products are prevalent at local restaurants and markets. Studies have revealed that an action plan for sea turtle conservation in this region is imperative and crucial for survival of dwindling populations. In order to promote a successful holistic conservation programme, Frontier-Nicaragua has initiated the project "Capacity Building for Sustainable Management of the Nicaraguan Pacific North Region," funded by the British government's Darwin Initiative. The project combines scientific and technical training to help safeguard sea turtle populations, training community members and park guards in the building of hatcheries, scientific data collection, beach patrolling and nest-relocation in each reserve. Though the certified training programme concentrates on sea turtle conservation, it places conservation management in a broader perspective with lectures and hands-on activities in tropical ecology, management strategies, eco-tourism, funding proposals and socio-economic surveys. This presentation highlights a prime example of how capacity building has led to true "conservation in action." The successes and lessons learned from the project are discussed, with suggestions for replication in other regions, where sea turtle conservation relies on the participation of local communities and maximizing the efforts of few protected area employees.

Order: 266 Abstract ID: 1813 Type: Poster Subject: Education, Outreach and Advocacy

STUDENT-SCIENTIST PARTNERSHIPS INVEST GALÁPAGOS RESIDENTS IN CONSERVATION

Julie G. Osborn, Scott B. Pankratz, and Monica Lopez Conlon

Ecology Project International

From 2003-2005, Ecology Project International (EPI) organized a collaborative student-scientist partnership between the Charles Darwin Foundation (CDF), the Galápagos National Park Service (GNPS), six Galápagos Island high schools, and five USA high schools. The partnership provided an education program and scientific training for Galápagos youth and supported applied research spearheaded by CDF. The focus of the collaboration was to monitor Green sea turtles (*Chelonia mydas agassizii*) nesting at two different beaches. A total of 177 students participated in sea turtle patrols in small groups of two students plus one researcher per patrol. Together, the students volunteered on 156 nights during which they worked a total of 1,542 times with turtles. This collaboration built upon lessons learned from a similar project with Leatherback sea turtles in Costa Rica. As a result of the experience gained and relationship built among all collaborators, community members who participated in this program have initiated their own research and monitoring efforts on other species in collaboration with the CDF and GNPS. The project catalyzed communication among various groups and enabled participants to raise awareness of other residents of the archipelago about current conservation efforts.

EDUCATION, OUTREACH, AND ADVOCACY: A CASE STUDY COMPARISON OF COMMUNICATION STRATEGIES FOR SEA TURTLE CONSERVATION

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Education, outreach, and advocacy all contribute to the ever-growing conservation movement and many leading sea turtle conservation organizations have found them to be highly effective for raising awareness of their cause. However, there appears to be a general lack of understanding between the differences of these approaches and a limited appreciation of how various organizations are implementing them. These three approaches to conservation are generally used as a way to bring about social change, instill a sense of stewardship, and create a political voice within the communities that have a direct impact on sea turtles, both locally and worldwide. In the face of limited resources, international conservation groups working in some of the world's most critically important sea turtle habitat regions, may implement education, outreach and advocacy as independent approaches combined in a three-part conservation mosaic: (a) Education is used to share new knowledge, (b) Outreach is used to network this knowledge from a grass-roots level, and (c) Advocacy is used to bring networks of individuals and organizations together to create solutions through a social movement. This study highlights the fundamental differences between approaches and goals for communication strategies and offers case study examples from key organizations featuring sea turtle conservation programs around the world. Ecology Project International (EPI), operating in Costa Rica, Galapagos, and Baja, engages local residents and international students in sea turtle field research, inspiring them to learn about science, culture and communication, and empowering them to engage in the world around them so that they can then make a difference. By focusing on education and outreach strategies, EPI has educated thousands of students who now make up a vast network of communities involved in sea turtle conservation. Sea Turtle Restoration Project (STRP), a sea turtle activism nonprofit, is diligently involved in a multitude of advocacy projects that bring the plight of sea turtles to the forefront on both a national and international level. In 2005, STRP facilitated a petition of 800 scientists from 83 countries and 230 environmental organizations from 54 countries, to urge the United Nation's Convention on the Law of Sea to address the issue of leatherbacks falling prey to longlines. Utilizing the advocacy strategy, STRP was able to work in conjunction with other groups who use education and outreach strategies to provide a consorted platform for conservation. Addressing the main threats to sea turtle survival on a global scale, groups such as Grupo Tortuguero, with 500 members from 30 coastal communities, and RARE support networks of individuals, grassroots communities, organizations, and institutions from around the world to build diverse conservation networks aiming to expand knowledge, develop innovative solutions and share solutions widely. Using a myriad the three strategies mentioned: education, outreach and advocacy, both Grupo Tortuguero and RARE have made measurable strides in the world of sea turtle conservation. The main focus of this study is to highlight the results of each approach and to present strategies that have proven to be most effective so that other organizations may adopt them.

EDUCATIONAL STRATEGIES AT THE CRAM FOUNDATION DIRECTED TOWARDS THE CONSERVATION OF SEA TURTLES

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For over ten years the CRAM Foundation has worked for the rescue and conservation of marine animals. The Foundation deeply believes that a key instrument for conservation is education. For this purpose, many educational initiatives have been developed at different levels: 1. Visits of school groups and the general public to the rescue centre are based on the philosophy that only a good knowledge of something can lead to its appreciation/comprehension and its protection. At the centre visitors are taught about the marine environment and the endangered species that inhabit it, always bearing in mind the age of the visitors. The different threats to these populations are explained, as well as ways by which the general public can help towards their conservation. 2. Training of fishermen: Fishermen are a key element in the rescue process of sea turtles in the North-western Mediterranean. Every spring meetings are organised with fishermen of different locations, where they are taught easy techniques to minimise the damage caused by the accidental capture of these animals and to reduce the related mortality. These meetings have been organised for the last ten years and since then every year more and more fishermen collaborate with the CRAM Foundation in the rescue of accidentally caught turtles. They understand the problems that long-line fisheries pose for the loggerhead sea turtle populations, and try to minimise this impact by following the techniques taught, and by bringing the accidentally caught animals to the rescue centre instead of throwing them back to sea. 3. Training of volunteers: i. On the one hand, volunteers working at the rescue centre receive periodical lectures on all aspects of marine animals, including biology, conservation problems, first aid and veterinary medicine. This helps them further understand the animals they are working with every day. ii. Because of the large coastal area of Catalunya (300km), specialised volunteers are needed along the coast in order to rapidly assist any kind of stranded marine animal until the arrival of the CRAM team. With several specialised courses spread out during the year, these volunteers are taught how to deal with all kind of emergencies related to stranded marine animals. 4. Courses for staff of Public Institutions, such as the police or the Red Cross, who are in the first line of action when a marine animal appears on a beach. They are instructed on how to proceed during the stranding of a marine animal, and how to deal with the people surrounding the animal to minimise its stress. 5. Summer courses and on-site training directed specifically to students and professionals of biology and veterinary medicine. These involve very advanced practical and theoretical lectures on all aspects of biology and medicine of sea turtles, cetaceans and marine birds, and are thought for people who work or want to work with these animals.

NEW HAMPSHIRE SEA TURTLE FOUNDATION - BETWEEN TRADITION AND INNOVATION

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We've inherited a rich history of sea turtle field conservation techniques passed down from one generation to the next, a tradition that is always larger than any single person or organization; and yet, a tradition must constantly change in order to survive. The focus might need to shift more towards public education, outreach and advocacy.

This is not to say that the traditional and long term studies about sea turtles should die out. On the contrary, traditional methods of tracking and tagging sea turtles during nesting are an important tool. But, again, times are changing and sea turtles are still disappearing. I had a goal to engage young people in New Hampshire and worldwide through a web-based school program to teach students and their teachers about the NH and Federally endangered leatherback sea turtle (*Dermochelys coriacea*). In 2005, I established the New Hampshire Sea Turtle Foundation and www.nhseaturtle.org. The website is designed to teach students, teachers and the general public about the critically endangered leatherback sea turtle. This project was designed specifically for middle school students and their educators to have easy access on the web in their classroom to the most current scientific information related to protecting and preserving the critically endangered leatherback sea turtle today. As project director, I worked with Conval High School students in Peterborough, NH, and their teacher from the ATC Region 14 Applied Technology Center on developing this website with a limited grant budget. I wanted to make the website simple and fun for students to use as well as to supply good information about sea turtle conservation and ways students can help sea turtles. This project directly raised awareness about leatherback sea turtles for over 500 students, their teachers and administrators in the Conval School District. It also informed a larger audience and raised public awareness about the leatherback sea turtle in a variety of other ways. The Monadnock Ledger ran a full page article about this project featuring middle students in Great Brook School, Antrim, NH. The Monadnock Ledger serves the heart of the Monadnock community region in NH and reaches thousands of people. I taught middle school students (grades 5th-8th) at Great Brook School about the leatherback sea turtle and promoted the use of this website to enhance their learning. Teaching students in their middle school years contributes to the recovery of the leatherback sea turtle in a number of important ways. By allowing students to get involved, they can share information with others and become life-long supporters of the conservation of marine turtles. Integrating real world projects into the classroom, where students can learn from good role models makes lasting impressions on young student minds. Because of the dramatic decline of leatherbacks worldwide, public education efforts like this project are becoming increasingly important. Through innovative sea turtle websites we can appeal to students, teachers and the general population worldwide. Our good work must not go unnoticed.

Acknowledgments: I am grateful to the New Hampshire Charitable Foundation, Monadnock Community Foundation for the financial grant assistance to complete this project. I am especially appreciative for the education, continued support and encouragement provided by the Caribbean Conservation Corporation & Sea Turtle Survival League, Sea Turtle Restoration Project and Sea Turtle Conservation League of Singer Island. Many thanks to the CCC for enabling me to participate in the 2005 Leatherback Project in Tortuguero, Costa Rica. Special thanks go to the Conval High School Graphic Design Program, Peterborough, NH, and Great Brook Middle School in Antrim, NH. I would also like to thank the sea turtle symposium for providing me with a travel grant. I am appreciative of the generous donations made by Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service, who provided funds making it possible for me to attend the 26th Annual Symposium on Sea Turtle Biology and Conservation.

Order: 270 **Abstract ID:** 1653 **Type:** Poster **Subject:** Education, Outreach and Advocacy

THE CESENATICO RESEARCH UNIT ON MARINE CHELONIANS

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A wide series of research interest, varying from eco-physiology to conservation, focusses on sea turtles. All Italian seas are frequented by three species, the main being loggerheads, as greens and leatherbacks are rare. A small

research unit was constituted in Cesenatico Aquaculture & Ichthyopathology Centre of the Veterinary Faculty of the University of Bologna in order to create a local effort to increase knowledge, student information and public awareness. Until now only *Caretta caretta* specimens have been collected and analyzed. Studies in the centre are carried out on stranded animals coming mainly from the north Adriatic Sea. Morphometrics, anatomy, pathology, ectobionts, parasite, food ecology, heavy metal and contaminant presence are the main focus of investigation pursued. Analytical support is also provided to the sea turtle hospital of Fondazione Cetacea in Riccione. Also the faculty has started, since the 2004-5 academic year, a course on sea turtle and cetacean biology that introduces students to reptiles in theory and practice. Moreover, in the last 5 years around a dozen of papers have been published by the group. Research relationships are under way with Fondazione Cetacea (Riccione), Centro Ricerche Marine (Cesenatico), Centro Studi Ambientali (Rimini) and other universities.

Order: 271 **Abstract ID:** 1565 **Type:** Poster **Subject:** Education, Outreach and Advocacy

MARINE CHELONIAN ILLUSTRATION PART FOUR: CARETTA, EXPLORATION AND THE ADVENT OF MODERN SCIENCE

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Although there is ample material evident throughout European and Middle Eastern prehistory, accurate knowledge of animals and the natural world did not emerge until the writings of the Greeks and Romans. Much of it is only preserved because it was translated into Arabic and preserved in Middle Eastern libraries, before being retranslated back into European languages. This is the case with Pliny, Dioscorides, and Aelian. They compiled and expanded upon earlier chelonian accounts, as later authors such as deCantimpré, vanMaerlant, Candidus, Gessner, and Aldrovandi, repeated and elaborated upon theirs. Many contained ample chelonian information and images, of varying degrees of accuracy. The first identifiable loggerhead appeared in Gessner. But the original watercolors of Aldrovandi produced the earliest, highly accurate, and beautiful representation. This is a particularly important milestone, as most naturalists were still basing accounts on secondhand information. Encyclopedists during this and later periods copied both accounts and pictures with minor or minimal changes. The middle age's bestiaries further confused natural histories, placing more emphasis on morality lessons, than accuracy. Caldesi and Gottwald both produced accurate chelonian anatomies with the latter including a very accurate *Caretta*. The 1400s introduced printing presses making zoologies more available, while data from New World voyages spurred institutions to embark on journeys of scientific discovery. But all of this built upon earlier efforts. Cuvier, and later Linnaeus, acknowledged their debt to those who went before them, particularly to Gessner, who devised the first real systematic key to the classification of life and to chelonians.

“LA COMUNIDAD” - TORTUGUERO, COSTA RICA

David Smith¹, Kelly Matheson², Ian Kellett², and Sebastian Troëng³

¹ CAVU

² Filmmaker

³ Caribbean Conservation Corporation

“La Comunidad” was shot in Tortuguero, on Costa Rica’s Caribbean coast. Presented by CAVU in partnership with the Caribbean Conservation Corporation (CCC), Costa Rica’s Ministry of Environment and Energy (MINEC) and La Comunidad de Barra del Tortuguero, the film celebrates the community’s recent successes due to its conservation ethic. Formerly, after generations of unsustainable over-harvesting of nesting sea turtles (for their meat and eggs), the community faced dwindling prospects. But under the initial guidance of Archie Carr and the CCC, the residents slowly changed their practices, and with the establishment of Tortuguero National Park, there began an influx of eco-tourists. Today the community is prospering economically. Numerous hotels and small hostels have been built, locally owned shops and restaurants are opening, the school is growing and campesinos looking for opportunity are immigrating to Tortuguero. The community is a conservation success story, and it is this fact that makes La Comunidad a potentially significant film, as CAVU takes it “on the road”, showing it up and down the Caribbean coast (from Honduras to Panama). It is CAVU’s hope that the film will resonate with other communities that are still struggling and may not have yet considered nature conservation and ecotourism as a viable development solution.

TEACHING THE LOCAL COMMUNITY TO COLLECT SEA TURTLE DATA AT JAMURSBA MEDI BEACH, PAPUA, INDONESIA

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The WWF-Indonesia program to conserve leatherback turtles and their nesting habitats at Jamursba-Medi Beach in Papua, Indonesia, has been largely supported by the local communities. The community has selected the individuals to regularly monitor the beaches. The presence of these local patrollers has successfully reduced poaching of adults and collection of eggs by outsiders. Based on this success, these patrollers were further trained to collect data in experimental plots to evaluate hatching success during the 2005 nesting season. Sixteen patrollers of different ages and educational background participated in the training. All patrollers appeared to understand the methodology and collected data regularly. However, towards the end of the season only 7 (43.75%) patrollers fully remembered the methodology and collected data. Some recommendations are provided to ensure successful training of the locals of Papua, Indonesia, for long-term conservation initiatives.

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MEETING OF THE YOUTH OF THE CALIFORNIAS FOR THE CONSERVATION OF MARINE TURTLES (BAJA CALIFORNIA SUR, MEXICO)

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Environmental Education on the conservation of sea turtle populations gives men and women the opportunity to actively reflect, propose and carry out solutions to environmental problems. It helps to foster processes that allow the acquisition of new information, as well as the development of practices that strengthen social and human development based on the values of personal growth and community participation (Acuario Mazatlán, 1998). One example of this process is the Program of Youth Conservation Meetings at the Acuario Mazatlán, a successful model of environmental education since 1987. Over 100 6th grade children from various fisherman communities participate in a week-long program of educational and camping activities centered on principles of sea turtle conservation on the Mexican Pacific coast, encouraging knowledge, environmental awareness, experience in the field, as well as the sharing of knowledge and experiences. This successful methodology was recently emulated with the children of fishermen from various communities throughout the Baja California Peninsula who were attending the Seventh Annual Meeting of the Grupo Tortuguero in Loreto in 2005. This was the first Meeting of Youth in the Californias for the Conservation of Sea Turtles, and the idea to make it an annual event was immediately adopted. The Meeting of the Youth of the Californias will enable youth to: 1) understand the urgency of participating in the conservation of sea turtles, 2) develop new behaviors of respect for their natural environment, 3) contribute to conservation in their region, and 4) acquire the tools necessary to carry out conservation in their schools and communities (Cruz Morelos, 1994). The first tangible results came to light during the second meeting, when those who participated in 2005 were given the opportunity to present the results of their work in their own communities. One of the highlights was the work of CAEM (Ecology Friends Club of Mulege) and JABA (Young Environmentalists of Bahía de Los Angeles), both of whom participated in the presentation of the now popular puppet theatre TORTUGOPOLIS. Aquatic Adventures also stood out, presenting a board game that follows the life cycle of the loggerhead turtle. The work by the youth of Puerto Adolfo López Mateos was also highlighted, the loggerhead turtle being an important part of their community, celebrated each year in a turtle festival. Most importantly, the meeting has provided a venue for every participant to share their knowledge and experiences with other communities throughout the peninsula. 31 young people between the ages of 4 and 15 participated in the first meeting in 2005, representing 12 communities throughout Baja California Sur. Participation more than doubled in January of 2006 with 70 participants from 10 communities. Young people are not only the future of our world, they are the present. They must begin actively participating in the conservation of sea turtles, developing and sharing new habits amongst themselves and with others. These annual meetings are dedicated to creating this sense of awareness in the youth of the Baja Peninsula, and establishing a continuing forum for them to learn from each other.

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CREATING A NETWORK FOR THE PROTECTION OF SEA TURTLES IN THE TOURIST CORRIDOR OF THE MUNICIPAL OF LOS CABOS, BAJA CALIFORNIA SUR, MEXICO

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Los Cabos, at the extreme southern tip of Mexico's Baja California peninsula is an Eden with a variety of accommodations to satisfy all budgets, including magnificent hotels and resorts. The cities of San Jose del Cabo and Cabo San Lucas anchor the Tourist Corridor, with over forty miles of stunning beaches, making it one of Mexico's most important tourist developments. In 2001, the Municipal Government of Los Cabos, through the Program for the Protection of Sea Turtles, formed the SEA TURTLE PROTECTION NETWORK in beachfront hotels in Los Cabos. The main objective is to voluntarily involve the hotel sector in sea turtle protection. Other Mexican tourist destinations like Mazatlan, Sinaloa; Puerto Vallarta, Jalisco and Xcaret in Quintana Roo operate similar conservation programs, the difference being that these are private projects also promoting sea turtles as a tourist attraction. To safeguard nesting zones in Los Cabos, ongoing workshops are offered on management and conservation, by the Municipal Program for the Protection of Sea Turtles personnel. Participants, collaborating with their respective hotels, receive training in sea turtle biology and risks, and tools to monitor and protect nesting beaches. During three years of operation, 21 hotels have voluntarily participated, represented by a democratically elected coordinator. Nearly 50% of the resorts in the beach zone are participating in the network. To date, 18 workshops have been held with approximately 470 qualified individuals participating in the network. A total of 288 nests were reported, of which 256 were protected, resulting in 18,113 olive ridley hatchling releases. 12 leatherback hatchlings were released from four nests recorded. Sea turtles were rescued. Four poachers were turned over to the authorities. Further, the network participants have proposed conservation strategies and management: protection of nests in situ, reduction of excessive artificial light in nesting areas, protection of major nesting zones, moving beach chairs and umbrellas back on the beaches, eliminating all vehicular beach traffic, avoiding hatchling manipulation by liberating at birth, and if released in the presence of tourists, a qualified hotel representative is present, environmental awareness campaigns to reinforce sea turtle protection by eliminating the culture of turtle egg and meat consumption. Unexpected results of the program are room reservations during the hatchling seasons. An indicator of the program's success is that the hotels have identified the need to maintain new personnel trained. Sea turtle habitats are critical for the reproduction and survival of these species. The consequences of man's impact can be severe. The success of a conservation program consists of diminishing or mitigating man's impact through citizens participating in solutions to environmental problems, and actions that individuals can do to reduce, stop, or remedy the damage impacting nesting areas. Unfortunately, major conservation programs and integral resource management do not achieve their objectives, in part due to the lack of private sector inclusion. The SEA TURTLE PROTECTION NETWORK is a model in which different sectors of society, including government and private initiatives, plays the ultimate role in voluntarily compromising citizens to care for their natural resources.

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“HELP OUT OR SEA TURTLES MISS OUT”: A SEA TURTLE EDUCATION AND OUTREACH PROGRAM FOR THE NETHERLANDS ANTILLES

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Education and community outreach have become integral components of successful sea turtle conservation projects. To raise awareness about sea turtles, an extensive year-long outreach and education campaign was developed and implemented by the Dutch Caribbean Nature Alliance (DCNA) for the Dutch Windward Islands of Saba, St Eustatius and St Maarten. The Truus and Gerrit van Riemsdijk Foundation sponsored this initiative. The DCNA is a recently formed foundation that brings together the Nature Conservation Management Organizations of the Netherlands Antilles and Aruba. The sea turtle awareness project was the first joint project of this extent for the Conservation Foundations of these three islands and their pilot project to implement environmental education. This all contributed to the new working structure of DCNA and the protected area management organizations. The campaign entitled “Help out or sea turtles miss out” and featuring “Scout” the mascot, was adapted from the “RARE – Promoting Protection through Pride” program that has achieved widespread success in many countries in the Caribbean region. The three aims were to increase pride in the fact that these islands still have sea turtles, to create awareness that they need protection and to identify concrete ways in which the public can help. Different educational methods and instruments were used to increase public understanding of the region’s sea turtles providing information on the different species, threats and conservation status. The local community of the three Windward Islands was divided into different target groups and approached at their levels. The activities included public presentations, a puppet show, a school song, a portable exhibition and various competitions. All lessons and activities were carried out with emphasis placed on active participation and fun. Also various attractive educational materials and information handouts were produced, such as posters, brochures and badges. The project effectiveness was evaluated by means of a survey that was conducted at the start and end of the program. The end survey showed that 75% of the persons interviewed had heard about the sea turtle project. 45% of them mentioned they had actively taken part or knew somebody that had taken part in a ‘sea turtle activity’ related to this project. School visits and newspaper articles appeared to be the most effective approach to reach the community. 36% of the persons interviewed mentioned that the program got them more interested in sea turtles and 42% mentioned they are proud that sea turtles exist still on our islands. When comparing the initial survey to the evaluation survey, it showed that people appeared to have better knowledge of sea turtle facts and therefore answered more questions correctly. In general, the project showed much positive feedback from the community on all three islands, and offered a great deal of encouragement to continue the work to prolong its success in sea turtle conservation and environmental education in general.

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LOCAL COMMUNITY, GLOBAL VOLUNTEERS, AND SEA TURTLES – DELIVERING SUSTAINABLE DEVELOPMENT ON KEFALONIA ISLAND, GREECE

Katerina Xenopoulou, Sarah Maynard, and Manuel Coleman

Katelios Group for the Research and Protection of Marine and Terrestrial Life, Greece

The Katelios Group for the research and protection of marine and terrestrial life is a small organization set up and ran by locals to protect and conserve the environment on Kefalonia, one of the seven Ionian islands in Greece. The Katelios Group began in 1994 with the majority of work involving the conservation of the local nesting population of *Caretta caretta*. Since 1999 research work has focused on data collection from the main nesting beach on the island, Mounda Beach. Volunteers from all over the world participate in the groups activities which focus on patrolling the nesting beaches, collating data (number of nesting females, success rates of nests), and increasing conservation awareness among tourists and local people. The presentation will highlight the importance of “local people” protecting their “local environment” in partnership with global volunteers as a means of delivering sustainable development. There will be an overview of the Katelios Group’s achievements over the past 10 years, followed by a breakdown of the research conducted over this period. This will focus on discussing the findings on nesting behavior and populations, conservation efforts, anthropogenic impacts on the *Caretta caretta* population and the interactions with the rest of the local community.

Order: 278 Abstract ID: 1844 Type: Poster Subject: Fisheries

AN ASSESSMENT OF THE RATE OF INCIDENTAL CAPTURE OF MARINE TURTLES IN FISHING ACTIVITIES OFF THE COAST OF MICHOACÁN, MEXICO

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In the 1980's, 65% of the world's population of leatherback turtles carried out its reproductive cycle on Mexico's Pacific coastline, mainly on the beaches of the states of Michoacán, Guerrero and Oaxaca. However, over the last 20 years, there has been a drastic depopulation of this magnificent species, as well as of the two other marine turtles that nest specifically on the 213 kilometer coastline of the State of Michoacán. Conservation efforts have been focused on land-based programs and activities tending to reduce nest-harvesting by illegal poachers. Nonetheless, at present, the population is still declining. For the first time in Mexico, a State Government has manifested interest in assessing the impact that coastal fisheries may have on marine turtle mortality, and is therefore carrying out a research project involving six different communities of fishermen along the coast. The information being collected for this Project will bring knowledge of foraging and mating areas, as well as migratory routes to nesting sites, resulting in a map with geo-references. In addition, information about the rate of mortality caused by coastal fisheries and other related activities along the coastline will allow the Government to design and implement an integral coastal management plan with marine turtles as an umbrella species. This will be accomplished through the knowledge and participation of members of the coastal communities. This research project, conducted and presented on behalf of the State Government, is crucial to marine turtle conservation in Mexico. It sets a precedent for the direct involvement of the coastal communities in the implementation of the investigation, taking into account their ancestral knowledge and their local expertise in the gathering of data about this seriously endangered species and its main nesting site in the eastern Pacific. Additionally, the active participation of the Fishing Cooperatives and the Committees for the Protection and Conservation of Marine Turtles—whose members are the inhabitants of the areas close to the nesting sites—will facilitate reaching agreements if it is determined that regulation of local fishing activities is required for the sustainable utilization of their natural resources. The results of this pilot study will not only impact one state, but will be incorporated into the Tri-State Conservation Plan pioneered and lead by Michoacán, which has now been operating for the past two years in partnership with the State Governments of Guerrero and Oaxaca, as well as with the two most important federal agencies dealing with environmental matters. It will also serve as a catalyst to induce other countries that engage in fishing activities along leatherback turtle migratory routes to manage their fisheries in conjunction with the efforts being made by our State and our country.

STUDY ON THE LONG-TERM EFFECT OF HOOKS LOGGED IN THE MID-OESOPHAGUS OF SEA TURTLES

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By-catch of long-line fisheries is one of the most important threats to the loggerhead sea turtle populations in the Mediterranean Sea. The aim of this study was to assess the clinical long-term effects of long-line hooks lodged in the oesophagus of loggerhead turtles. Eleven juvenile loggerhead sea turtles (SCL 37,2 +- 8,7) admitted to the Rescue Centre for Marine Animals – CRAM (Barcelona) during the fishing seasons of 2001 and 2002 were used for this study. They had been accidentally captured by long-line fisheries and were brought to the Rescue Centre with a hook lodged in the oesophagus or stomach. For different reasons these animals could not be operated at the time of admittance in order to remove the hook. However, they were healthy and behaved normally. Therefore, it was decided not to intervene at all, in order to observe the effect that the lodged hooks would have on the animals over a period of time. For two years the veterinary team observed the clinical progress of these turtles, performing routine radiographs and blood analysis. None of the animals needed special veterinary treatment during that time. Five turtles spontaneously expelled the hook during the observation period and were taken off the study. After two years, each turtle was sedated, and an endoscopy of the oesophagus was carried out in order to assess the oesophagus wall and the exact location and position of the hook. In four animals the hook had turned around, so that the point was in the lumen of the oesophagus, with the shank outside the wall of the oesophagus. The hook was removed through endoscopy in most of the cases, with the exception of two animals which needed an oesophagotomy. This study shows that a hook lodged in the oesophagus of a turtle may cause minimal damage and distress to the animal in the long term, as long as there are no large tears, and the fishing line has been cut short. These data might help determine the post-capture mortality rate of incidentally caught turtles by long-line fisheries.

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CANCELLED

MODELING THE RELATIONSHIP BETWEEN FISH LANDINGS, FISHING EFFORT AND STOCK ABUNDANCE

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Sea turtles are incidentally caught to fishing operations worldwide. Understanding and mitigating this threat is critical to species' survival. To accurately assess the impact of by-catch on sea turtles, an accurate measure of fishing effort (the amount of fishing gear in the water) is fundamental to understanding how fisheries may be impacting non-target species. However, effort data are not available for many fisheries and new approaches are needed to gain insight on fishing effort for data-deficient areas. We investigate the relationship between landings, a more universally available measurement, and fishing effort for gillnet fisheries in the Atlantic for which comparable datasets exist. We used observer data from the Gulf of Maine anchored gillnet dataset (1996-2004) to develop a regression model of catch against effort. The catch-effort relationship for 3 demersal species, cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and dogfish (*Squalus acanthias*) were considered representing over-exploited, fully exploited and a developing fishery respectively. We assume that the error associated with landings is greater than the error associated with effort; as a consequence we modeled catch as a function of effort. Additional explanatory variables investigated included month, season, year and location (latitude/ longitude). The performance of different models was compared using a cross-validation analysis in which we randomly assigned 75% of the data to train the model and then validated the model with the remaining data. Regression models including year and month alone had no predictive capability. The relationship between catch and effort has been intensively examined from the perspective of deriving reliable indices (e.g., CPUE) for abundances estimates for surplus production models. However, much less focus has been placed on treating catch and effort as a bivariate series and looking at non-linearities between the two. Many regions are without observer programs, sporadic collection or limited information on fishing effort and the use of unbiased indices or proxies to represent fishing effort would be tremendously useful. To this end we are heartened by research such as undertaken by Gaertner *et al.* (2001) and Worthington *et al.* (1998). Gaertner *et al.* developed a fishery indicator based on limited effort data and knowledge of the relative trend in effort in the yellow fin tuna (*Thunnus albacares*) and skipjack (*Katsuwonus pelamis*) fisheries in the Indian Ocean. Worthington *et al.* examined the relationship between catch, effort and CPUE in the New South Wales abalone (*Haliotis rubra*) fishery.

Acknowledgments: RB gratefully acknowledges travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service, provided through the Symposium Travel Committee.

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SEA TURTLES AND LONGLINE FISHERIES – WHAT NEXT?

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Research to mitigate the bycatch of sea turtles in pelagic longline fisheries is reviewed at four levels of interaction: mechanistic, demographic, ecological, and socio-political. We focus on the importance of taking an ecological approach to bycatch reduction and present data on shark bycatch to illustrate what can happen when we focus our research efforts on only a single taxonomic group -- sea turtles. We address the advantages of two ecological approaches: marine protected areas and a multiple-mechanism decision-based approach that integrates the bycatch probabilities of all taxonomic groups of concern. A spatial model is presented to support the need to develop time-area closures (= protected areas), and research priorities are recommended to accomplish this approach.

IMPACT OF THE COMMON DOLPHIN FISH LONGLINE FISHERY ON SEA TURTLES ALONG THE PERUVIAN COAST BETWEEN 2003 AND 2005

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Seventeen fishing trips targeting common dolphin fish were conducted in the Peruvian sea between 2003 and 2005. A total of 221,447 hooks were deployed in one hundred and thirty-two sets during one hundred and forty-four days. Seventy-seven sea turtles were captured in fifty-two of these sets. From the total, 67 were evaluated and 10 got free when the gear was being hauled back. The sea turtle species reported were *Chelonia mydas* (50%), *Caretta caretta* (27.4%), and *Lepidocheys olivacea* (12.9%). Regarding the interaction with the gear, 38.5% got hooked in the mouth, 30.8% in the flippers, 12.3% in the esophagus, 1.5% in the plastron, and 16.9% were entangled with the line. The majority of *C. mydas* and *C. caretta* were hooked in the mouth and the majority of *L. olivacea* in the flippers. The average CPUE of sea turtles in this fishery is 0.348 turtles per 1000 hooks. More turtles were captured during the summer season and the CPUE showed a decreasing trend at the end of the summer. In general, these results show that even when the calculated CPUE of sea turtles is not very high it is an important value if we compare it with fisheries in front of nesting beaches and that the interaction with the gear for *C. mydas* was highly unexpected due to the well known fact that green turtles are less likely to bite the bait.

ANALYSIS OF LOGGERHEAD SUMMER CAPTURE PATTERNS IN THE SPANISH MEDITERRANEAN SURFACE DRIFTING LONGLINE FISHERY

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The Spanish surface longline fleet in the Mediterranean primarily targets swordfish year-round. The incidental capture of loggerheads extends from spring to late autumn, with the highest catch occurring in summer. The surface longline is considered one of the most dangerous fishing methods for threatened marine turtles, and is the principal threat for marine turtle populations in the Western Mediterranean Sea. This paper analyses the fishing strategy and the environmental conditions in the Western Mediterranean Sea and their effects on loggerhead conservation. Fifty-two fishing operations (sets) were observed during the 2003 summer fishing period of the traditional (without roller) Spanish surface drifting longline fleet (July to September). The vessels represent the largest Spanish surface longline fleet (> 12 m. length). The analysis was performed on 1,068.4 fishing hours and 146,100 deployed hooks, corresponding to the traditional Spanish gear (50 nm main line; 2,500 “J” hooks, Mustad N° 1 from O. Mustad and Son, Norway; baited with squid and chub mackerel), as well as on the variables that could determine the incidental catch of loggerheads within the summer period sets. During the observed period, 239 loggerheads were incidentally captured. For each fishing single operation, environmental variables (wind direction and force and surface water temperature) and technical variables (number of hooks, time that the hooks remain in the water (soak time), mean value between the nearest distance to the coast at the beginning and the end of the long-line letting (distance to the coast), and mean value between the depth at the beginning and the end of each long-line set (fishing depth)) were recorded. The normality of the data was tested with the Kolmogorov-Smirnov test. Linear multiple regressions and second-degree polynomial regressions were performed on observed variables to test unimodal and bimodal responses of the incidental catches predicted by several environmental and technical factors. Two independent models were used to explain the incidental turtle catch: A) a simple linear model as a function of fishery distance to the coast ($R^2= 0.56$; F-value= 64.85; sig.= 0.001) and B) positive polynomial model as a function of soak time ($R^2= 0.79$; F-value= 63.61; sig.= 0.001). The first model was related with the fishing strategy and preference for deep water and the second model explained the increasing gear effects on sea turtles with soak time. The best fit among several significant regressions was selected in accordance with the highest F-value. Sets distance to the coast are closely correlated ($r= 0.886$) with fishing depth. Nevertheless the fishing depth doesn't explain the variability of the Loggerhead catches. Loggerhead catches increase in open water within the tested fishing area. Future studies should check these results before being generalized to other Mediterranean areas.

ANALYSIS OF LOGGERHEAD (*CARETTA CARETTA*, LINNAEUS, 1758) AND SWORDFISH (*XIPHIAS GLADIUS*, LINNAEUS, 1758) CAPTURE DISTRIBUTION WITHIN SETS IN THE SPANISH MEDITERRANEAN SURFACE DRIFTING LONGLINE FISHERY

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The Western Mediterranean Sea is one of the main areas of concentration for juvenile and adult loggerheads, as well as for targeted fishing species, such as swordfish. The Spanish surface longline fleet based in the Mediterranean mainly targets swordfish throughout the year, as well as bluefin and albacore tuna during summer periods. The incidental capture of loggerheads extends from spring to late autumn, with most captures occurring in the summer. Surface longlining is considered one of the most dangerous threats for marine turtles, and is the principal threat for turtle populations in the Western Mediterranean Sea. Therefore, it is necessary to analyze variables (fishing strategy and environmental conditions) within sets and their effects on loggerhead conservation in the Western Mediterranean Sea. The objective of this paper is to analyze within each set the spatial distribution of loggerheads captured on longlines and the inter-specific association of large pelagic fish inferred from catch data of the surface longline. The longline is divided into transects. The mainline of one transect runs between two consecutive floats and includes the branch lines that hang from the mainline. During the 1999 fishing period of the traditional (without roller) Spanish surface drifting longline fleet (August to November), a total of 141 on-board fishing operations (sets) were observed. The boarded vessel characteristics represent the larger Spanish fleet (> 12 m. length). The analysis was performed on 451,842 deployed hooks (50 nm main line; 2,500 “J” hooks, Mustad N° 1 from O. Mustad and Son, Norway; baited with squid and chub mackerel). During the observed period, 180 loggerheads were incidentally captured. Fifty-nine of the observed sets were analyzed. The selected fishing operations were technically homogeneous, composed of 23 sections each. In these homogeneous sets, 44 loggerheads (0.8 loggerhead by fishing operations) and 1,465 swordfish were captured (25 swordfish by fishing operations). A chi-square test was used to compare loggerhead and swordfish distribution among sections. Significant differences were found in loggerhead captures ($\chi^2(22, N=59)= 52.000, p< 0.01$). The results showed that 93% of the loggerheads were caught on the second half of the longline, which is the last part of the gear on board. These results were related to set time: the longer the set time, the more turtles captured. Significant differences were not found for swordfish catches ($\chi^2(22, N=59) = 33.016, p< 0.05$). In conclusion, the loggerhead captures present a distribution pattern within the gear but the target swordfish captures are randomly distributed.

CO-MANAGEMENT POTENTIAL FOR MARINE TURTLE FISHERIES IN ANGUILLA, BRITISH VIRGIN ISLANDS, MONTSERRAT, AND TURKS AND CAICOS ISLANDS

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Co-management, or the inclusion of user groups in decisions about and management of resources, is popularly promoted in fisheries literature. Including fishers allegedly improves policy by better reflecting existing local institutions and knowledge, and by improving fisher-management relations, enforcement, and fisher 'buy-in' to conservation and management practice. This paper considers the potential for co-management of marine turtle fisheries in four British Overseas Territories in the Caribbean. Based on a socio-economic survey undertaken as part of the Turtles in the Caribbean Overseas Territories project, the paper presents data from Anguilla, British Virgin Islands, Montserrat, and Turks and Caicos Islands, where 291 stakeholders (including 115 fishers) were surveyed. Results suggest that fishers and non-fishers often value turtles in a similar manner, but that important differences exist. Furthermore, fishers in general support co-management, but the extent of support varies according to territory. The implications of results for co-management in each territory, and for establishing similar management regimes throughout the region, are discussed.

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TURTLE BY-CATCH AROUND LAMPEDUSA ISLAND, CENTRAL MEDITERRANEAN

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Loggerhead turtles are known to frequent the central Mediterranean both in the southern shallow waters and in the northern deep waters, which are close to the Sicily strait connecting eastern and western Mediterranean. Lampedusa is a small island in the middle of the two areas, and is the base for many large vessels from other ports, mainly trawlers, fishing in the wider area. However, there are local vessels fishing around the island too. In order to assess the level of interaction of this fishery with sea turtles, we monitored the fishing effort of the 81 small vessels (mean length 13 m) working on the island during the 2005 summer and calculated turtle catch rates through voluntary reports by seven vessels. Most vessels of the fishery are bottom trawlers targeting demersal fish, the other ones alternate different gear: drifting longline targeting swordfish, bottom longline, nets and lines. We estimated 1016 captures (95% CI = 604-1427) in the period Jun-Sep by trawlers only, while the total annual catch for the whole fishery is probably much higher. The long haul duration adopted by these vessels (2-4 hours) can potentially induce high mortality rates and this aspect should be properly investigated. Standardized catch rates highlight the importance of the central Mediterranean for both neritic and oceanic habitats: the observed catch rates of bottom trawlers (0.051 Turtles/std net hour) are second only to those from the south of the same area, while those of drifting longline for swordfish (0.97 Turtles/1000 hooks) are second only to those from the western Mediterranean. We also conducted specific interviews to 61 vessels, revealing, among other things, that the fishermen's opinion is that turtle catch is declining.

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STUDY OF THE STRANDED AND BIOMETRY OF LOGGERHEAD SEA TURTLE, CARETTA CARETTA, IN SICILIAN COASTS

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In the period between 1999 and 2003, 233 exemplars of loggerhead sea turtles (*Caretta caretta*) have been studied stranded or accidentally captured with fishing tools near the coasts of Sicily. In this presentation we propose to supply a synthesis of the problems to which sea turtles come across more often along the Sicilian coasts in an attempt to better understand the effects of human activities on these last there. Besides a contribution regarding the biometric parameters in relation to the causes of stranding and in relation to the different periods of the year taken in examination is offered .

TRANSLATING EXPERIMENTAL RESULTS INTO FLEET OPERATIONS; LESSONS IN MITIGATING THE BYCATCH OF SEA TURTLES, SEABIRDS, AND MARINE MAMMALS

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Fishermen and resource managers have made substantial progress mitigating bycatch (incidental take) of sea turtles, seabirds, and marine mammals through various methods, including physical modifications to fishing gear. Many bycatch mitigation measures have been developed and tested successfully in controlled experiments. The results of these tightly controlled experiments have led to regulations that require important changes to several fisheries, including: TEDs to reduce bycatch of turtles in trawls; streamers and dyed bait to reduce seabird bycatch in longlines; and acoustic pingers to warn marine mammals of the presence of gill nets. But even with rigorous testing, success in by-catch experiments may not lead to effective mitigation in commercial fisheries, especially when experimental conditions are relaxed in real-world conditions. Bycatch mitigation methods may be less effective when implemented by a fishery because of a lack of compliance, misuse of the gear modification, regional differences in fishing practices, or other factors. Such an efficacy 'discount' between experimental results and fleet implementation may have serious implications for management and conservation of species taken as bycatch. Here we consider the difference between experimental and implemented bycatch reduction and suggest approaches that may be necessary to increase the efficacy of bycatch reduction in industrial fisheries.

VERTICAL DISTRIBUTION OF LOGGERHEADS CAUGHT BY LONGLINE IN THE IONIAN SEA

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The present study, carried out in the context of EU 98/008 Project, is to attempt to identify the depth usage of loggerheads and their vertical distribution from instrumented longline data. The investigation was conducted aboard fishing professional vessels between May 1999 and December 2000 in an area laying off the Italian coasts in the Ionian Sea. The fishing activities was carried out by means of two types of longlines targeting swordfish (*Xiphias gladius*) (SWO-LL) and albacore (*Thunnus albacore*) (ALB-LL). Data on capture depth and water temperature were recorded using P2TLL100 sensors attached to the longline. No differences in depth preference (0 to 60 m of depth) were found for the loggerheads caught by SWO-LL. Instead, differences were found for the specimens caught by ALB-LL. In fact, most of the loggerheads caught by this gear were captured at depths ranging between 0 and 5 m. During the retrieval of the long line, the branch line position where turtles hooked was recorded. Regarding SWO-LL, most of the specimens were caught by the hook of the branch line between two floats, which is the deeper hook within the gear but also in respect to the deeper hook in ALB-LL. Where ALB-LL is concerned, no differences for the specimens captured by the branch lines at different depths were observed. Technical modifications and seasonal environmental characteristics' changes need to be taken into consideration for fishery management and resource conservation.

INCIDENTAL CAPTURE OF MARINE TURTLES BY COMMERCIAL FISHERIES IN THE WATERS OF THE ARCHIPELAGO OF GUADELOUPE

Eric Delcroix and Johan Chevalier

Association Kap'Natirel

The «Association Kap Natirel» is a sea turtle conservation project in Guadeloupe that was established in 1998. Information collected by this program over the years suggests that incidental capture in fisheries constitutes the primary threat to sea turtles in the region. In Guadeloupe, fishing is primarily artisanal, with no large commercial fleets of trawlers or longliners. Indeed, most fishing activities take place on 6-8m long boats with outboard motors. These boats are used to capture a wide diversity of target species using a variety of fishing gear. To date, there has been little information available on the impact of this fishery on bycatch. In order to increase our knowledge of fisheries and bycatch in Guadeloupe, we conducted interviews with nearly 80 fishermen in Guadeloupe in 2003. The specific objectives of our survey were the following: - Identify the different types of gear used - Characterize the fishing effort of each gear - Estimate the frequency of capture and mortality of marine turtles in different types of gear - Calculate the impact of bycatch of these fisheries for all of Guadeloupe We identified 14 different types of gear being fished throughout the archipelago. Of these, 6 have little or no incidental captures of marine turtles (e.g. hook and line, lobster pot), 3 have occasional incidental captures with little mortality (seine nets) and 5 have numerous incidental captures with relatively high levels of mortality (deepwater gillnets, bottom trammel nets). Based on data collected by the survey, we have been able to make the following conclusions about marine turtle mortality associated with certain fisheries: - The conch fishery (open from 01 October through 31 January) primarily uses large-mesh deepwater gillnets, locally called « folles ». Each conch fisher normally deploys between 500 and 1000m of net that is 2m high. During the season, each fisher on average will incidentally capture 1-3 turtles (Green turtle and Hawksbill) with nearly 100% mortality. - The lobster fishery, normally confined between the months of September and November, usually employs deepwater trammel nets. A single lobster fisher uses 200m of net that is 1.5m high. During the 3 months season, each fisher will capture 1-2 marine turtles (principally Hawksbill), with nearly 100% mortality. - The finfish fishery is active year-round and primarily uses deepwater trammel nets. A fisher normally uses about 1000m of net with a height of 4m and will capture on average 3-6 marine turtles (principally Hawksbill), with >50% mortality. These fishing gears are used throughout the Lesser Antilles. A promising step forward would be to investigate and test gear modifications in order to reduce bycatch of marine turtles and other species.

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DISTRIBUTION AND STOCK ORIGIN OF SEA TURTLES CAUGHT INCIDENTALLY IN THE CHILEAN LONGLINE FISHERY FOR SWORDFISH, 2001-2004

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Several studies have examined sea turtle bycatch in pelagic longline fisheries in the Atlantic and North Pacific. However there is a paucity of reliable data from the South Pacific. Furthermore, the data available consist of

estimates extrapolated from data collected from a small portion of the fleet (2-20%). These estimates typically have large errors associated due to the relatively low encounter rates between pelagic longline fishing gear and sea turtles in the Pacific. Here we present the first quantitative study to provide reliable information on sea turtle bycatch in the Southeastern Pacific based on observer data from the experimental commercial longline fishery targeting swordfish off the coast of Chile (in Zone 87 FAO). The observer program in this area had over 95% coverage of the fleet over a 4 year period (2001-2004). We present seasonal distribution and abundance of sea turtle bycatch relative to fishing effort, and present catch-per-unit-effort (CPUE) data. Interactions with sea turtles were generally rare, and primarily with leatherbacks and to a lesser extent, loggerheads. Seasonal distribution of leatherback bycatch reflects the seasonal patterns of fishing effort, and is not indicative of leatherback distribution in the absence of fisheries. In contrast, we found that loggerheads appear to be restricted to warmer northern waters throughout the year, even though fishing effort shifted south in later quarters. This finding suggests it may be possible to reduce loggerhead bycatch with time-area closures. Potential impacts on stocks are discussed in the light of genetic results indicating that the majority of leatherbacks are from the eastern Pacific nesting stock, and the loggerheads are from the Australian nesting stock.

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TRANS-ATLANTIC LEATHERBACK CONSERVATION – BUILDING SOLUTIONS THROUGH INTERNATIONAL COOPERATION

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Leatherback turtles spend most of their life at sea and can travel across the entire Atlantic Ocean. However, today's intensive fishing operations mean that the sea is no longer a safe place for turtles, and tens of thousands of leatherbacks are caught each year on fishing hooks or drown entangled in nets – a problem known as 'bycatch'. Bycatch is recognized as the most important, current threat to marine turtles. Leatherbacks are now listed as critically endangered by IUCN. Knowledge of when and where bycatch occurs is crucial to enable conservationists to implement solutions where they are needed most. Unfortunately, much of this information is currently lacking, particularly in the Central and Southern Atlantic. WWF, along with many partners, is therefore implementing a multinational study of Atlantic leatherback movements using satellite telemetry. This technology will allow scientists to identify 'hot-spots' of interaction between leatherbacks and fisheries. The project aims to tag at least 25 leatherbacks from Panama, Suriname, French Guiana, Uruguay and Gabon. Data from turtles tagged so far are mapped on the WWF website and up-dated weekly (see:www.panda.org/atlantic_leatherbacks). The information obtained from this study will help WWF and partners, along with governments, scientists and fisheries agencies, to design bycatch mitigation solutions. These may be: i) time-area closures, ii) fisheries "best practices" and iii) changes in fishing gear – such as the conversion from a 'J' shaped hook to large circle hooks on longlines, which can reduce marine turtle hookings significantly.

INTERACTION OF MARINE TURTLES WITH LONGLINE FISHERIES IN THE REGION OF ZARZIS (GULF OF GABES, TUNISIA)

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All species of marine turtles are threatened or endangered worldwide. Fishing activities constitute the main problem for these animals. In this study, we have attempted to assess the interaction between turtles and longline fisheries in the southern part of the Gulf of Gabes, which is considered an important wintering and foraging area for the loggerhead turtle, *Caretta caretta*, in the Mediterranean. The study took place from June through September in 2004 and 2005, corresponding to the fishing campaign targeting mainly sharks and groupers by pelagic and bottom longlines, respectively. A total 57 marine turtles were incidentally caught during 33 observed trips with surface longlines and 24 observed trips with bottom longlines. All marine turtles captured were *Caretta caretta*, the most common species in Tunisian waters. These results show a high interaction with catch rates estimated at 0.823 ± 0.385 turtles/1,000 hooks for surface longlines and at 0.278 ± 0.229 turtles/1,000 hooks for bottom longlines. Total catches are estimated at 486.486 ± 160.083 turtles/year for surface longlines and at 732.89 ± 439.27 turtles/year for bottom longlines. However, total direct mortality was null for the surface longlines and estimated at 91.61 ± 20.01 for the bottom longlines. Captures affected all size classes but results showed differences between fishing gear: turtles captured with surface longlines were larger (mean=57.49 cm SCL) than turtles captured by bottom longlines (mean=48.68 cm SCL). The most important catch selectivity factor seems to be the hook size: hooks used for bottom longlines are smaller than hooks used for surface longlines. Live turtles are often released with a hook in the mouth.

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POPUP ARCHIVAL TRANSMITTING (PAT) TAGS AND THEIR APPLICATION TO LOGGERHEAD SEA TURTLE SURVIVAL STUDIES

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Popup Archival Transmitting (PAT) tags are used in survival studies. They are designed to provide information on the fate of the turtle – more so than conventional satellite tags. We also conducted a feasibility study of using PAT tags for a full survival study of sea turtles. We deployed 39 tags on wild loggerhead turtles in the North Atlantic. Most had interacted with the pelagic longline fishery, but some were control turtles dip netted from the surface. We monitored the fate of these turtles for up to 1 year and assessed our ability to use this technology in sea turtle studies. Lastly, we combined the sea turtle data with data from PAT-tagged billfish and evaluated tag performance over 3 generations of tags by Wildlife Computers.

UNDERSTANDING THE THREAT: LOGGERHEAD (*CARETTA CARETTA*) SEA TURTLE INTERACTIONS WITH VIRGINIA (USA) WHELK POT FISHERY GEAR

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Virginia coastal waters and the Chesapeake Bay are an important foraging habitat for juvenile loggerhead sea turtles (*Caretta caretta*). The whelk pot fishery may pose a threat to the seasonal population of loggerheads in the Chesapeake Bay and the coastal waters. Loggerhead turtles appear to be attracted to whelk pots by both horseshoe crabs used as bait and targeted whelk species (*Busycotypus canaliculatus*). Upon interaction, these turtles may become entangled in the bridle or line and subsequently suffer serious injury or death. Several voluntary observer trips were conducted with a whelk pot fisherman, setting pots in the lower Chesapeake Bay and coastal waters. Catch data for each hauled pot and pot type were recorded, and any evidence of sea turtle interaction was documented. Preliminary results indicate that the three types of whelk pots resulted in similar CPUEs for whelks. There were no incidences of sea turtles caught as by-catch during these trips; however evidence of sea turtle interactions was present. Behavioral, in-tank, experiments were conducted in Galveston Texas using captive reared loggerhead sea turtles greater than 60cm CNT. Whelk pots were placed in a tank with a randomly chosen turtle, and the turtle was given 40 minutes to interact with the pot. Two bridle configurations were tested for each of the three pot types used. Preliminary results show that while sea turtles are attracted to whelk pots, they may not become entangled unless there is a lot of slack in the buoy line that leads from the pot to the surface of the water. Final, in-depth results will be presented at the symposium.

A CALL TO ARMS AGAINST THE CONSERVATION POLICE: A BRIEF HISTORY ON THE BATTLE TO EVALUATE HATCHLING "FITNESS" IN THE SOUTHEASTERN UNITED STATES

Michael G. Frick

Caretta Research Project, USA

Published and unpublished data from multi-year studies on hatchling fitness conducted in the southeastern United States are summarized to the 'state-of-our-knowledge'. I also discuss the views and opinions from policy makers and authors regarding hatchling fitness as it relates to nest relocation. And, I advocate the need to continue, some times intense, nest relocation practices - a position that has had insufficient representation in oral presentations during the past several symposia, while arguments against nest relocation have abounded (i.e. Mrsovsky's 'Maniacal Egg Relocators', my presentation is an adequate answer to his from last year's symposium).

BYCATCH MORTALITY OF LEATHERBACK TURTLES IN TRINIDAD'S ARTISANAL GILLNET FISHERY

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Although listed as critically endangered, leatherback turtles maintain a strong nesting population in Trinidad. Slaughter of nesting females and egg poaching have been reduced dramatically by active conservation efforts on key beaches. Trinidad supports an estimated population of 7,000 nesting females, which despite increased beach protection still face significant risk in the form of coastal gillnets. Incidental capture has previously been estimated between 1,000-3,000 turtles annually, with approximately 50% mortality. Incidental captures also impact fishers, who incur financial losses in reduced fishing time from net damage and associated repair costs. These fishers have expressed interest in collaborating with fishery managers to develop methods to minimize leatherback bycatch. During the 2005 nesting season, this pilot project used fisher participation in villages in the northeast region of Trinidad to attempt bycatch quantification. Fishers reported any leatherbacks caught in their nets, along with gear information and turtle status upon release. Beach stranding surveys were concurrently conducted in an attempt to link at-sea mortality reportings with strandings in order to calculate overall mortality. The project is evaluated for its capability for expansion to encompass a greater number of communities during the entire nesting season to gauge bycatch mortality. Challenges encountered during the project are also assessed to plan modifications of project methods to enhance fisher participation and confidence in results. The adaptations allow for quantification of the effects of planned bycatch reduction measures as they are implemented. This project demonstrates the value of incorporating fisher knowledge and participation in the process of fisheries management.

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INVESTIGATING THE EVIDENCE FOR INJURIOUS IN-WATER INTERACTIONS BETWEEN SCALLOP DREDGES AND SEA TURTLES

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Sea turtle interactions and injuries have been documented in the Atlantic sea scallop dredge fishery. Turtle injuries can occur while the dredge is fishing or when the catch is dumped on deck. On-deck injuries can be directly observed, whereas in-water injuries are more difficult to document. The purpose of this poster is to evaluate the evidence for injurious in-water and on-deck interactions between scallop dredges and sea turtles. Comments recorded by observers from the Northeast Fisheries Science Center's Fisheries Sampling Branch and from observers associated with industry gear trials allowed us to categorize injured turtles into three groups: those injured prior to the gear being brought on board, those injured on deck, and those where the origin of the injury was

unclear. We also examined the injury pattern observed in an experiment that placed turtle carcasses in the path of fishing dredges. We then used the information about injury patterns associated with documented in-water and on-deck sources to evaluate cases where injury sources are unknown. Although this evidence suggests that injurious in-water turtle-dredge interactions likely occur in this fishery, our ability to estimate the percentage of sea turtle injuries from dredge interactions in-water versus on-deck remains severely limited by the low sample sizes of injuries with known sources, variety of injury patterns, and frequency of unknown information in observer records. The National Marine Fisheries Service and the scallop industry are continuing to investigate ways to estimate the level of in-water injuries and develop methods to reduce in-water and on-deck injuries.

Order: 300 **Abstract ID:** 1858 **Type:** Poster **Subject:** Fisheries

STAVNIK AS A VALUABLE FISHING MEANS FOR THE PROTECTION OF MARINE ORGANISMS

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Stavnik is a trap-based gear type that originated from Russia and was brought to Albania 50 years ago. The word 'stavnik' means something fixed. The gear is composed of eight essential elements: the arm, two gates, the garden, falls baskets and two producer baskets. Stavnik gear is used in shallow waters (10-15m deep), near the shore. This means the gear is deployed primarily in lagoons and river mouths, where the basin is muddy with a little sand. However, stavnik also catches many species of fish, jellyfish, octopus, inkpot and very rarely sea mammals. Because of the configuration of the gear, non-target species caught are not damaged and can be returned to the sea alive and unharmed. Despite the low level of lethal discards, stavnik fishing (approximately 6 vessels) only represents about 15-20% of the total fish catch in Rodoni Bay, an important fishing area in Albania, where the majority of fishing in this area is trawling. Due to a lack of legal enforcement and low engine power of the vessels in Rodoni Bay, the trawl vessels fish in shallow water where bycatch is likely to be the highest. Stavnik gear may offer an important alternative to trawl gear in areas where economic constraints limit fishing to near shore, high bycatch, areas.

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RELATIVE IMPACT ASSESSMENT FOR LOGGERHEAD BYCATCH IN NORTHERN ADRIATIC FISHERIES

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Fisheries bycatch often affects particular size classes of turtles. Because of the late age at maturity for loggerhead turtles, the reproductive value of individual small juveniles, large juveniles and adults may vary by orders of

magnitude. The reproductive value, which is based on age, provides a relative measure of value for individuals, thereby allowing us to estimate the effects of different stressors based on the number of animals killed. Using reproductive value as a comparative index, we assessed the relative impact of trawl and gillnet fisheries operating in the northern Adriatic Sea on loggerhead populations. The northern Adriatic hosts one of the most important developmental habitats for the species in the Mediterranean and, at the same time, is one of the heaviest fished areas, resulting in high bycatch rates. Bottom trawl fisheries take fewer turtles than gillnets, and have a lower mortality rate, but affect individuals that are older than average and hence have higher reproductive values. Because of data limitations for vital rates and bycatch estimates, we looked at a distribution of potential impact for each fishery. Lessons learned include the need for relative, rather than absolute, impact assessment because of the sensitivity of adult reproductive value to parameters such as clutch frequency, sex ratio and remigration interval. We anticipate that our analysis will help managers prioritize needs for regulation and mitigation among different fisheries.

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PRELIMINARY ASSESSMENT OF SEA TURTLE INTERACTIONS WITH INDONESIAN FISHERIES

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In addition to the protection of leatherback turtle nesting beaches in Indonesia, WWF-Indonesia has started to address threats to leatherback turtles at sea. A preliminary assessment of interaction between turtles with Indonesian fishing fleets was carried out. Together with the Indonesian Institute for Science and Technology, the tuna fishing industry associations and a Fisheries Academy, a survey was conducted in five major fishing bases across the country using semi-structured interviews. Additionally, on-board observations were conducted for 3 months for some shrimp trawls and long-line boats operating in eastern Indonesia. In the Indonesian tuna long-line fisheries typically 1,100 - 2,000 hooks are set at depths of 60-75 m in one setting (shallow setting) targeting yellowfin, albacore, and big eye tuna, marlin and sword fish. Common types of by-catch included shark, rays and sea turtles. Most respondents (95 %) confirmed encountering at least one turtle/fishing trip. The main species of sea turtle hooked are Loggerheads (Indian and Pacific Oceans, and inner Indonesian seas), Leatherbacks (mostly in Pacific Ocean) and green turtles (small number, mostly in-shore within Indonesian waters). Turtles hooked in deeper waters (Indian and Pacific Ocean) are larger (CCL > 50 cm) as compared to those from within Indonesian waters (25-50 cm). Since 1980 supported by Presidential Decree no. 39/1980 commercial fishing with trawl was prohibited. The use of modified pocket bottom trawl gear for shrimp was later allowed (Presidential decree No. 85/1982) to operate in eastern Indonesia waters especially Arafura Sea (130 E to the north excluding shallow water of 10 m iso-depth). Under the Fisheries Decree (IK.010/S3.80.75/82), all shrimp trawlers are obliged to deploy TEDs. Trawl's mode of operation involves 10 minutes setting (depending on the water depth), 2 hours towing and around 15 minutes hauling. The fishing ground is often decided based on the fishing yield; higher catches in one location will allow longer fishing effort in the region. On-board observations from 12 shrimp trawl vessels operated in the Arafura sea revealed that sea turtles are often incidentally caught. During this observation period (52 days fishing trip on average), 2 to 33 sea turtles were encountered as by-catch. Interviews with boat crews also confirmed the findings that on average, 2-20 sea turtles were incidentally caught during the trawl operation times. The turtle species mostly subjected to by-catch were hawksbills (*Eretmochelys imbricata*) and greens (*Chelonia mydas*), whereas Loggerheads (*Caretta caretta*), Olive ridleys (*Lepidochelys olivacea*) and Leatherback turtles (*Dermochelys olivacea*) were also encountered occasionally. The data above shows that Arafura Sea and adjacent waters are important migratory grounds for sea turtles. The observation discovered that almost all incidentally caught sea turtles were released (98.5%), and only 1.5% was kept for consumption. The justification of the release was (1) awareness of the protection status of the turtles, (2) lack of space onboard to keep large animals, (3)

keeping turtle on the boat is considered taboo. Meanwhile, it is also obvious that the presence of fish by-catch induced direct incentive for boat crews, thus discourage the use of TEDs.

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SEA TURTLE BY-CATCH IN THE GREEK DRIFTING LONG LINE FISHERY

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The Greek drifting long-line fishing fleet is mainly targeting swordfish. Some vessels are also employed in the albacore fishery, limited to the Central Aegean Sea. Blue fin tuna is a secondary target species. The drifting long line fleet registered for the years 1999-2000 consists of 337 vessels (5-10m length = 113; 10-15m length = 172; 15-20 m length = 42; 20-25 m length = 7; >25 m length = 3). Those vessels belong to the small scale fishing fleet that have a special licence, valid for one year only, to operate drifting long lines. The fleets selected for the monitoring operate in the main sword fish fishing areas and cover the entire Aegean and the South Ionian Seas. The monitoring of turtle by-catch was conducted through on board observations during the summer fishing season of 1999 and 2000. A total of 256 on board observations were conducted, (134 in 1999 and 122 in 2000) on 17 vessels (7 in 1999, 10 in 2000). 4 of these vessels belong to the 5-10m category (3 in 1999, 1 in 2000). 8 belong to the 10-15m category (2 in 1999, 6 in 2000). 5 belong to the 15-20 m category (2 in 1999, 3 in 2000). The total effort of the drifting long line fleet expressed in units of 1000 hooks provided by the National data collection system for fishing activity was 16,238 in 1999 and 20,762 in 2000. Two species of sea turtle were captured during the observations, *Caretta caretta* (Total = 21, 5 in 1999, none dead and 16 in 2000, 1 dead) and *Dermochelys coriacea* (1, captured alive in 2000). The observed effort was 70,900 for loggerheads and 60,700 for leatherbacks. Total capture estimation is strongly dependent on estimated total effort for drifting long-lines, which is an external parameter provided by the National data collection system. Based on the total effort estimations, total captures per species are as follows: *Caretta Caretta*: total captures were estimated to be: 1,145.7 for 1999 and 5,474.5 for 2000, with 95% C.I. of total captures $1,145.7 \pm 131.789$ (1999) and $5,474.5 \pm 405.196$ (2000). *Dermochelys coriacea*: total captures were estimated at 0 for 1999 and 342.16 for 2000 with 95% C.I. of total captures being 0 (1999) and 342.16 ± 340.65 (2000). These estimations were based on the actual captures recorded which were: *Caretta caretta*: CPUE = 0.0706, 95% C.I. of CPUE = 0.0706 ± 8.1 (1999). CPUE = 0.2637, 95% C.I. of CPUE = 0.2637 ± 19.5 (2000). *Dermochelys coriacea*: CPUE = 0, 95% C.I. of CPUE = 0 (1999). CPUE = 0.0165, 95% C.I. of CPUE = 0.0165 ± 0.0322 (2000). The results show low direct mortality for loggerheads. This is probably due to the fact that the loggerhead turtles maintain enough power to raise the lines to the surface. A capture in a line with hook timer showed that a turtle was able to survive for 18 hours and 9 minutes.

THE MARINE TURTLE STRANDING NETWORK: PRELIMINARY DATA IN THE GULF OF GABES (TUNISIA)

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This study was carried out from June 2004 through July 2005 within the frame of the National Stranding Network launched in 2004. The study area encompasses the southeastern Tunisian coast, including the Gulf of Gabes, a foraging and wintering area for marine turtles in the Mediterranean. The Gulf of Gabes is also considered the most important fishing area in Tunisian waters for trawling and bottom and pelagic longlining. Three species of marine turtles frequent the Tunisian waters. The green turtle, *Chelonia mydas*, is rare; the leatherback turtle, *Dermochelys coriacea*, is regularly observed; and the loggerhead turtle, *Caretta caretta*, is very common and reproduces on some beaches. A total of 73 stranded turtles have been documented: 70 loggerhead turtles (96%) and 2 green turtles (2.7%). One turtle was too decomposed to identify accurately and most of the turtles were too decomposed to necropsy. Many cases of stranded leatherback turtles have been reported in the literature. However, this is the first report of a stranded green turtle. The first was a juvenile (SCCL=35.5), found in December 2005. The second was an adult female (SCCL=98.5), tagged on the nesting beach of Kazanli (Turkey) in July 2003. Loggerhead strandings occur frequently in summer and winter, mainly juveniles (51.42%) that have a SCCL between 50-70 cm. Causes of mortality were apparently due to fishing activity. Some of stranded turtles still had a hook in the mouth or in the digestive tract. In addition, we also identified the epibionts that occurred on the carapaces of some stranded turtles, as well as live turtles that were captured incidentally. This initial analysis indicates a variety of fauna and flora, including crustaceans (18 species), annelids (3 species), green algae (1 species), red algae (4 species), brown algae (2 species) and foraminifera (2 species). The esophagus, stomachs and intestinal tracts of five loggerhead sea turtles were removed during necropsies and found to contain benthic prey items; primarily crustaceans, molluscs, sponges, and ascideans. Some endoparasites (trematods and nematods) were also found in these samples.

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FISHERMEN'S ATTITUDES TOWARDS SEA TURTLES ON CRETE: AN ANALYSIS

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Crete is an island in the Mediterranean, hosting three important nesting sites for loggerhead sea turtles in Europe. Stranding data recorded in the period 1992-2002 have shown Crete to represent 10-15% of the total number of turtles reported dead or injured in Greece (Panagopoulos *et al.*, 2001), rendering it a "hot spot". In the course of a LIFE-Nature Project aiming to reduce mortality of turtles at sea, a collaborative programme with fishermen is implemented on the island since 2002. Project members visited a total of 24 fishing ports and, using information provided by the port authorities, met representatives of the local Coastal Fishermen's Associations. Their attitudes

towards sea turtles were recorded through private interviews and questionnaires. 18 of these Associations have signed a Memorandum of Understanding, concerning the issue of accidental capture of protected species. Moreover it was noted that very few fishermen would openly admit to killing turtles. According to information acquired over the original contacts and during follow-up meetings, three different types of fishermen's attitudes have been recorded: There is a group of fishermen which is tolerant and understanding towards sea turtles believing it to be closely connected with the plight of sea resources in general. They usually release sea turtles accidentally captured in their gear, which is reflected in the reduced number of strandings observed in their area. This group represents 20% of the fishermen approached, and is usually found in close proximity to nesting areas where ARCHELON has had a long-term presence. Another group of fishermen have an attitude of reserved understanding but they acknowledge the fact that turtles cause damage to fishing gears; thus they justify fellow fishermen who deliberately attack them. This group is the widest of those approached (50%). These fishermen find it difficult to grasp the necessity for the protection and conservation of natural resources. The last group of fishermen, representing 30% of those approached, attains an attitude of open hostility. This group does not even try to hide their hostility towards sea turtles. Some are explicit in their description of the best method to kill incidentally captured turtles, which was confirmed by relevant stranding reports. In spite of the above, a reduction in the number of strandings has been noted on Crete over the last years. Specifically, in the 12-month period May 2001-April 2002, before the initiation of the project, 33 strandings were recorded. During the next three 12-month periods, the number of strandings dropped to 17, 19 and 23 respectively. By the end of January 2006, 18 strandings have been recorded, indicating a more or less stabled reduced level. It has become obvious that ARCHELON should reinforce efforts to educate and collaborate with fishermen on Crete.

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STRANDED SEA TURTLES ALONG THE GREEK COASTLINE: AN INDICATOR OF FISHING INDUCED MORTALITY?

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Populations of sea turtles are considered to be under human threat worldwide. During the last years, conservation programs, carried out throughout the Mediterranean, focused mainly on protection of nesting beaches and on the monitoring of nesting populations. Knowledge on the main threats in the turtle's principal habitat, the sea, is limited. In this study we analyzed 386 stranded turtle records of the species *Caretta caretta* (Linnaeus, 1758) and *Chelonia mydas* (Linnaeus, 1758). Stranded turtles were recorded during the period 1990-2004, at the areas of Crete and Aegean Sea. The data for this study were provided by ARCHELON and were collected within the context of a LIFE-Nature project aiming to reduce mortality of *Caretta caretta* at sea. The data on fishing activity were derived from the Hellenic Fisheries Resource Management System. Each stranded turtle's point was located (longitude and latitude) and introduced in a database using ARC/INFO GIS. The database on strandings along with the database on fisheries activity were used for statistical analysis and additionally for the creation of GIS

maps, combining the two databases. Strandings were sorted into five categories according to their possible causes: fisheries, indirect human action, direct human action, natural & unknown causes. Three size categories were also created according to CCL (curved carapace length): 5-40cm (hatchlings, post hatchlings and small juveniles), 41-60cm (juveniles), 61-150cm (sub adult and adult turtles). During the period 1990-2004, there was a considerable increase in stranding reports with a significantly higher number in 2001. Most of the deaths were recorded during summer while lower numbers were reported during winter. The area with the highest percentage of strandings was Attiki (Aegean Sea), followed by Rethymno (Cretan Sea), an important nesting area. Furthermore, a high percentage (44%) of records concerned individuals that were sub adults and adults. The major cause of death was fisheries activity, in the cases where the cause of death could be determined. Results show a positive correlation between the number of stranded turtles and fishing effort of coastal fishery in the period 1995-2004 with an increase of fishing activity and turtle strandings in the summer. Moreover, GIS maps of combined stranded turtle locations and coastal fishery activity show areas of increased incidental mortality. The collection of stranding information is an essential and valuable tool in turtle conservation. However this study suggests that it is important to combine turtle strandings with turtle bycatch data for a possible determination of turtles' death causes and consequently for the development of effective management schemes.

Order: 307 **Abstract ID:** 1554 **Type:** Poster **Subject:** Fisheries

INTERACTIONS OF GILLNET FISHERY WITH LOGGERHEAD SEA TURTLES *CARETTA CARETTA* IN THE NORTHERN ADRIATIC SEA

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We analyzed bycatch of loggerhead turtles in N Adriatic Sea based upon (i) interviews with professional gillnet fishermen in two selected regions in Croatia and Slovenia in 2004, and (ii) data on incidental capture of 92 turtles in gillnets in 2000-2005. We calculated Catch Per Unit Effort (CPUE) as the number of turtles/vessel/year (mean: 2.81, SD: 3.14) and the number of turtles/km of gillnet (mean: 1.11, SD: 1.64). When grouped together, CPUE of trammel nets (3-layers) was 4 folds higher than 1-layer gill nets (1.34 and 0.33 turtles/km, respectively), however these values not differ statistically (Mann-Whitney $U = 152.0$, $p=0.07$). Gillnet bycatch was associated with the warm period of year (May-October, Chi-sq.= 4.33, $p = 0.03$, d.f. = 1). From 234 vessels registered for gillnetting in N Adriatic (Croatia and Slovenia), we estimated a minimum of 657 loggerhead captures/year, with direct mortality of 54.9%. If multifunctional vessels are also considered ($N = 1,203$), gillnet bycatch may be as high as 4,038 captures/year, suggesting a significant conservation concern for loggerheads in N. Adriatic.

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GENETIC STOCK DETERMINATION OF MARINE TURTLE BY-CATCH FROM THE CALIFORNIA-BASED PELAGIC LONGLINE FISHERY AND CALIFORNIA/OREGON DRIFT GILLNET FISHERY

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Genetic samples are routinely taken from marine turtle interactions in both the California-based Pelagic Longline Fishery (CA LL) and California/Oregon Drift Gillnet Fishery (CA/OR DGN) observer programs. Genetic analysis using mitochondrial DNA (mtDNA) was performed on 47 sea turtle samples collected between 2002 and 2004 for the CA LL and 9 samples collected between 1997 and 1999 for the CA/OR DGN. A majority of the samples from both fisheries were made up of loggerhead turtles (43 of the CA LL and 5 of the CA/OR DGN). Two additional animals captured in the CA LL were leatherbacks. One green turtle, 2 leatherbacks and 1 olive ridley comprised the remaining animals caught in the CA/OR DGN. Stock origin of the samples collected in each of the fisheries was determined by comparing the mtDNA control region sequences with known haplotypes from key Pacific nesting beaches. All of the loggerheads from both fisheries were from the Japan nesting stock reinforcing previous findings that loggerheads found across various habitats in the North Pacific, in all life stages, are part of the Japanese nesting stock (Bowen *et al.* 1995 and Hatase *et al.* 2002). Each of the 5 leatherbacks were of Western Pacific origin, suggesting that leatherbacks migrate through and forage in areas of the fisheries in the North Pacific (Benson *et al.* 2004). The green turtle and the olive ridley from the CA/OR DNG were of Eastern Pacific origin implying that these animals have a higher propensity to journey away from coastal foraging areas to more pelagic areas (LeRoux *et al.* 2004). These results further our understanding of marine turtle migration and stock structure of foraging assemblages in the Pacific, however further sampling of nesting beaches is needed to continue to expand the rookery database, especially in the Western Pacific and Indian Ocean. Sampling from foraging areas is also needed in order to further expand our understanding of marine turtle stock structure and habitat use in the Pacific. Continued sampling from fisheries interactions is also essential to determine which stocks are affected by fishing efforts.

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CONSIDERING THE RELATIVE IMPACT OF FISHERIES INTERACTIONS IN THE ATLANTIC AND THE PACIFIC: ACCOUNTING FOR DIVERGENT POPULATION TRENDS

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Beach surveys indicate dramatic declines for nesting Pacific leatherback and loggerhead turtles. However, Atlantic nesting populations of the same species appear to be stable and, in some areas, increasing. Direct and delayed mortality from interactions with fishing gear have been identified as one of the factors likely to be contributing to observed declines. Using the data available, we consider whether ocean-wide observations of fisheries interactions support this hypothesis. Incorporating life history attributes and recruitment patterns of these affected species, we take a large-scale comparative approach to map known past and present bycatch hotspots and consider the relative impact these interactions are likely to have. Despite data deficiencies, a comparative analysis of known fisheries interactions for the two species in the two ocean basins is a critical step to understand the relative impact of bycatch on these species. Here, we present maps of the most comprehensive spatial and temporal representation of known bycatch events across three gear types – longlines, trawls and gillnets. These maps graphically represent the magnitude of bycatch (as a categorical variable), the life stage affected (and highlight the number of records for which life stage is not known), and illustrate the temporal and spatial overlap of bycatch with known turtle distribution. This exercise is a first step towards evaluating the hypothesis “Is fisheries bycatch a significant factor affecting population trends in the Pacific and Atlantic”. Although our analysis is primarily qualitative, we show that this synthetic approach, integrating all available data across gears and ocean basin, is an essential component in addressing data gaps in our understanding of potential fisheries effects and our ability to evaluate the fisheries bycatch hypothesis.

TRINIDAD’S LEATHERBACKS: THE NET COST?

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Trinidad’s north and east coasts support a large population of nesting leatherbacks, possibly the third largest remaining in the Atlantic Ocean. Incidental entanglement in the local gillnet fishery has been identified as the most serious threat faced by leatherbacks in Trinidad’s coastal waters. Here we present a multifaceted approach to assess the magnitude of the nesting population size and its current status, given the perceived high levels of fishing pressure. Intensive monitoring carried out on the north coast nesting beaches within the context of a community participation project during 2000 - 2004 has provided a reliable mean population size of 2,728 (1,949 - 3,410) nesting females per year, contributing to an estimated annual nesting population of approximately 4,300 nesting females for the whole of Trinidad. This figure is much higher than previous estimates, especially for the

understudied north coast. Evaluation of past data suggests a significant increase in population size over the last 30 years. It has been proposed that conservation effort on several east coast beaches is the reason for the increase in numbers of nesting leatherbacks in that area. However, we outline why this is unlikely for the north coast. Although the leatherbacks nesting on both coastlines are considered as one population, preliminary tagging data suggests that the females exhibit some beach fidelity behaviour and prefer to nest on the beaches of one particular coast. To quantify the level of leatherback capture and mortality as a consequence of gillnets we used leatherback stranding data and questionnaire-based surveys (n = 36). Interviews concluded that the majority of leatherback deaths are caused by gillnet fishermen, frustrated by damaged nets and catch as a result of leatherback entanglement. Few leatherbacks drown due to regular net tending. We estimate that with approximately 5,250 leatherback captures annually, and a mortality rate of 26 - 30 %, between 1,365 and 1,575 leatherbacks die in gillnets each year on the north coast. The captured leatherbacks include both female and male individuals although the sex ratio is not known. However, considering the nesting female population size on the north coast, this level of adult mortality is regarded as highly unsustainable. The possible means of mitigating the incidental capture of leatherbacks in Trinidad are discussed, and include a combination of spatial and temporal closures and alternative fishing methods. It is essential to work in close partnership with the fishing industry on the development and organization of a successful management plan. Fishing is the primary source of income for the communities on the north coast and it is in their interest to solve the turtle bycatch problem, since damage to nets is costly. It is clear that the leatherback rookery in Trinidad is important in global terms, and it is encouraging to discover another stable, possibly increasing leatherback population in the Atlantic. However, if the high level of incidental capture in the gillnet fishery continues, this may not be the case for long.

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ANALYSIS OF STRANDED LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN NORTH AND SOUTH CAROLINA USING MITOCHONDRIAL DNA AND STRANDING RECORDS

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Loggerhead sea turtles (*Caretta caretta*) along the southeastern coast of the United States are divided into two genetically distinct nesting units: a Northern subpopulation (NEFL-NC) and a larger South Florida subpopulation (SFL). Mixed stock analysis indicates a disproportionately high contribution from the NEFL-NC nesting subpopulation to the seasonal juvenile feeding aggregate in coastal waters from North Carolina to northern Florida, suggesting anthropogenic hazards (i.e. commercial fishing, recreational boating, etc.) on these feeding grounds may pose a greater threat to the smaller NEFL-NC subpopulation. This study aims to determine if loggerhead strandings in North and South Carolina are representative of the seasonal juvenile feeding aggregate off the southeast Atlantic coast of the United States. Identifying the proportion of the NEFL-NC subpopulation represented in North and South Carolina strandings is critical to the development of future protection measures. The mitochondrial DNA control region was sequenced from biopsies of seventy stranded loggerheads in North and South Carolina. Haplotype frequencies from North Carolina strandings were compared to those in South Carolina and no significant

difference ($p=0.696$) was found between states. Data were subsequently pooled and compared to offshore data from live captured loggerheads to test for homogeneity. Stranding haplotype frequencies were not significantly different ($p=0.736$) from that of the offshore data, indicating loggerhead strandings in North and South Carolina are representative of the seasonal juvenile offshore population. Additionally, loggerhead stranding records ($n=255$) from May, June, and July of 2000-2003 in South Carolina were compared to live-capture data ($n=284$) from the same time period and a significant difference in size distribution was observed in 2003 ($p<0.05$). Differences were evident in the juvenile (< 90 cm CCL, $p<0.05$) size category. Anecdotally, in 2003 the size of openings on Turtle Excluder Devices (TEDs) on shrimp trawlers off the southeast Atlantic coast of the United States were increased in an effort to reduce leatherback sea turtle (*Dermochelys coriacea*) and adult loggerhead mortality. South Carolina stranding records from 2000-2003 were examined to determine if these changes had an effect on adult loggerhead strandings. No difference was observed in total adult (>90 cm CCL) stranding numbers across years nor were differences observed in yearly adult size distributions. However, these data need to be taken with caution due to sample size limitations. Further investigation is necessary to explain effects of the TED size increase and the observed juvenile size distribution differences.

Order: 312 **Abstract ID:** 1815 **Type:** Oral **Subject:** Fisheries

BYCATCH ASSESSMENT OF SEA TURTLES BY A COASTAL BOTTOM TRAWL FISHERY ON THE RIO DE LA PLATA ESTUARY, URUGUAY

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The coastal bottom trawl fishery that operates in the Río de la Plata estuary and adjacent marine coastal waters usually interacts with green (*Chelonia mydas*), loggerhead (*Caretta caretta*), and leatherback turtles (*Dermochelys coriacea*). From April 2002 to June 2005, 12 fishing vessels participating on Karumbé's "Onboard Tagging and Data Collection Programme" collected information about incidentally captured sea turtles. Biological aspects, spatial and temporal distribution of the captures, and mortality were analyzed from all the incidentally captured turtles ($n=126$). The most frequently caught species was *C. caretta* ($n=94$; mean CCL=73.5 cm); followed by *C. mydas* ($n=21$; mean CCL=44.2 cm), *D. coriacea* ($n=10$; mean CCL=144.5 cm) and 1 adult *Lepidochelys olivacea* (CCL=61.0 cm), being the southernmost record in the South Western Atlantic Ocean. Only one of all the incidental captures recorded, occurred during winter. Mortality reached 35.7% ($n=45$), and during the last year we determined that at least 25% of the discarded dead turtles are recaptured by the stranding networks. Of the alive turtles, 93.8% were tagged. Two immature loggerheads previously tagged by this Programme were recaptured in the area, together with two recaptures of nesting loggerheads from Brazil. The species and length frequencies differed substantially from the ones observed on turtles incidentally captured by artisanal coastal bottom-set gillnets and pelagic longliners. The presence of immature and adults of different species during most of the year using the Rio de la Plata estuary, which is very far from the nesting habitats, suggests that this might be an important area for sea turtles.

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STRANDINGS AND SEA TURTLE FISHERIES INTERACTIONS ALONG THE COAST OF RIO GRANDE DO SUL STATE, BRAZIL

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Sea turtle stranding was studied in southern Brazil through 250 samplings on the coast of Rio Grande do Sul state, between Arroio Chuí (33°44'S; 053°22'W) and Torres (29°20'S; 049°44'W). From January 1995 to October 2004, a total of 30,837 km were searched for stranded turtles. During the study 994 sea turtles were found: 496 *Caretta caretta*, 347 *Chelonia mydas*, 106 *Dermochelys coriacea*, 9 *Lepidochelys olivacea*, and 36 unidentified sea turtles. Only 33 turtles (3.3%) were found alive, usually debilitated or entangled in fishing gear. Inter-year comparison, corrected for sampling effort differences (turtles km⁻¹), show that 2004 was the year with the highest number of sea turtles stranded, accounting for 35% of the total number of turtles. Increasing stranding rates in relation to preceding years could be related to an increase on the number of turtles migrating to southern Brazil and/or increasing levels of sea turtle-fisheries interaction during this year. The Loggerhead turtle was the most abundant species for seven out of ten years, with mean Curved Carapace Length – CCL=74.3 cm. Statistical analysis shows that this mean is significantly higher than the mean size of Loggerheads incidentally caught by pelagic longline fishery in southern Brazil (mean CCL=58.6 cm; Mann-Whitney, U=3049.5, p<0.0001), sampled along six fishing cruises targeting tuna, swordfish and sharks. This result strongly suggested that stranded Loggerheads are interacting with other fisheries, possibly bottom trawling and gillnet, with longline representing a minor mortality factor for the Loggerheads found on the beach. Green, Leatherback and Olive Ridley had a mean CCL of 40.5 cm, 136.7 cm and 67.0 cm, respectively. In spite of Loggerhead, Green and Leatherback being recorded during all months, highest stranding rates occurred during warm months, from October to March. This seasonal pattern is related to an increase of the sea surface temperature during summer months, when the warm Brazilian Current reaches the study area and has a strong influence on sea turtle migration and occurrence. Stranding rates were positively correlated with bottom trawling fishing effort (Spearman correlation, rs=0.83, p= 0.001). However, external evidences indicating fishery related mortality, such as cuts on the carapace produced by sharp objects, entanglement in fishing lines, hooks and nets, as well as a fresh Green turtle with meat and carapace removed close to fishing discharges, was observed in only 3.4% of turtles. This result is clearly a sub estimative of sea turtle mortality caused by fishery. On the other hand, high number of sea turtles on Rio Grande do Sul coast confirm the importance of the area as feeding and developmental ground for juvenile Green turtles, and a feeding ground for immature and adult Loggerhead and Leatherback turtles. These characteristics associated with an intense and diverse fishery along the Rio Grande do Sul coast, indicated that research on fisheries potentially dangerous for sea turtles are urgently required, in order to subsidize mitigation measures and conservation practices effective for the conservation of these endangered reptiles.

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THE MARINE TURTLE RESCUE CENTER OF LINOSA: 11 YEARS OF ACTIVITIES

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Starting in 1994, a program on Loggerhead sea turtle (*Caretta caretta*) conservation was conducted on the island of Linosa (Pelagic Islands, south of Sicily) by Hydrosphera Association, and, subsequently, in collaboration with CTS. Since 1995 a Rehabilitation Center has been active on the island, sustained since 1999 by EU Life-Nature Project NAT/IT/006271 and now part of the EU Life-Nature Project LIFE03/NAT/IT/00163 “DeI.Ta”. Linosa is known as an important nesting site in Italy, and one of the main objectives is the monitoring of the beach and its environmental parameters, mainly sand temperature. During summer, Linosa is even haunted by a small longline swordfish fleet coming in particular from the southern coast of Sicily. Longline fishing is considered a very important cause of mortality of sea turtles in the Mediterranean area. In these years more than 600 sea turtles have been rescued; the main activity of the Centre thus, is the rehabilitation of specimens found hooked or entangled in fishing gear. In this presentation, some of the most significant data concerning loggerhead bycatch and rehabilitation in the study area are reported and discussed.

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REGULATION OF SEA TURTLE BYCATCH IN HAWAIIAN SWORDFISH LONGLINE FISHERY

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The swordfish longline fishery in Hawaii has been regulated for sea turtle interactions since the fishery reopened in April 2004. The fishery, which was shut down in 2001 due to excessive sea turtle bycatch, is operating under a unique set of regulations. The new regulations include three caps: a cap on loggerhead interactions (17), a cap on leatherback interactions (16), and an effort cap of half of the historical effort. The fishery closes for the remainder of the calendar year when one of the three caps is reached. Other regulations include new circle hooks and mackerel bait for vessels and 100% observer coverage on every swordfish longline trip. The other longline fleet in the fishery, which targets tuna, is subject to 20-25% observer coverage. The swordfish effort is allocated evenly amongst longliners that request certificates. The fishermen are free to trade and sell the effort allocation within the fishery. This fishery is being followed closely by regulators. If the fishery is successful, similar regulatory schemes could be implemented in other fisheries that are catching excessive sea turtles. We were awarded a NMFS contract that gives us access to the industry data of the fishery. We will report our findings for the first two years and will present results that show how various regulatory schemes impact both the profitability of the fishery and sea turtle interaction rates. Insight into the successfulness of replicating this regulatory scheme in other fisheries impacted by sea turtle bycatch will also be provided.

IMMATURE LEATHERBACK MORTALITY IN COASTAL GILLNET FISHERIES OFF SAN ANDRES, SOUTHERN PERU

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Fisheries bycatch is a cause of decline for the critically endangered leatherback turtle (*Dermochelys coriacea*). Off of San Andrés (13° 45' S, 76° 13' W), southern Peru, leatherbacks are vulnerable to entanglement in coastal multifilament nylon drift gillnets (140 m x 7.2 m., each net) set for small sharks and rays with stretched mesh sizes up to 20cm. At this locality, entanglement turns into mortality because fishermen sell sea turtle meat. Approximately 8 to 12 boats operate 8-10 nets year round, but the number could increase to 30 during the austral summer. Historic data suggest a mortality of 200 leatherbacks captured / year. During the period of 1999 through 2005 we carried out beach surveys at San Andrés Port and the surrounding areas, recording the remains of a minimum of 15 captured leatherbacks. Curved carapace length (CCL) ranged from 88 cm to 132 cm. (n= 10, mean = 109.27 ± 14.4 cm.). A comparison with the mean CCL (144.9 cm) of nesting females from Michoacán, Mexico indicated that all individuals examined at San Andrés were immature. Similar results were obtained in 1979, when 7 recorded leatherbacks ranged from 116.8 to 121.9 cm CCL. Therefore, leatherbacks recorded in the study area are mostly large juveniles approaching the coastal waters off San Andrés mainly from December through April, when sea surface temperature oscillates between 18.7°C and 23°C. Conservation efforts focusing on the whole life cycle of the species, including assessing the impact of coastal gillnet fisheries, would contribute to the recovery of the Pacific leatherback population.

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HOOK, LINE AND BYCATCH WORKSHOP SETTING THE AGENDA FOR MITIGATION OF BYCATCH IN LONGLINE FISHERIES

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During the IUCN World Conservation Congress in 2004, we identified the need for a forum where bycatch issues could be considered at an ecological, multi-species level rather than on a case-by-case basis. We recognized that several bycatch reduction measures are already in place, but noted that there was insufficient communication and collaboration among the various species groups impacted by longline fisheries, and that opportunities might exist for cross-group information sharing and collaboration. The workshop was intended as a forum to: 1. Exchange knowledge on bycatch problems and mitigation techniques among four key species groups (turtles,

seabirds, cetaceans, sharks); 2. Identify conflicts/mutual benefits of mitigation gears and fishing strategies; 3. Share knowledge on the spatial-temporal overlap of distributions of these species; 4. Identify needs, priorities and opportunities for collaborative mitigation research; and, 5. Define a priority global agenda to create a significant and measurable reduction in longline bycatch. The workshop brought together marine resource specialists composed of managers and policy makers, scientists, NGOs, IGOs, industry representatives and fishers, from 14 countries and sharing a wealth of global experience, who worked to identify, develop, and recommend applicable and integrated solutions to reduce interactions of birds, mammals, turtles and sharks with pelagic longline fisheries. The technical report includes commonalities, synergies and conflicts between species groups and mitigation measures for target (and non-target) species, through the use of a comparative matrix, and identifies criteria for evaluating trade-offs in the application of bycatch mitigation methods. It highlights the potential for the use of risk-based methods for assessing i) bycatch reduction priorities and ii) multi-species effects of bycatch reduction methods and strategies, and suggests means of monitoring and evaluating mitigation efforts with respect to performance indicators and adaptive management approaches, including timing considerations. The outcomes highlight research priorities including filling data gaps, and promising new mitigation methods and strategies aimed at raising awareness of multi-species data needs, to encourage governments and industry to collect standardized multi-species data in all observer programs. The Technical Report is envisioned to form the basis of a 'roadmap' or plan of action with regard to multi-species bycatch mitigation. A second key outcome was a preliminary mathematical model based on existing mitigation measures and intended to assist fisheries managers in decision making. The model is a process through which decision-makers can determine the top priorities for mitigation, both in terms of the bycatch species and the mitigation options, and combinations thereof at a multi-species (ecological) level. The model requires an up front determination of the species being impacted by a given fishery, which are then assigned 'conservation values' or some form of risk assessment weighting based on existing criteria. Based on the groups of species being impacted, a list of all potential bycatch mitigation measures is then assembled, and a matrix drawn up of the potential positive or negative impact of any given measure on each species or species group. A mathematical modeling process then assigns weights to species value, factors these against mitigation measures, and prioritizes the top mitigation measures.

Order: 318 **Abstract ID:** 1579 **Type:** Poster **Subject:** Fisheries

BOTTOM TRAWLING IS A THREAT FOR THE CONSERVATION OF LOGGERHEAD SEA TURTLES OFF NORTH-EASTERN SPAIN

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A survey, which included questionnaires for fishermen and the placement of observers on board fishing vessels, was conducted to assess turtle by-catch off North-eastern Spain. The annual fishing effort carried out per vessel was recorded as the number of months the vessel operated with a considered fishing gear. This information revealed that bottom trawling and trammel nets were the most widely used fishing gears, as they generated 3,783.63 and 3,548.95 fishing months on a yearly basis respectively, or 33% and 31% of the total fishing effort of the whole fleet (11,236.70 fishing months). Other major fishing gears were purse-seines (1,163.14 fishing months) bottom longlines (783,93 fishing months), traps (450.64 fishing months), and drifting longlines (107.75 fishing months). The fishermen's perception was that the abundance of loggerhead sea turtles have declined and that fishing was involved in such a decline. The observer reports indicated that the figures produced by the interviewees for catch per unit effort (CPUE: number of turtles by-caught monthly per vessel) were reliable. Therefore, on the basis of these figures (CPUE_{bottom trawling}= 0.07 turtles monthly per vessel, CPUE_{drifting longlines}= 1.2 turtles monthly

per vessel, CPUE_{bottom longlines}= 0.01 turtles monthly per vessel, and CPUE_{trammel nets}= 0.02 turtles monthly) we calculated the number of turtles by-caught annually by the whole fleet. Most turtles were by-caught by bottom trawlers (270; 95% CI: 406-134) or in drifting longlines (130; 95% CI: 222-38), whereas the contribution of trammel nets to the total number of by-caught turtles was much lower (65; 95% CI: 95-35). Turtle by-catch with other fishing gears was negligible. Ivlev's electivity index revealed that turtles were by-caught off Ebro Delta by bottom trawlers more often than expected on the basis of the distribution of the fishing effort. This is probably because the continental shelf off Ebro Delta is extremely wide and bottom trawlers operate mainly in shallow areas. Conversely, turtle by-catch was lower than expected where the continental shelf narrows, probably because there bottom trawlers operate mainly on the continental slope.

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SEPARATING SEA TURTLES FROM FISHERIES: OCEANOGRAPHIC HABITAT MODELS OF SEA TURTLES ENCOUNTERED IN THE EASTERN TROPICAL PACIFIC TUNA FISHERY

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Relatively little is known about the habitat preferences of pelagic sea turtles. Reliable habitat models may allow fisheries to minimize turtle interactions while maintaining catches of target species. Satellite telemetry studies suggest that turtles associate with dynamic oceanographic features such as sea surface temperature and chlorophyll density fronts and use oceanic currents during migratory movements. These studies tracked small numbers of turtles typically for weeks or months. We developed an alternative approach that involved point sightings of thousands of turtles encountered during 15 years of purse seine fishing operations in the eastern tropical Pacific tuna fishery. We analyzed sightings of five turtle species logged by Inter-American Tropical Tuna Commission observers during 162,376 purse seine sets between 1990-2004: olive ridley (n=9,055), green (n=2,463), loggerhead (n=224), hawksbill (n=106) and leatherback (n=37). Using a Geographic Information System and non-parametric multivariate statistics, we modeled turtle habitat by species, size class and sex in terms of remotely-sensed oceanographic parameters, including sea surface temperature, sea surface chlorophyll density, sea surface height gradient, bathymetry and distances to sea surface temperature and chlorophyll fronts, shore, and locations of seamounts inferred from bathymetry. We also considered fishery parameters such as the set type (dolphin, floating object, or tuna school) and presence of other bycatch. We will present preliminary results from the modeling exercise and discuss implications for fishery managers.

TESTING MACKEREL BAIT AS A POSSIBLE BYCATCH MITIGATION MEASURE FOR THE SPANISH MEDITERRANEAN SWORDFISH LONGLINING FLEET

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Bycatch estimates of over 20,000 loggerhead turtles per year by the Spanish Mediterranean swordfish longlining fleet have focused a lot of attention on the southwestern Mediterranean fishing grounds. In order to establish measures to reduce bycatch rates and turtle mortality, researchers, scientists and fishery authorities are working together within the context of an EC LIFE Nature project. During August 2005, 15 experimental longline sets were carried out onboard a typical Spanish Mediterranean longlining vessel, the “Hilario Paredes” from the port of Cartagena. Apart from the experimental gear design, consisting of a homogenous longline of 810 hooks split in 40 hook segments, the fishing operation was developed as would have normally been done by the fishermen. Results presented show a first test focusing on bait, comparing the two main types used by this fishing fleet. Mackerel (*Scomber* sp.) was tested using squid bait (*Illex* sp.) as control. In 15 sets, a total of 38 loggerhead turtles were caught. Of these, 27 were caught on control bait and 11 on hooks with mackerel. Swordfish catches totaling 74 fish (1900 Kg) showed no significant differences between test and control baits. The study includes the analysis of catches by hook location with respect to buoys and segments as well as location and severity of hooking on turtles. Data from sightings from the longliner (n=79) and from a visual survey carried out from a research ship onsite during the same period shows a concentration of loggerhead turtles along the Mazarron Escarpment and its extension south of the balearic islands. The implications of this first bycatch mitigation measure test in the context of the regional loggerhead turtle conservation plan are discussed.

SHARK LONGLINE FISHERY AND SEA TURTLES IN PERUVIAN WATERS

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In the Peruvian Economic Exclusive Zone and its adjacent waters, pelagic longline fisheries occur. One of these fisheries target mainly the shortfin mako *Isurus oxyrinchus*, the blue shark *Prionace glauca* and to a lesser extent the smooth hammerhead *Sphyrna zygaena* and thresher shark *Alopias vulpinus*. This fishery occurs principally

during autumn and winter (from March to August) and is comprised of the biggest artisanal longline vessels and a few industrial ones. The interaction between this longline fishery and sea turtles was evaluated during ten fishing trips with on-board observers. These observations were conducted from March to July of 2003, 2004 and 2005. Preliminary results show that forty-five sea turtles were captured during 65 sets observed resulting in 0.294 individuals per 1000 hooks. This bycatch rate is highly variable per set (st. dev. 0.432) and might be related to the fishing area. All the individuals were released alive. The most frequent species captured were loggerhead turtles *Caretta caretta* (59%), followed by green turtles *Chelonia mydas* (31%). Leatherback turtles *Dermochelys coriacea* and olive ridley turtles *Lepidochelys olivacea* were also captured but at a low frequency (5% each). The sea turtles were found mainly lightly hooked in the mouth (30%) and entangled in the gangions and main line (28%). Deep ingestions of the hooks were only found among loggerhead turtles, greens got either hooked in the mouth or entangled. All olive ridleys were just entangled and one leatherback bit the hook while the other got entangled in the gear. We also conducted generalized linear regression models to determine the relation between sea turtles bycatch rate and sea surface temperature among sets.

Order: 322 **Abstract ID:** 1620 **Type:** Poster **Subject:** Fisheries

ANALYSIS OF THE CLANDESTINE CAPTURE OF TURTLES BY FISHERMEN OF LA REFORMA, ANGOSTURA, MEXICO

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The illicit capture of marine turtles, mainly of the species: olive ridley (*Lepidochelys olivacea*) and black turtle (*Chelonia agassizi*), has always been constant and forceful, mainly in the fishing communities of the state. The existence of a state prohibition since 1983 and a national one since 1990 has not worked as a legal instrument to protect and preserve these species from the threat of extinction. On the other hand, it's difficult to make studies about the effect of clandestine fishery over species populations on their way to recovery. A way to try this type of studies is the analysis of carapaces in waste. This work presents preliminary results of a study which we try to do in all the state. It consists of locating and identifying the species, and measuring the width, length and curve of the caparace. In this occasion we display the collected data of shells located in two waste lands of the fishing community of La Reforma, Sinaola, Mexico.

Order: 323 **Abstract ID:** 1376 **Type:** Poster **Subject:** Fisheries

LOGGERHEADS AND SHRIMP TRAWLERS: NEW MANAGEMENT IDEAS FOR AN OLD PROBLEM

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Population models show high survival among large size classes as essential to conserving and restoring sea turtle populations. Our research investigated ways to reduce interactions between shrimp trawlers and adult female

loggerhead turtles in Georgia waters to increase survival rates for that population life stage. Female loggerheads (n=22) were outfitted with satellite, VHF, and sonic transmitters during nesting attempts on Georgia beaches in 2004 and 2005. Locations were acquired remotely with satellite transmitters, and manually using VHF and sonic technologies. Remote and manual data sets were compiled and censored prior to analysis using a 2-hour minimum time interval between locations and outlier analysis to reduce autocorrelation and error while maintaining sample size for each turtle. Aerial surveys of shrimp trawlers were conducted over a seven year period (1999-2005) during summer months (May-August), which coincided with the loggerhead nesting season. Shrimp trawl activity around marked turtles was determined by calculating mean number of trawlers observed per flight within 95% fixed kernel home ranges of each turtle divided by total area (km²) of the respective home range. Several stochastic spatially explicit closure models and models of varying levels of randomized trawler reduction (10%, 30%, 50%, 70%, and 90%) were imposed upon the trawler location data as possible management scenarios within state waters. Spatial closure models took the form of Single Large or Several Small (SLOSS) closures. Trawler locations within closures were randomly redistributed multiple times (n=10) outside closure boundaries based on three competing hypotheses and re-entered into the trawler location database. Trawler reduction scenarios were conducted by randomly eliminating trawler locations from the database multiple times (n=10) at the varying levels. Trawler activity within turtle home ranges were recalculated for each of the 10 random redistributions and 10 random reductions under each management scenario yielding mean predicted trawler activity levels for each turtle under each scenario. Pre and post management action trawler activity levels were analyzed using a pair-wise comparison with ANOVA under a nested design. Spatial closure models (n=5) yielded no detectable decrease in trawler activity within turtle home ranges. Only trawler reductions of 50% or greater produced a significant decrease in trawler activity around turtles. Marked turtles, on average between years, used Georgia state waters (0-3 miles from shore) more frequently than federal waters (78.7% and 19.2% respectively). Similarly, shrimp trawlers, on average between years, were also located in Georgia waters more frequently than federal waters (87.3% and 12.7% respectively). Therefore the burden of in-water management for nesting female loggerheads falls largely on state agencies. Given our data, spatial closures alone do not appear effective management options for reducing shrimp trawler/adult female loggerhead turtle interactions in Georgia. Turtles within the closure boundaries received benefits from lessened trawler activity, but other turtles located outside the closure boundary experienced higher trawler activity producing negligible overall population benefit. Randomized reductions in trawlers showed consistent benefits to all marked turtles. Based on our results, we recommend that natural resource managers consider options that effectively limit the number of shrimp trawlers operating each day.

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Order: 324 **Abstract ID:** 1421 **Type:** Oral **Subject:** Fisheries

AN OVERVIEW OF THE INTRODUCTION OF TURTLE EXCLUDER DEVICES IN SHRIMP TRAWL NETS IN NIGERIA

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In Nigeria, over 250 licensed industrial shrimp trawlers catch marine shrimps which are exported to earn foreign currency worth about US\$ 65 million annually. Demersal shrimp trawling invariably and inadvertently capture the endangered sea turtles as incidental catch to shrimps because they stay in close proximity to each other in the marine environment. The Turtle Excluder Device (TED) is a conservation strategy to exclude the endangered sea turtles from being captured while the shrimps enter the codend of the trawl net. In 1996 TED became a

pre-condition and a regulatory requirement for all nations which export shrimps to the United States. This is in accordance with the Turtle Conservation Regulations of Fisheries Act of Nigeria (decree) No. 71 of 1992. The Nigerian Institute for Oceanography and Marine Research, Lagos in collaboration with the Federal Department of Fisheries developed the locally made TED with super shooter or bent rod or weedless grid for adoption by the Industrial fishermen. Nigeria was certified in 1998 among other 43 nations, to export all categories and species of shrimps to the United States of America based on satisfactory compliance by the operators in the fishing industry. The design characteristics, specifications and procedures for the construction and installation of TED (which are essentially the same as the standard USA recommended TED) are highlighted. Development of TED optimal rigging method is in progress in order to minimize shrimp loss and gain the confidence of fishermen and thereby facilitate better compliance. The TED technology (complementary to By-catch Reduction Devices) is being introduced to shrimp trawlers' fishermen in Cameroon under a Global Environmental Fund (GEF)/UNEP/FAO sponsored project on responsible shrimp trawling practices in the Gulf of Guinea or West Africa sub-region.

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REFINING POST-RELEASE MORTALITY ESTIMATES FOR SEA TURTLES CAUGHT IN FISHING GEAR: AN ASSESSMENT OF THE IMPACTS OF ENTANGLEMENT ON PHYSIOLOGY AND BEHAVIOR

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Accurate estimates of the number of sea turtles that die as a result of capture in fishing gear are critical for making scientifically-sound management decisions with far-reaching conservation, economic, and social implications. Documenting the number of sea turtles that are found dead in fishing gear is relatively straight-forward, but post-release mortality resulting from complications associated with the stress of capture is difficult to assess based on current knowledge. Severe disruption of physiological homeostasis and induction of the systemic stress response may result in alterations of normal diving and foraging patterns and leave sea turtles susceptible to other threats, such as predators, boat strikes, and further encounters with commercial fisheries. To date there has been little effort to incorporate physiological data into estimates of mortality. Sea turtles exposed to stressful situations such as confinement, entanglement, or forced submergence may undergo profound physiological changes which would be detectable by analysis of blood chemistry. Sea turtles rely heavily on anaerobic metabolism during periods of intense activity (Jackson and Prange, 1979; Dial, 1987; Baldwin *et al.*, 1989), and struggles to escape fishing gear would likely result in a build-up of lactate, metabolic acidosis, and changes in ion concentrations in the sea turtle's blood that could have deleterious effects on normal physiological function (Stabenau *et al.*, 1991; Hoopes *et al.*, 2000; Harms *et al.*, 2003; Stabenau and Vietti, 2003). The adrenocortical stress response may be triggered in sea turtles that are exposed to physiological or environmental stressors, resulting in an increase in plasma levels of the adrenal steroid hormone corticosterone (Aguirre *et al.*, 1995; Gregory *et al.*, 1996; Jessop *et al.*, 2004). The adrenocortical stress response is thought to promote survival in the short-term, but may be deleterious if it persists for a prolonged duration. The presence of elevated levels of heat shock proteins (HSP) in sea turtle blood may also be indicative of the degree of stress experienced by turtles as a result of capture. We propose an integrative approach to refine current estimates of post-release mortality of sea turtles caught in fishing gear. The goals of our study are 1) to make a comprehensive assessment of the health status of sea turtles captured in longlines, gillnets, and poundnets based on physical examination and blood biochemistry at the time of capture, 2) to monitor post-

release movements of sea turtles and document mortalities, and 3) to test the feasibility of using logistic models to predict the likelihood of post-release mortality based on biochemical data. This approach has been used to effectively identify predictors of post-release mortality for blue sharks captured in longline fishing gear in the central Pacific Ocean (Moyes, 2003), and is being tested with blue marlin in the catch-and-release recreational fishery in Hawaii (Musyl *et al.*, 2004). If reliable biochemical predictors of delayed mortality can be identified for sea turtles, this information could be used to refine mortality estimates for sea turtles released from fishing gear and contribute to the ability of fisheries agencies to make sound management decisions regarding sea turtle-fisheries interactions.

Order: 326 **Abstract ID:** 1757 **Type:** Poster **Subject:** Fisheries

MORPHOMETRIC PARAMETERS AND ONTOGENY OF THE ORAL CAVITY IN LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)

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In order to further understand interactions between incidentally captured sea turtles and pelagic longline fishing gear, we investigated the morphometric parameters and ontogeny of the oral cavity in loggerheads. Of particular interest was how these measures relate to the size parameters of hooks fished in pelagic longline fisheries. We performed a series of repeated measures, both standard and specific to the oral cavity, on captive loggerheads (n = 30) at 45cm, 55cm, and 65cm standard straight carapace length (SCL), spanning the range of turtle size classes most often captured in western North Atlantic Ocean pelagic longline fisheries. Wild and captive turtles (n = 134), ranging in size from 35cm - 80cm SCL, were also measured in a non repeated measures study. These measures included: mass, SCL notch-to-notch (minimum) and notch-to-tip (maximum), straight carapace width (SCW), head length (HL), head width (HW), gape height, internal gape width, esophagus width (approximated at the anterior opening), upper jaw length and lower jaw length. Using a canine mouth gag to hold open the jaws, we took oral cavity measures with inside spring calipers and/or dial calipers. Measures were analyzed to investigate oral cavity ontogeny. Hooks used in pelagic longline fisheries were measured to compare how anatomical characters of the oral cavity relate to hook dimensions. We plan to examine mathematical relationships between standard and oral cavity measures to predict the ability of a known size turtle to ingest hooks. With this knowledge, we hope to prevent future incidental capture and mortality through mitigation measures.

EVALUATION OF INJURY POTENTIAL IN INCIDENTALLY CAPTURED LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) RELATING TO HOOK SIZE AND BAITING TECHNIQUE

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In an effort to develop an empirical understanding of the interaction between sea turtles and baited hooks, we conducted controlled feeding trials, investigating methods to reduce post-hooking injury in sea turtles incidentally captured in pelagic longline gear. We examined effects of hook and animal size, behavior, baiting type and technique as these relate to loggerhead sea turtles' ability to swallow a baited hook. Researchers modified 14/0, 16/0, 18/0 and 20/0 circle hooks, removing the barb and wrapping the end to prevent injury, and baited ("single hooked" or "threaded") them with whole squid or sardines. Baited hooks (taken away before ingestion or injury) were offered to captive reared loggerheads (n=30 per size class) in three size classes (45, 55, and 65cm standard SCL). The turtle's reaction was recorded, and trials were videotaped to further elucidate behavioral details of the interaction. Results indicated that as hook size increased, the potential for full ingestion (and serious injury) decreased. Larger turtles were more likely to attempt ingestion of larger hooks. Turtles were less likely to attempt to ingest hooks baited with sardines than squid, or "single hooked" rather than "threaded". Results are likely due to differences in bait texture, shielding effects, and behavioral differences in how turtles respond to different hook/bait combinations. Smaller hooks baited with squid (the industry standard prior to recent rule modifications) pose a greater risk for serious injury/mortality. Fishing with larger circle hooks (18/0 or greater) single baited with finfish would reduce injury or mortality resulting from incidental capture.

Order: 328 Abstract ID: 1787 Type: Oral Subject: Fisheries

SEA TURTLES AND LONGLINE FISHERIES INTERACTIONS IN BRAZIL - AN UPDATE ON FIELD TRIALS AND POST-RELEASE MORTALITY AND MOVEMENTS

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The pelagic longline fishery in Brazil generally targets swordfish (*Xiphias Gladius*), tuna (*Thunnus* spp.), and sharks. For the past 3 years, the TAMAR program has been monitoring sea turtle bycatch in all of Brazil's fisheries and has aimed to identify areas with high concentration of bycatch and to work within fishing communities to minimize the threats of fisheries for pelagic-stage turtles. This presentation will focus on results of experimental field trials aimed to determine the effects of large (18/0) circle hooks on CPUE of sea turtles and target-species in the longline fishery. The species primarily caught in this fishery is *Caretta caretta*, which apparently bite baited

hooks, and secondly *Dermochelys coriacea*, which primarily become entangled in the line. The experiments were conducted on commercial vessels (on a volunteer-basis) and also on a federal research vessel. Rates of turtle capture and location of hook were compared between large circle hooks and traditional 9/0 J hooks. Hooks used in experiments alternated along sets. Preliminary data from 9 trips (approximately 50,000 hooks) suggest that 18/0 circle hooks appear promising to reduce the incidental capture of sea turtles while simultaneously not negatively influencing the productivity of the fishery. Swordfish sizes are also believed to be larger when caught on 18/0 circle hooks as compared to 9/0 J hooks. Furthermore, use of circle hooks likely increases the probability for survivorship of *Caretta caretta* post-release due to the finding that more turtles are caught in the jaw rather than ingesting the hook. We will also report on findings of loggerhead movements and survivorship after their release from longline gear as determined by both PSATs tracking mechanisms. Of major significance to this work is the excellent working relationship among the various stakeholders--fishermen, conservation groups, fish exporters, and European fish importers, all of whom are working cooperatively to promote the use of “turtle-friendly” fishing practices in the longline fishing industry.

Order: 329 **Abstract ID:** 1860 **Type:** Oral **Subject:** Fisheries

DEVELOPING A COMMUNITY-BASED “SOLUTIONS MODEL” FOR MITIGATING MARINE TURTLE BYCATCH MORTALITY IN VIETNAM’S GILLNET FISHERIES

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Previous marine turtle conservation measures in Vietnam have focused on one stage of their lifecycle - protecting beaches. Although critically important, threats to marine turtles in Vietnam outside of this lifecycle are considerable and have significantly contributed to the decline of all five species of marine turtles found in Vietnam. Though there is little official data, it is widely believed that Vietnam’s gillnet fisheries produce the greatest overall marine turtle mortality - encounters are particularly significant in offshore fisheries and during the nesting season among inshore gillnet fisheries. Mitigation options for gillnet fisheries are problematic. Decreased mesh size is difficult to regulate, and can be counteractive to sustainable fisheries strategies. Gillnets tend to be used either in shallow inshore areas or in the high seas, and therefore no practical excluder device can be fitted. This poster (or presentation) will provide an overview of fisheries interactions with marine turtles in Vietnam, then outlining a project – launched in December 2005 - to develop a “solutions model” for mitigating gillnet fisheries and marine turtle interactions. The aforementioned project will produce a gillnet management Options Paper, through the delineation of marine turtle hotspot areas along Vietnam’s coastline. This will be done using community-based, participatory techniques, the establishment of a first-of-its-kind Observer Programme in three Provinces, as well as the identification of mitigation strategies and (where appropriate) future experimental design, combined with an assessment of the socio-economic impacts of identified measures.

GETTING HOOKED: THREATS ON SEA TURTLES IN THE VALENCIAN COMMUNITY WATERS (SPANISH MEDITERRANEAN)

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A network involving several public and private institutions, funded by the local government (Conselleria de Territorio y Vivienda de la Generalitat Valenciana) and coordinated by the University of Valencia, deals with the strandings of cetaceans and sea turtles in the Valencian Community coasts (East Spain, 40°31'N-0°31'E to 37°51'N-0°45'W). Within this network in the years 1994 - 2005, we have recorded along the 419 km of these coasts 557 sea turtles stranded dead (N= 426) or alive (N= 131) from 1994 to 2005, with an annual mean of 46.4 ± 30.6 turtles (range: 14-127). Almost all of them were loggerhead turtles, except one leatherback and one Kemp's ridley, both recorded in 2001. Strandings occurred more frequently during summer months. The loggerheads presented sizes of juvenile or subadult (mean CCLn-t= 53.6 ± 13 ; N= 285), according to previous studies in the area. No significant annual trend on turtle size was detected. In the present study, we analyse the causes of stranding of these turtles, when possible, in order to ascertain the main threats affecting sea turtles in the Valencian Community waters. A total of 161 (71%) of the 227 turtles with identified cause of stranding interacted with longline fishery. However, a significant decrease of this interaction has been observed in the last three years, probably due to the reduction of the fishing effort of the Spanish longline fleet. Turtles interacting with longliners (mean CCL= 58.1; range: 33 - 80.2 cm) were significantly larger than turtles stranded due to other causes (mean CCL= 51.1; range: 16 - 78 cm) (t-test, $t = -4.826$, $p < 0.001$). Other identified threats were (in order of importance): collision with boats, entanglement, debris ingestion, and interaction with other fisheries as trawlers and gill-nets. Legacy and conservation measures applied to reduction of threats on sea turtles in the Spanish Mediterranean must count on fishermen. However, fishing vessels from other Mediterranean countries fish regularly in the international waters surrounding the Spanish Mediterranean. As a result, any measures and collaboration with fishermen must be undertaken not only in a regional or national scale but within a Mediterranean context.

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RESEARCH FINDINGS FROM A SEA TURTLE BYCATCH RELEASE PROGRAMME IN KENYA

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Anecdotal evidence has long suggested that the incidental capture of sea turtles by artisanal fishermen occurs regularly in the inshore waters of Kenya and surrounding region. It is also widely known that turtles incidentally caught are inevitably slaughtered by local fishermen for their products, whether retrieved alive or dead from fishing gears. In

1998 Watamu Turtle Watch (WTW) initiated the region's first sea turtle bycatch release programme for the artisanal fishery operating in Mida Creek and the inshore waters of Watamu, Kenya. This interventionist conservation activity works in co-operation with local fishermen based on a compensatory payment scheme and includes research and awareness elements. It provides the first study on foraging turtles and artisanal bycatch in the East African region. Fishermen participating in the programme handed over incidentally caught turtles to WTW for release and were compensated for costs incurred. WTW collected information related to capture, turtle biometrics and undertook tagging. Selected research findings are presented on 1,422 turtle release events (including 368 recaptures) over a six year period. 82% of turtles released were green turtles (*Chelonia mydas*), the remainder hawksbill (*Eretmochelys imbricata*) except for three Loggerheads (*Caretta caretta*). 96% of green and 79% of hawksbill captures were juvenile turtles. In comparison to other international studies the Watamu research data showed very high mean growth rates (MGR) for green turtles, right through to 80cm CCL. The data suggests greens foraging in the locality take, on average, less than nine years to grow from 30 to 80cm CCL; with MGR never lower than 4.3cm/yr. The highest MGR for a green was 12.2cm/yr in the 50-60cm CCL size class. Surprisingly, green growth rates overall exceeded those of hawksbills recorded over the same juvenile phases, with hawksbills taking on average 9 years and 4 months to grow from 30 to 70cm CCL. However one repetitively caught individual hawksbill grew from 32.7 to 67.8cm in just 3 years and 2 months. Higher than expected growth rates were recorded in larger size classes for both species. Evidence of carnivory green turtle activity was found, with 153 line captures of greens, 10% hooked inside the mouth, the remainder mostly in the front flipper/shoulder area. Recaptures indicated both residency and migratory juvenile green and hawksbill behaviour, with recorded distances of up to 380km by greens into Somalia and Tanzania; and 160km by hawksbills towards Tanzania. The project also recorded the presence of green and hawksbill post-hatchlings (young juveniles of less than expected recruitment size) in inshore waters. Based on bycatch data, recorded mortalities and fishermen interviews WTW estimates the total annual catch of turtles within the Watamu National Reserve area to be between 690 and 1160. Despite WTW's release programme turtles are still slaughtered in the Reserve. With turtles foraging throughout Kenya this study illustrates the seriousness of the artisanal bycatch threat to regional turtle populations and the urgent need for conservation resources to be directed to further research and the initiation of conservation activities to address the artisanal bycatch problem.

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Order: 332 **Abstract ID:** 1806 **Type:** Oral **Subject:** Fisheries

FIRST YEAR RESULTS OF THE HOOK SUBSTITUTION EXPERIMENT TO REDUCE SEA TURTLE BYCATCH IN PERU

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As part of the Pacific wide effort to reduce sea turtle mortality due to longline fisheries, an experimental hook substitution program was set up in three Peruvian ports. No nesting occurs in Peru, but five species of sea turtles feed in the Peruvian sea and highest concentrations coincide with the mahi-mahi season during the summer, the busiest time for Peruvian longliners. During the experiment's first year, results showed that the adoption of circle hooks could be an effective tool to reduce sea turtle bycatch, if attention is paid to crucial details and to differences with Atlantic

fisheries. First, target species as well as most abundant sea turtle size classes are smaller in Peru. The necessary smaller circle hooks create additional difficulties for handling, storing and baiting the hooks, which may explain the lower hooking rates experienced by some fishermen. Several fishermen also reported a significant occurrence of mahi-mahi escaping right before they were hieved on board. Also, Peruvian longliners are typically artisanal fishing boats ranging from 2TM to 12 TM, owners having limited purchase capacity, basic technological support, and significant economical constraints to reach areas where species are typically found. However, boats can easily switch gears until mahi-mahi approaches the Peruvian coast, or shark density in the preferred fishing areas increases. Differences among ports include different sea surface temperature dynamics which determine predominating target and sea turtle species, but also social particularities such as fishermen's flexibility to adopt hooks and attitudes towards sea turtles.

Order: 333 **Abstract ID:** 1830 **Type:** Poster **Subject:** Fisheries

EVALUATION OF FEEDING AREAS AND THE FISHERIES IN THE AGGREGATIONS OF SEA TURTLES PRESENT IN THE ARCHIPIELAGO LOS TESTIGOS, SOUTH CARIBBEAN, VENEZUELA

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Grupo de Trabajo en Tortugas Marinas del Estado Nueva Esparta, Fundación Científica Los Roques. Provita. Isla de Margarita, Estado Nueva Esparta, Venezuela

We evaluated the feeding areas used by the sea turtles and the level of impact of the fisheries on them in Los Testigos archipelagos at the east of the Venezuelan Caribbean, with the intention of establishing efficient strategies of conservation. 77 surveys were applied to fishermen from the local area and zones around obtaining information of the most common sites of observation of these species. We did observation in the field by diving, using visual superficial censuses with snorkeling equipment and by recording the number of observed turtles, species, frequency, hour, direction, depth, substratum, class of size and the presence of sea grass to confirm feeding. We found four areas used by *Chelonia mydas* juveniles in the internal zones of the archipelago in the waters around of La Iguana, El Chivo, Angoleta and Testigo Grande islands. These are shaped by sandy bottoms with moderated depths and presence of sea grass. We also found two areas used by *Eretmochelys imbricata* in the Angoleta and Testigo Grande islands, which are characterized by rocky substrata, reef patches and a variety of marine sponges. We confirmed the existence of resident populations for both species including adults in open waters. The information about fisheries in these populations dates back from 1999, where local settlers' catches are moderated, only for consumption, approximately 30 individuals a year. Nevertheless, in the years 2000-2003, extraction with commercial purposes by foreign fishermen exceeded 350 individuals a year, the *Caretta* sea turtle being the most affected.

Order: 334 **Abstract ID:** 1774 **Type:** Poster **Subject:** Fisheries

LIGHT STICKS USED IN LONGLINE FISHERIES ATTRACT JUVENILE LOGGERHEAD SEA TURTLES: POTENTIAL MITIGATION STRATEGIES

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Sea turtle interactions with pelagic longline fisheries are a significant source of injury and mortality. The risk

of entanglement with fishing lines or ingestion of baited hooks increases when sea turtles become attracted to longline fishing gear. Recent behavioral experiments indicate that light sticks (chemiluminescent lights as well as battery-powered electrolumes) used in many longline fisheries attract sea turtles. Thus, to limit the number of sea turtles that are impacted by the longline fisheries, we investigated several potential strategies that could be used to minimize the attraction of these lightsticks. We studied the responses of captive-reared juvenile loggerhead turtles to a variety of modified lightsticks. Experiments with turtles were conducted at the NMFS Galveston Sea Turtle Facility. Turtles were tethered to an electronic tracking system inside a large, water-filled arena, so that their orientation behaviors could be monitored in response to lightsticks. Our results showed that lightstick which flash intermittently, or have wavelengths between 540nm and 600nm, or project only downward may be potential strategies that limit the attractiveness of lightsticks to juvenile turtles.

Order: 335 **Abstract ID:** 1393 **Type:** Oral **Subject:** Freshwater & Terrestrial Turtles

AN ENERGETIC APPROACH TO UNDERSTANDING EGG SIZE VARIATION IN AN OVIPAROUS REPTILE

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Egg size in oviparous reptiles can significantly influence life history traits such as offspring size, growth, sex, survivorship, and ultimately individual fitness. For this reason, understanding the co-evolution of egg size and clutch size is central to life history theory. The diamondback terrapin is an emydid turtle that inhabits brackish water from the coastal region of New England through Texas in the United States. Females in northern populations lay relatively small eggs in large clutches whereas in southern populations they deposit larger eggs in small clutches. Neutral lipid extractions indicate that not only is the absolute amount of energy stores higher in the larger eggs, but the larger eggs contain a higher proportion of lipids in their yolk. Under similar incubation conditions, the larger eggs produce larger hatchlings that have proportionally higher lipid stores, a higher mass-specific metabolic rate, and a faster growth rate. A common garden design experiment indicates much of the variation in these variables is explained by genetic differences and not phenotypic plasticity. These data suggest that an increased metabolic demand in the warmer climates of southern populations select for larger offspring in southern populations. This constraint is released in northern populations where metabolic demands decrease during hibernation. In northern populations, females can allocate less energy to each offspring allowing for higher clutch sizes and increased fecundity.

Order: 336 **Abstract ID:** 1710 **Type:** Oral **Subject:** Freshwater & Terrestrial Turtles

REPRODUCTIVE PARAMETERS VARY WITH AGE IN THE PAINTED TURTLE

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In long-lived organisms, trade-offs between growth and reproduction may differ across an individual's lifetime, with the balance shifting from growth towards reproduction as an individual ages. A number of traits have been shown to vary with either female age or body size in turtles, including clutch size, egg size and reproductive frequency. However, these characters have rarely been tracked within individuals across years. We performed a multi-year study to investigate longitudinal variation in the reproductive parameters in the painted turtle, *Chrysemys picta*. Nesting was monitored from 2002-2005 for a marked population that nests in Illinois along the Mississippi River, USA. Females were classified at the outset of the study as having either high nesting experience (HNE) or low nesting experience (LNE). We measured female body size, egg mass, reproductive frequency, and testosterone and estradiol concentrations in the egg yolk at oviposition. The concentration of steroids in the yolk

at oviposition is thought to reflect female physiology at the time of folliculogenesis and, as such, may provide insight into female condition during the period of yolk formation. Preliminary analyses reveal that LNE females are smaller than HNE females and produce significantly smaller eggs, but have significantly higher growth rates and lower reproductive frequencies than HNE females. Analysis of yolk steroids indicates that LNE females produce eggs with higher testosterone concentrations, but roughly equivalent levels of estradiol. These results are indicative of an ontogenetic trade-off between growth and reproduction in painted turtles.

Order: 337 **Abstract ID:** 1464 **Type:** Poster **Subject:** Freshwater & Terrestrial Turtles

THE 'GREY' TURTLE (*TRIONYX TRIUNGUIS*): A CHALLENGE TO THE DEFINITION "SEA TURTLE"?

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Evidence suggests that the Nile Soft-Shell Turtle (*Trionyx triunguis*) travels widely within the coastal waters of the Eastern Mediterranean, with many meeting their deaths in fishermen's nets each year and one individual even turning up at the Greek Island of Kos. This paper seeks to gently provoke the marine sea turtle 'establishment' by arguing that this species provides a controversial 'grey' subject area between freshwater and marine habitats, and thereby is not only of particular significance with respect to our understanding the evolution of sea turtles, but also warrants the concern and attention of sea turtle conservationists.

Order: 338 **Abstract ID:** 1664 **Type:** Poster **Subject:** Freshwater & Terrestrial Turtles

THE EFFECTS OF BEACH NOURISHMENT ON THE NESTING AND REPRODUCTIVE SUCCESS OF THE NILE SOFT-SHELL TURTLE (*TRIONYX TRIUNGUIS*); A CASE STUDY AROUND THERMAL LAKE KUKURTLU, MUGLA-TURKEY

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The study site is located in Dalaman which is reported as one of the most important sites for *Trionyx triunguis*. Kükürtlü Lake was an ideal site for a case study because it had never been nourished and has a dense *Trionyx triunguis* population. The population and nesting success were monitored from 2002-04. For the first year, the population was observed to obtain baseline data on natural nesting behaviors. A total of 77 emergences of nesting females was recorded with only 22 (28.6 %) resulting in nests in 2002. Before the 2003 nesting season, the nesting ground was scratched, stones were removed and more sand was added. There were 62 (45.6 %) nests from 136 emergences in 2003. In 2004, 22 (12.4 %) nests from 177 emergences were observed. There was an increase in nests from 2002 to 2003 but the number of nests decreased in 2004. The annual differences in the number of nests could be a result of the increase in suitable nesting grounds; or perhaps an adult female of this species nests every other year.

ECOLOGY OF A RARE AND ELUSIVE NORTH AMERICAN TORTOISE: THE IMPORTANCE OF GENETICS ANALYSES

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The ability to manage and conserve populations effectively requires historical and present information about population dynamics. Information such as this can be used to help: (a) identify natural structure within and among populations, (b) determine the historic migration among populations, and (c) evaluate the extent to which conservation strategies are sufficient to maintain ecological processes. Although direct methods to estimate movements of animals (e.g., mark/recapture, radio-tracking) are commonly used to estimate movements of individuals, they can be expensive, labor-intensive, and perhaps ineffective to obtain adequate data for analyses that can discern general population phenomena in wide ranging species. Indirect methods, i.e. genetic markers, can provide a useful alternative for inferring ecological and evolutionary processes of populations. The desert tortoise (*Gopherus agassizii*) is a long-lived, wide-ranging, rare, and elusive species of the Mojave Desert of the southwestern United States. Population characteristics of the desert tortoise make it an ideal species for inferring population processes from genetic data. We have used genotype data from highly variable genetic markers (i.e. microsatellites) to assess historical gene flow and current migration rates among populations across the range of the Mojave Desert tortoise. Conservation actions to recover this federally-listed species critically require information about population differentiation, movements of individuals within the species range, and the interaction between threats and genetically differentiated populations within the species range. Thus, use of genetics can be very important to the future management of this sensitive species.

Order: 340 Abstract ID: 1504 Type: Poster Subject: Freshwater & Terrestrial Turtles

INTEGRATING ECOLOGY AND GENETICS TO DEFINE POPULATION EXTENT FOR A CONTINUOUSLY-DISTRIBUTED SPECIES, THE DIAMONDBACK TERRAPIN (*MALACLEMYS TERRAPIN*)

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Diamondback terrapins are distributed along the US Atlantic and Gulf coasts in brackish water habitats. To determine ecologically and evolutionarily relevant management units (MUs) for this species of special concern, we used molecular techniques to test the hypothesis that *M. terrapin* in the US comprises one single, homogeneous population. To assess the magnitude of the threat that actively-fished commercial crab pots pose for terrapins, we conducted experimental fishing studies with commercial crab fishers in North Carolina and tested the ability of several bycatch reduction devices (BRDs) to exclude terrapins but retain valuable blue crabs. Finally, to estimate adult survival rate, capture probability, and population size for the elusive mangrove terrapin, we conducted a mark-recapture study in Everglades National Park, Florida, and analyzed individual encounter histories. Results of microsatellite DNA analysis indicate that *M. terrapin* exists as at least six distinct regional MUs, which do not coincide with previous morphologically-based subspecies designations, and dispersal in this species is male-mediated. Field studies revealed that terrapin interaction with blue crab fishery activity primarily occurs in the early spring, close (i.e. < 250m) to shore. Terrapin bycatch in crab pots can be mitigated by using BRDs, although

some BRDs still allow adult male turtles to enter: larger BRDs (i.e., 5.0 cm) did not significantly affect catch rates of valuable crabs, but smaller BRDs (i.e. 4.5 and 4.0 cm) did ($p < 0.001$). Finally, we established the first adult survival rate ($\phi=0.79$) and population estimate (mean $N = 1545$ individuals) for mangrove terrapins.

Order: 341 **Abstract ID:** 1665 **Type:** Poster **Subject:** Freshwater & Terrestrial Turtles

POPULATION SIZE AND REPRODUCTIVE ECOLOGY OF THE NILE SOFT-SHELL TURTLE (*TRIONYX TRIUNGUIS*) IN TURKEY

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The present status of Nile soft-shell turtle (*Trionyx triunguis*) populations in Turkey was surveyed and intensive studies were carried out at Dalaman, one of the two most important sites of *T. triunguis* (Seyhan and Dalaman). We counted up to 305 adult *T. triunguis* and 137 nests, primarily in the Dalaman region. There were 79 nests recorded in Dalaman in 2003 and the hatching success of these nests was 59%. The mean depth of the nests was 34cm with clutch size ranging from 9 to 59 eggs. The incubation period varied between 54 and 59 days. Nest temperatures were affected by changes in air temperature and ranged between 24.1 and 35.7°C. Levels of heavy metals were also measured in the eggshells and tissues of the turtles. The main threat to nests was depredation by feral dogs, weasels and cats. We found a total of 19 dead adult and sub-adult individuals. The majority of these dead turtles were recorded in Dalaman, Seyhan and Dalyan regions. The morphometric measurements of adults were also recorded. The cause of these mortalities was found to be fishery and/or boat related due to external injuries. The results indicate that Turkey is the most important nesting area for *T. triunguis*, hosting up to 60% of the Mediterranean population according to the literature.

Order: 342 **Abstract ID:** 1851 **Type:** Oral **Subject:** Freshwater & Terrestrial Turtles

PHYLOGEOGRAPHY AND POPULATION GENETICS OF THE AEGEAN *MAUREMYS RIVULATA* (TESTUDINES; GEOEMYDIDAE)

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Species distributed on the Balkan Peninsula, especially in the Aegean area, represent a challenge for phylogeographic studies since these areas have experienced many geological events that have created barriers for the dispersion of species and gene flow. There are dense populations of the fresh water turtle, *Mauremys rivulata* (Valenciennes, 1833), on the island of Crete, but natural wetlands are gravely endangered in southern Greece and the extinction of some populations (and probably loss of genetic diversity) has been documented. The phylogeographic pattern of *M. rivulata* and its relation to the other Mediterranean *Mauremys* species are studied with the use of mt-DNA sequences. In addition, 6 microsatellite loci are used to gain information about

the evolutionary history and population genetics of the species. The present study includes 33 populations of *M. rivulata*. Populations of the closely related species *M. caspica* and *M. leprosa* are also incorporated. The study is based on samples collected from Greece, Jordan, Syria, Spain and Morocco. The information gained from this study may prove to be crucial for the conservation of the species, since habitat fragmentation and destruction is intense in Crete and on the Aegean islands.

Order: 343 **Abstract ID:** 1584 **Type:** Oral **Subject:** Freshwater & Terrestrial Turtles

ONTOGENY OF STEROID RECEPTOR DEVELOPMENT IN THE BRAIN AND GONADS OF THE RED-EARED SLIDER (*TRACHEMYS SCRIPTA*)

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Research on turtles with temperature-dependent sex determination (TSD) has demonstrated a critical role for steroids in sexual differentiation. Precisely how steroids and temperature interact to produce a sex determining signal remains enigmatic, but recent studies have found sex specific steroid and aromatase expression in the brain prior to gonadal expression suggesting that the brain may be the initial site for steroid action. If steroids are to produce a sex determining signal in the brain prior to the gonads, steroid receptors must be present at the appropriate time to receive that signal. The goal of this study was to characterize steroid receptor development in a species with TSD, the red-eared slider turtle (*Trachemys scripta*). We used immunocytochemistry (ICC) to determine androgen and estrogen receptor distributions in the brain and gonads of developing embryos. First, ICC was performed on adult brains to optimize the technique and to determine the spatial distribution of receptors. To look at the ontogeny of receptor development, eggs were incubated at a female producing temperature (31°C) and sampled every five days of development. Developmental stage of the embryo was determined prior to cryosectioning for ICC. Characterizing steroid receptor distributions simultaneously in the brain and gonads of developing embryos will allow us to determine where receptors are initially expressed. Future studies will examine differences in receptor development between the sexes.

Order: 344 **Abstract ID:** 1515 **Type:** Oral **Subject:** Freshwater & Terrestrial Turtles

REASSESSMENT OF THE TURTLE COMMUNITY IN THE NORTH FORK OF WHITE RIVER, OZARK COUNTY, MISSOURI, USA

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The turtle community in a 4.6 km section of the North Fork of White River, Ozark County, Missouri was studied in 1969 and 1980. In 2004, the turtle community was reassessed to determine if alterations since 1980 had occurred in the habitat, community composition, or population size and structure of the Northern Map Turtle, *Graptemys geographica*. Recent data were compared to historical data from the 1969 and 1980 studies. *Graptemys geographica* population estimates from 1969, 1980 and 2004 indicate the North Fork of White River supported a fairly stable population of *G. geographica* between 1980 and 2004, though the population was significantly reduced from the 1969 estimate. Red-eared sliders, *Trachemys scripta elegans*, became established in the research section between 1971 and 1980, and expanded their

distribution within the research section between 1980 and 2004. Threats to the *G. geographica* population include lack of basking sites, increased human recreational use of the stream, siltation, and pollution, including fecal coliform and nutrient-loading. This project was completed with support from the Saint Louis Zoological Park, the Reptile and Amphibian Conservation Corps (RACC), Cloud 9 Ranch, Sunburst Ranch, and the Wild Branch Fly Shop.

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Order: 345 **Abstract ID:** 1563 **Type:** Oral **Subject:** Freshwater & Terrestrial Turtles

WHERE IT ALL BEGAN: EARLY IMAGES FROM THE ART OF CHELONIAN SCIENCE

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Throughout prehistory, knowledge of animals and the natural world was initially communicated orally, subsequently by cave art, pictograms, clay tablets, utilitarian forms and hieroglyphics, and then much later, in manuscripts and books. The earliest known documentations of turtles occurred in the Mediterranean region. Although turtle effigies exist from as early as the Egyptian Predynastic period, most were tied to religion, as is the case of the Egyptian text, the Book of the Dead (Nefertubaneb 1550-1069 BC). However, Europe was the point of origin for a significant portion of the natural history of chelonians. Empirical natural science began its evolution into a more scientifically-based discipline through the work of the Greeks, and later the Romans. Pliny (AD23), Dioscorides (AD40), and Aelian (AD220) compiled and expanded upon earlier chelonian accounts as later authors did with theirs. As with later bestiaries, these were often utilized as vehicles for morality lessons. Much of what passed for science, often in the form of allegorical bestiaries [The Aberdeen Bestiary (AD1200)], belonged to the domain of the church. Works of deCantimpré (AD1240-earliest image on paper) and vanMaerlant (AD1350) contained fanciful turtle images. Candidus (AD1460), Gessner (AD1555) and Aldrovandi (AD1522) provided more accurate representations during a time of transition, when scientists wrote of distant lands based on secondhand information. Caldesi (AD1687) and Gottwald (AD1781) both produced accurate chelonian anatomies. In the Middle East, Abu'l-Ma'ali Nasr Allah (AD1400s) produced illuminated allegories, while in Europe, printed accounts became more available through the invention of the printing press, and the New World's discovery provided ample material.

Order: 346 **Abstract ID:** 1892 **Type:** Poster **Subject:** Freshwater & Terrestrial Turtles

TESTUDO TERRAPIN (SCHOEPF): A BRIEF HISTORY OF ITS ILLUSTRATION

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Images are a key element in zoology, the process evolving from primitive cave art to precise modern photography. First appearing on paper in handwritten drawn manuscripts, most early images were exaggerated, seeking appeal

with unrealistic stylized designs, sacrificing accuracy for socio-religious conformity. Animals were often drawn from descriptions or legends and the depictions bear witness, giving credence to inaccuracies and myths. From the 1500's on, the art developed from early printed images engraved on wood, to those on steel or copper plates as seen in Schoepff's *Testudo terrapin* (1792-1801), Shaw's *Testudo concentra* (1802) and Boulenger's *Malacoclemmys terrapin* (1889). Later examples, such as Latreille's *Testudo centrata* (1801), Holbrook's *Emys terrapin* (1842) and Wied's *Emys pileata* (1865), illustrate the scientific method's influence paired with hand-colored realism. During this time, works written for public appeal increased and common animals such as the *Malaclemys* were seen in a new light. Although images had been copied from earlier works since the 1600's, the practice became more rampant during this time with accuracy and detail decreasing dramatically. During the late 1800's, chromolithography, the first true color printing, was utilized widely, later augmented with photography in Hay (1905). Fewer illustrations were drawn from this time on due to the labor-saving qualities of photography, yet hand-drawn images remain an important documentation tool. More easily reproducible than photographs, they have a certain life to them, an embodiment of the artist. Images also serve as type specimens (neotypes), as is the case with Gray's *Chitra indica* and Schoepff's *Malaclemys (Testudo) terrapin*.

Order: 347 **Abstract ID:** 1754 **Type:** Oral **Subject:** Freshwater & Terrestrial Turtles

TURTLES AS ENVIRONMENTAL INDICATORS: USING THE DIAMONDBACK TERRAPIN (*MALACLEMYS TERRAPIN*) TO MONITOR ESTUARINE MERCURY CONTAMINATION

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Existing knowledge of mercury levels, cycling, and bioaccumulation in estuarine systems is deficient relative to similar knowledge of freshwater systems. Through a combination of field and laboratory experiments, we are currently investigating use of the diamondback terrapin (*Malaclemys terrapin*) as a biomonitoring tool for mercury contamination in estuaries of the southeastern United States. Determination of blood and scute mercury concentrations has been used to establish baseline mercury levels for male and female terrapins at four South Carolina estuaries and a mercury superfund site at Brunswick, Georgia. Overall, female terrapins showed higher scute mercury concentrations than males ($n=32$, $p<0.05$). Furthermore, a strong correlation was observed between scute and blood mercury concentrations ($\tau=0.78$, $p<0.001$). Preliminary results indicate scutes could be a valuable tool for monitoring estuarine mercury pollution. Additionally, through the use of a stable isotopically enriched mercury tracer, a toxicokinetic model for short-term mercury exposure is being developed to describe uptake, storage, and remobilization of mercury in terrapin blood. An ongoing dietary exposure study is investigating long-term mercury accumulation in terrapin blood and scutes. Together, these experiments will evaluate the efficacy of determining short-term and long-term mercury exposure through repeated sampling of blood and keratin. Ultimately, we will assess the ability of mercury to accumulate in the terrapin, an organism occupying a high trophic level in many estuarine food webs. Results from these experiments will be combined with observations on reproductive, behavioral, and endocrine endpoints to examine the relationship between mercury contamination and overall terrapin health.

RECENT STATUS OF THE EUPHRATES SOFT-SHELLED TURTLE, *RAFETUS EUPHRATICUS*, IN THE EUPHRATES AND TIGRIS RIVERS, TURKEY

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In this study we describe the current status of populations of *Rafetus euphraticus* in the Euphrates and Tigris basins of Southeastern Turkey based on data collected since 2000. We surveyed *R. euphraticus* populations entrapped within the Reservoirs of the Atatürk Dam, Birecik Dam and Karkamis Dam on Euphrates River and in the Tigris River from the Iraqi border to Devegeçidi Dam Lake, the northernmost recorded occurrence of the species. Water temperature, pH and bottom structure measurements were taken at each site to characterize aquatic habitat. We also attempted to identify appropriate terrestrial habitats for natural and artificial nest incubation in order to safeguard the future survival of the softshells in this region. Both adult and juvenile animals were observed at many sites indicating persistence of many populations; however the straight line carapace lengths of the specimens captured since 2000 are statistically smaller than the size given in former literature indicating the potential of a demographic shift to younger animals at these sites.

TESTUDO TRADE IN TURKEY

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The expanding international wildlife trade has contributed significantly to the decline of many tortoise and turtle populations in the wild. Regulations set forth by the Convention on International Trade in Endangered Species (CITES) could be used as a tool to help stem these declines, but serious problems in enforcement have prevented their successful application. The export trade in the genus *Testudo* from Turkey between 1976 and 2004 is reviewed using compiled import data from the CITES database. A total of 468,006 live animals were exported from Turkey. Nine importing countries were recorded. The sources of origin of the exported tortoises were largely unknown (95%), however, the bulk from known sources consisted of specimens taken from the wild (66%) while only 8% represented captive bred animals. The authors' personal observations during an ongoing project (2002-2005) on the genus *Testudo* have been included.

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REPRODUCTIVE ECOLOGY AND STATUS OF *TRIONYX TRIUNGUIS* IN DALYAN, TURKEY

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The Nile soft-shell turtle, *Trionyx triunguis* (Forsskål 1775), is a little-known species. In the Mediterranean, it is confined to a few countries: Israel, Egypt, Syria and Lebanon, with the largest population found in Turkey. The Mediterranean population of *Trionyx triunguis* has been listed by IUCN as ‘critically endangered’ and is included in the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and CITES (Convention on International trade in Endangered Species of Wildlife Fauna and Flora). Dalyan is one of the most important habitats for *Trionyx triunguis*. The nesting population was studied during the 2005 reproductive season. A total of 33 nests were recorded. The nests suffered from a high rate of fox predation. Protection measures for the survival of the species were discussed.

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TRIONYX TRIUNGUIS: THE BRACKISH WATER TURTLE THAT ALSO LIVES IN THE MEDITERRANEAN SEA

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The Mediterranean subpopulation of the Nile soft-shell turtle (*Trionyx triunguis*) is listed by IUCN as “critically endangered” and classified as “severely fragmented”. It is confined mostly to lower courses of rivers and brackish water wetlands. However, there are many records of *Trionyx* in the open sea. This suggests it spends part of its lifecycle there, possibly for range expansion and population exchange. Its ability to tolerate salt water has enabled the initially African species to colonize the southeastern Mediterranean. This subpopulation may represent a different ecotype that is geographically isolated from the main distribution area. Due to the lack of in-depth studies as well as their secretive nature, it is hard to estimate the size of this population. However, it is believed that the entire Mediterranean population comprises less than 1,000 adults. Turkey and Israel are the only countries with strong populations. In the lower Nile area, a MEDASSET survey of fishermen conducted in 2002 suggested that the species has not been recorded for over 20 years and was believed to be extinct. Recently, isolated sightings have been reported in Greece, Lebanon and Syria. In 1993, heavy flooding in Israel destroyed most of a large population at Nahal Alexander and it took several years for the Mediterranean population to recover. The species has been introduced into the inland Hula Reserve with individuals transferred from the Mediterranean population, where it could potentially establish a significant population. MEDASSET’s research in Turkey since 1997 shows that the Çukurova and Dalaman deltas have the only remaining significant populations in the Mediterranean. Reproduction occurs at a minimum of 8 other sites in Turkey. Habitat destruction, fisheries interaction, pollution

and human disturbance are the main threats. Figures for by-catch offshore from the Çukurova Delta are far higher than for marine turtles. Trawling poses a severe threat to the species and numbers caught in mid-water trawls are much higher than those caught in bottom trawls. Many are also killed by fishermen because they are aggressive creatures that destroy fishing nets and traps. Since 1998, MEDASSET has initiated annual field survey assessments of the *Trionyx* population status along the Mediterranean coast of Turkey, and has produced recommendations for its conservation and management to the Standing Committee of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) at the Council of Europe, in order to enable the Convention to follow-up on the actions of the Turkish State. Sadly, since 2003 and despite our 2004 report stating that ‘No practical steps nor considerable progress toward conservation could be demonstrated,’ the issue has not even been referred to or followed up by the Convention. To ensure the survival of this small Mediterranean sub-population, the following priority actions are recommended:

- Drafting a Conservation and Management Action Plan;
- Conserving the most important nesting and mating sites; and
- Persecuting fishermen who don’t take protective measures against turtles drowning in trawl nets.

Order: 352 **Abstract ID:** 1886 **Type:** Oral **Subject:** Peter Lutz Scientific Tribute

WHAT IT TAKES TO BE A GOOD SCIENTIST IN A CRISIS DISCIPLINE

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Conservation biology has been called a “crisis discipline” with a strong emphasis on integrated problem-solving. Yet, biology is at its core so rigorous that evidence-based science is required in both research and decision-making. To achieve good conservation, we must rely on the fundamental requirements of “good science”. Good science starts with good questions; in conservation biology, they must also be relevant questions. In our research, we must apply basic ecological or biological principles, thoroughly evaluate alternative hypotheses, and routinely look for context and inspiration outside of traditional and comfortable disciplines. The best examples in sea turtle research are those that integrate across disciplines and include strong experimental designs. Recent advances in genetics, population dynamics, physiology, and behavior, based within a strong analytical framework, have had profound impacts on sea turtle conservation. This is particularly true when results have been presented in ways that make them relevant to policy-makers. As sea turtle biologists and conservationists, our challenge is to be the best scientists we can while working toward a common goal: understanding and preservation of a unique group of vertebrates.

Order: 353 **Abstract ID:** 1887 **Type:** Oral **Subject:** Peter Lutz Scientific Tribute

FROM WAVES TO GEOMAGNETISM: AN INTEGRATIVE APPROACH TO SEA TURTLE NAVIGATION

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The long-distance migrations of sea turtles involve some of the most remarkable feats of orientation and navigation in the animal kingdom. As hatchlings, turtles that have never before been in the ocean are able to establish unerring courses toward the open sea and then maintain their headings after swimming beyond sight of land. Juvenile turtles follow complex migratory pathways that often lead across enormous expanses of seemingly featureless ocean, and adult turtles also migrate considerable distances along coastlines or through the open ocean when they return to nest on their natal beaches. Thus, the itinerant lifestyle of sea turtles is inextricably linked to an ability to navigate long distances across vast expanses of seemingly featureless sea. Unraveling the sensory cues that underlie orientation and navigation requires an intimate understanding of the behavior, physiology, ecology, and life history of sea turtles, as well an appreciation of the evolutionary and oceanographic factors that have shaped their migrations. Integrative studies that combine both laboratory and field approaches have been most successful in revealing how both hatchlings and older turtles guide themselves through the sea. The emerging picture is that sea turtle navigation depends on several sources of directional and positional information. Among these are several unusual and previously undescribed sensory abilities, including the ability to sense ocean wave direction by perceiving underwater accelerations and an ability to exploit the Earth’s magnetic field as a kind of map for assessing geographic location.

**A LUTZ-IAN APPROACH TO THE LEATHERBACK:
INTEGRATION OF ORGANISM AND OCEANOGRAPHY**

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Among the air-breathing vertebrates, the leatherback sea turtle exhibits some of the most striking adaptations for a life on and deep within the high seas. Its fast rate of growth, large size, and unique physiological attributes set it apart from all other sea turtles. Like bluefin tuna, leatherback turtles have one of the largest latitudinal and vertical ranges in world oceans, and both species cover vast distances, traveling between tropical areas where they reproduce, to cool temperate regions where they forage. Peter Lutz was known for his integrative approach to science, bringing together laboratory and field research in order to understand how an animal copes with its environment. This paper will examine the physiological ecology of the leatherback, with specific reference to the leatherbacks of Puerto Rico, and their movements and behavior in relation to oceanographic features.

SKELETAL GROWTH IN TURTLES: PATTERNS OF FORM AND FUNCTION

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The morphology of bone and cartilage growth in turtles has evolved as two separate and very different patterns, reflecting the functional significance of different growth rates, body size, and physiological requirements. Nearly all turtles, including all Cheloniidae, have slow bone growth with non-vascular cartilage. A few large marine turtles, including Dermochelyidae and the extinct Protostegidae, have developed rapid bone growth with vascularized cartilage. The leatherback turtle is the only extant species with this derived pattern of rapid skeletal growth, and has also developed a suite of other morphological specializations which render it without a doubt the most remarkably specialized turtle in the world, and unique among living reptiles. This paper reviews the anatomical, histological, and ultrastructural patterns of skeletal growth in the leatherback, work originally stimulated partially by Peter Lutz. Growth rates (gm/day to maturity) in the leatherback are much higher than in other living sea turtles or other large reptiles and are more similar to certain marine mammals.

BIOLOGICAL IMPLICATIONS OF TEMPERATURE-DEPENDENT SEX DETERMINATION IN SEA TURTLES

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Sea turtles like many reptiles have temperature-dependent sex determination (TSD) in which the incubation temperature of the egg determines the sex of the embryo. This form of sex determination generates a wide variety of biological questions. The purpose of this presentation is to address a variety of implications regarding TSD in sea turtles. First, many previous studies have examined the physiology underlying TSD in reptiles. These data provide insight on the specific mechanism by which temperature determines sex in sea turtles. Second, TSD has significant implications for the ecology and evolution of sea turtles. As a method of addressing this subject, many studies have begun examining naturally occurring sex ratios in sea turtle populations. Those studies provide a foundation for generating hypotheses regarding the ecological and evolutionary significance of TSD. Finally, TSD has serious implications for the conservation of sea turtles. Manipulation of sex determination could potentially be used as a management strategy. In fact, data from some studies suggest that it may be an effective means of enhancing recovery efforts for endangered populations. Through a wide variety of studies over the past 25 years, biologists are gradually gaining an understanding of the biological implications of TSD in sea turtles.

Population Biology and Monitoring

Order: 357 Abstract ID: 1733 Type: Poster Subject: Population Biology and Monitoring

FIVE YEARS OF MARINE TURTLE CONSERVATION EFFORT IN LEBANON: MONITORING AND AWARENESS

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The importance of Lebanon's coasts for sea turtle nesting was discovered in 2001 under the framework of MEDASSET's ongoing conservation program in the Eastern Mediterranean (since 1990), when the first beach survey to assess nesting potential took place. Surveys along the entire Lebanese coast showed that nesting was sparsely distributed along parts of the northern coast and scattered on several developed beaches, but the southern nesting sites were found to be more important both nationally and regionally. Loggerhead turtles (*Caretta caretta*) are widespread along the coast of Lebanon and high-density nesting can be observed at specific sites throughout the Lebanese coastal belt. The green turtle (*Chelonia mydas*) is far less common and nesting is confined to the less developed areas of the south. Lebanon signed and ratified the UNEP Mediterranean Action Plan (UNEP/MAP) in 1975, the Convention on Biological Diversity in 1994 and the Barcelona Convention, its protocols and revised Action Plan for the conservation of marine turtles in 1999. The 5-year monitoring project on El Mansouri Beach and the 2-year monitoring at the Tyre Nature Reserve and Abbassiyeh Beach, in collaboration with the Lebanese Ministry of the Environment's MEDWETCOAST Project and with support from RAC/SPA (UNEP/MAP) and the Marine Conservation Society, have provided useful data, although long-term monitoring is required before population size can be accurately assessed. Nesting in South Lebanon ranges from 37-70 *Caretta* nests and from 0-16 *Chelonia* nests per year. At a regional level, being within the range of 21-100 *Caretta* nests per season, Lebanon can be classified as a nesting area of 'moderate importance'. Although numbers for greens are considerably lower, *Chelonia* nesting effort in Lebanon is also considered of 'moderate importance' as the Mediterranean sub-population is classified as 'critically endangered' on the IUCN Red List. Turtles in Lebanon are under threat from tourism development, predation, interaction with fisheries, a lack of awareness/information and pollution. A coordinated interdisciplinary approach is urgently required for their conservation. The exploitation of turtles and their eggs does not appear to present a major problem. Since 2001, progress has been made along the most important nesting beaches in setting up beach monitoring and nest protection programs, as well as conducting awareness programs for Ministry of the Environment staff, the general public and fishermen. Lebanese volunteers are also trained in beach monitoring methodologies. In 2005, a survey was conducted among fisherman regarding the interaction between fisheries and sea turtles, as well as a light pollution study of businesses in the tourist zone of the Tyre Coastal Nature Reserve. A National Action Plan has been compiled for the Ministry of Environment outlining the major threats to turtles and identifying the urgent need for protection of critical nesting areas. South Lebanon has been under considerable socio-economic strain as a result of its political situation, so development has been limited. As tourism returns, uncontrolled development could become a real threat. Continued support from all parties involved is needed for the program to progress.

GENETIC STOCK ORIGIN OF HAWKSBILL TURTLE STRANDINGS ON THE TEXAS COAST BASED ON MTDNA

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Little is known about the abundance and distribution of hawksbill turtles in the Gulf of Mexico. Juvenile hawksbills strand regularly along the coast of Texas, and the nesting stock origin is an enigma. We used genetic analysis to evaluate the nesting stock origins of 61 stranded hawksbill sea turtles found on Texas beaches from 1998-2002. Mitochondrial DNA (mtDNA) sequences were obtained from samples collected from stranded animals and compared with mtDNA haplotype data from Atlantic and Caribbean nesting stocks in order to determine their stock origin. We used a Bayesian mixed stock analysis approach to evaluate stock composition of the strandings (Pella and Masuda 2001) based on the published 384 bp (Bass *et al.* 1996) and 480 bp (Diaz-Fernandez *et al.* 1999) mtDNA sequences for Atlantic and Caribbean nesting stocks. Results suggested that the majority of the Texas strandings belonged to the Mexican nesting stock. Additionally, two new haplotypes were identified, indicating that further work is needed to characterize additional nesting populations. Our results expand the understanding of stock distribution and linkages between nesting and foraging populations and are valuable for evaluating the stock-specific threats to hawksbills in the region.

Acknowledgments: This study would not have been capable without the help of the Texas Sea Turtle Stranding Network and Cynthia Rubio of USGS.

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CANCELLED

FIRST RECORD OF NESTING ACTIVITIES OF THE SEA TURTLE IN THE GULF OF VENEZUELA: NOT JUST FOR FOOD

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The Gulf of Venezuela has been considered one of the more important feeding areas in the country. We have focused the first investigations of sea turtles in the area on habitat use and in-water studies of these reptiles, since the possible nesting activity on its beaches ceased. Nevertheless, in May of 2005, we recorded for first time on Zapara Island (Southwestern Coast of the Gulf of Venezuela), the appearance of a hawksbill nest (*Eretmochelys imbricata*). Some previous authors confirmed leatherback (*Dermochelys coriacea*) nesting in the area of the Gulf of Venezuela. However, this is the first photographic record which confirms nesting activity here, even though it is not with the previously mentioned species. This fact emphasizes the importance of the Gulf of Venezuela as a habitat of great ecological value within the life cycle of the sea turtles that inhabit these territorial waters.

Acknowledgments: HBG gratefully acknowledges travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service, provided through the Symposium Travel Committee.

RECRUITMENT OF POST-PELAGIC GREEN TURTLES (*CHELONIA MYDAS*) TO NEARSHORE REEFS ON FLORIDA'S EAST COAST

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Green turtles inhabiting nearshore reefs on Florida's east coast typically range in size between 25.0 – 55.0 cm SCL. These turtles utilize the high energy nearshore reefs as a developmental habitat for a number of years before they are thought to move on to alternate foraging grounds. Data collected at the St. Lucie power plant reveals when green turtles recruit to these nearshore reefs and how long they reside there. The power plant is located on Hutchinson Island, Florida, adjacent to nearshore reefs that support a high density of juvenile green turtles. These green turtles are routinely captured and recaptured throughout the year at the power plant. Between 1990 and 2005, 3,911 green turtles have been captured and released at the St. Lucie power plant. From data collected at the power plant site we have determined that a majority of post pelagic green turtles recruit to these nearshore habitats during the months of December, January and February every year.

CARIBBEAN LEATHERBACKS: RESULTS OF NESTING SEASONS FROM 1984 TO 2005, CULEBRA ISLAND, PUERTO RICO

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The beaches of Culebra Island (18°18'N, 65°18'W), Puerto Rico, are considered critical nesting habitats for leatherback turtles. For the past twenty years, leatherback nesting areas have been monitored at Culebra Island suggesting their importance and local contribution to the Caribbean population. The objective of this study is to report the last two nesting seasons and to compare them with previous years. Since 2004, an Index Nesting Beach Survey has been implemented at the main nesting beaches of the island. During a fixed period of approximately 3 months a total of 110 nests were counted, showing its highest peak at the beginning of the survey. This result represented 64% of the total number of nests (n= 173) recorded for that year. Results were similar during the 2005 season, counting 116 nests at the index nesting period and depicting its highest peak also at the beginning of the survey. Nevertheless, this result represented 46% of the total number of nests (n= 257) reported for 2005. Additional data such as nesting trends since 1984 until present, hatching success and hatchling production for 2004-2005 nesting seasons will be reported. We will also emphasize tourist and urban development, both of which continue to be major threats to the leatherback nesting population of Culebra Island and mainland Puerto Rico.

PATTERNS IN NUMBERS OF NESTING LOGGERHEADS (*CARETTA CARETTA*) DERIVED FROM A 41-YEAR TIMELINE OF REPLICATE SEASONAL SURVEYS (1964-2005), LITTLE CUMBERLAND ISLAND, GEORGIA, USA

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We have compiled 41 years of seasonal data on 2203 records of nesting loggerhead sea turtles (*Caretta caretta*) on Little Cumberland Island, Georgia, USA. Annual counts have been precisely replicated across all years. These data from 1964 to 2005 show a timeline of changing population dynamics, which poses the question.... what can 41 years tell us about nesting loggerhead numbers in Georgia? The first decade of research exhibits elevated variance across these years relative to subsequent years, as has also been observed in other nesting populations of sea turtles. However, this pattern ends and additional patterns appear, as well as our first evidence for population decline. Quantitatively, the Little Cumberland data introduce a host of questions. Given that counts from 1964 to 2005 express a significant decline, we question whether patterns nested within the 41-year timeline exist, their statistical objectivity, and the possibility that outside factors might correlate with these patterns.

SEX-RATIO OF JUVENILE PELAGIC LOGGERHEADS, *CARETTA CARETTA*, OFF MADEIRA ISLAND (PORTUGAL), NE ATLANTIC, USING HISTOLOGIC ASSIGNMENT

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Like many other reptiles, loggerhead turtles exhibit temperature-dependent sex determination (TSD), i.e. the sex of the offspring is influenced by the incubation temperature of the eggs. Knowledge of the population's sex-ratios is essential for the management and conservation of wild populations, but sea turtles exhibit no sexual dimorphism up to sub-adult or adult age classes. Therefore, sex determination needs to be identified using other techniques, such as histology of the gonads on juvenile individuals. In this study we present preliminary data on the sex-ratio of the loggerhead population from the Madeira Archipelago, using a histological approach. Despite its laboriousness, the histological method allows more accurate results. During the warmest seasons of 2004 and 2005, the sea turtle population was sampled in the waters off Madeira Island (Portugal), north-eastern Atlantic. Animals were caught using a scoop-net and brought into the laboratory. Biometry data was collected, as well as blood samples for posterior sex identification using testosterone levels. Laparoscopies were performed in order to get a biopsy of the gonad, which was kept in Bouin's preservative for histological sex assignment. The tissue samples were dehydrated through a series of alcohols, embedded in paraffin and sectioned at 6 μm and stained using haematoxylin and eosin staining technique, after which they were examined with a light microscope (40X magnification). The gonads of 45 juvenile loggerhead turtles ranging from 230 to 601 mm CCLnt (mean 397.78 ± 81.76 mm, $n=45$) from the seas off Funchal (Madeira Island) were examined for histologic sex assignment. Males were identified by the presence of seminiferous tubules and flat, monostratified surface epithelium, whereas females exhibited more or less developed, spherical follicles, enclosed by a membranous structure. Thirteen males and 32 females were identified, comprising an overall sex-ratio of 2.46 (i.e. 1M:2.5F). This sex ratio was compared with the known sex ratios of the hatchling source population (1M:6F), as well as with the adult population (1M:2F) from the eastern United States using a χ^2 test ($p<0.01$). In the first case the sex ratios were considered significantly different, whereas in the second case the sex ratios were considered the same. These results are consistent with the sex ratios found for another sample of sea turtles from this area, and indicate a probable female biased differential mortality during the first few months/years of the life cycle. This study aims to contribute to a better knowledge of this population structure, and can be used as a helpful tool for management and conservation policies.

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ANALYSIS OF ARRIBADA IN 1947 HERRERA FILM AT RANCHO NUEVO, MEXICO

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On 18 June 1947, Andrés Herrera filmed an amazing arribada of Kemp's ridleys (*Lepidochelys kempi*) on a 2-km

stretch of beach at Boca San Vicente near Rancho Nuevo, Mexico. After evaluating the film in 1963, Dr. Henry Hildebrand estimated that there were at least 10,000 turtles on the beach at one given time and probably 40,000 nested that day between 0900 and 1300 hours. These estimates were generated without the aid of computer and imaging capabilities available today. During this study, the original black and white film footage was transferred from a VHS tape to a DVCam digital tape to generate an AVI file. Once the film footage was digitized, a 50-second AVI clip was extracted with the clearest and widest panoramic view from the dune of the arribada. Over 1,000 JPEG images were generated using software that extracts still photos from video clips at 20 frames per second. The JPEG images were individually viewed to identify the images showing the longest distance of the arribada with the clearest photographic quality. These selected images were used to create a “stitched” panoramic still photo of the filmed event. Volunteers ($n = 39$), who were either naive or knowledgeable with the film’s history, systematically counted turtles in the “stitched” panorama and estimated distance shown in the photo. Although turtles can be counted in the panoramic photo (mean = 475.4, SD = 77.8, var. = 6,052), it would be difficult to accurately calculate a single measure of turtle density or provide a single estimate of turtles at one given time since the beach dimensions are unknown in the photo. Therefore, using the mean turtles counted, a matrix was created to provide the range of turtle densities (0.23 - 9.51 turtles/meter) and 2-km “snapshot” totals (460 - 19,020 turtles) given beach lengths from 2000 to 50 meters. The range of total turtles nesting over the 4-hour period observed by Herrera (1,840 - 76,080 turtles) was calculated by multiplying each “snapshot” total by four (as did Hildebrand). Using the mean value of 650 meters (subjective volunteer estimates) as the photo beach length and 475 as the mean photo turtle count then there were approximately 1,500 turtles at a given time and 6,000 turtles for the 4-hour period on the 2-km stretch of beach. This evaluation indicates that the assessment of turtles generated in 1963 may have been overestimated due to the limited capabilities at the time for image analyses.

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***IN-SITU* NEST INCUBATION TEMPERATURE STUDY IN A SEA TURTLE NEST WITH INTERNET-BASED DATA ACQUISITION TECHNOLOGY: POTENTIAL FOR CONCURRENT ANALYSIS OF GLOBALLY COORDINATED RESEARCH ACROSS MULTIPLE SITES BY MULTIPLE RESEARCHERS**

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Sea turtle biologists have been intrigued by temperature effects in sea turtle nests for decades. Incubation temperatures influence incubation duration, hatchling sex ratio, emergence, embryonic growth, phenotype and recruitment into a population. Conventional dataloggers are typically deployed to study nest temperatures that are later downloaded for offline analysis. We report here our experiment with one turtle nest using an Internet-based data acquisition system that offers researchers a method of investigation previously unavailable – real time collaborative investigation of sea turtle nests at multiple sites by multiple researchers on a global scale. The study was conducted on Talang-Talang Besar Island nesting beach at Talang-Satang National Marine Park, Sarawak, Malaysia. We placed five platinum PT 100 RTD sensors (Minco Products Inc, USA) at the nest-bottom, nest middle-center, nest middle-side, nest-top, and sand at 15 cm below the surface, in a *Chelonia mydas* nest (1°44'N, 109°46'E). Sensors were factory calibrated to $\pm 0.1^\circ\text{C}$ (N.I.S.T., USA) from 15.6 to 43.3°C. Air temperature and humidity were measured with two other sensors (model HS-200V, Precon, USA) placed 1m above the nest. All seven sensors were wired to a weatherproof solar-powered data acquisition system comprising a datalogger with built-in embedded Internet gateway, a global system mobile modem, and a GSM signal booster. We subscribed

to iSCADA hosted data acquisition service (www.devicesworld.net, Cyberjaya, Malaysia) for the duration of this study. In the 51-day experiment from 22 Jul to 12 Sep 05, we received, and discussed on-line, real time temperature data as incubation events unfolded and remotely altered our pre-set temperature threshold alerts and sampling frequency to study incubation events. Temperatures at nest middle-center averaged $32.53 \pm 1.19^\circ\text{C}$, with a 4.95°C range from 30.17 to 35.13°C ($n=1303$); air temperatures averaged $29.68 \pm 3.54^\circ\text{C}$, with a 19.49°C range from 23.30 to 42.79°C ($n=1303$). Sand temperature leads, and not lags, nest top temperature. The nest was well insulated against temperature fluctuations arising from conduction. The end-to-end Internet-based system described here opens unique opportunities for biologists to conduct coordinated studies on nest temperatures on a global scale. A research team normally invests equipment and resources for a localized study using conventional methods. However, when several research groups collaborate on a regionally or globally coordinated experiment using a web-based data acquisition system, each research group's project investment in one site enables the group access to real time data from the total number of sites. Thus, multiple researchers from multiple sites are able to conduct nest temperature studies of the population with minimum costs. The advantages of regionally or globally coordinated real time study include: simultaneous access to data with avenues for on-line analysis and collaboration, standardization of research equipment and methodology, greater transparency, lower risk of experimental failure, flexible sampling rate and incubation event threshold settings and timely intervention.

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ESTIMATING JUVENILE SURVIVAL RATES AND AGE AT FIRST NESTING OF LEATHERBACK TURTLES AT ST. CROIX, US VIRGIN ISLANDS

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Although juvenile survival rates and age at first nesting (AFN) are important life history parameters for marine turtle populations, direct estimates of these vital rates have been elusive due to the oceanic distribution of juveniles. Using data collected from a nesting beach that has been intensively monitored over a 20-year period, we estimated the average annual juvenile survival rate and AFN of leatherback turtles at Sandy Point, St. Croix, US Virgin Islands. The increasing population trend in recent years is associated with the dramatic increase in hatchling production that resulted from beach protection on St. Croix in the 1980's. We used data on estimated hatchling production and numbers of neophytes subsequently observed each year to model the following parameters: the average annual survival rate of oceanic juveniles and the proportion of female hatchlings that nest for the first time at a certain age. A log-normal distribution was used as the likelihood function for the estimated annual hatchling production. Beta and multinomial distributions were used to model the average juvenile survival rate and AFN, respectively. These parameters were estimated using a Bayesian approach. We built an informative prior distribution for juvenile survival rates, based on the prior conjecture that one in 1000 eggs would survive to maturity. For the proportion of hatchlings that mature at certain age, we used a non-informative prior distribution. We assumed that leatherback turtles mature between ages 9 and 12. We also assumed the sex ratio of hatchlings was 65% female. To assess the fit of the model, we used Monte Carlo simulations on the observed number of neophytes and estimated hatchling counts. The median of the posterior distribution for annual survival rate during the juvenile stage was 0.63 and its 95% posterior interval was 0.60-0.66. Marginal posterior distributions for the proportion of juveniles that mature between ages 9 and 12 were imprecise, where 95% posterior intervals for the proportions

were [0.03, 0.84], [0.01, 0.59], [0.002, 0.37], and [0.02, 0.58], respectively. Using the random samples from the posterior distributions, we simulated (1) the number of expected neophytes given the estimated female hatchlings, and (2) the number of expected hatchlings given observed number of neophytes. Both simulations indicated the model captured the general trend, although large uncertainties were apparent. Using the estimated median annual survival rate, the total survival rate during the juvenile stage of female leatherback turtles from hatchlings to the first year of reproduction was estimated to be between 0.004 and 0.02.

Order: 368 **Abstract ID:** 1703 **Type:** Poster **Subject:** Population Biology and Monitoring

NESTING ACTIVITY OF THE MARINE TURTLES (*CHELONIA MYDAS* AND *CARETTA CARETTA*) DURING 2005 IN ALATA, MERSİN-TURKEY

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The nesting activities of green turtles and loggerhead turtles were recorded on Alata beach, Turkey during the 2005 nesting season. A total of 90 and 62 green turtle and loggerhead turtle emergences were recorded in Alata beach 2005, respectively. The number of green turtle and loggerhead turtle nests were 20 and 26, respectively. The incubation period of nests varied between 48-55 days for *Chelonia mydas* (mean 51 days) and 37 -52 days for *Caretta caretta* (mean 46 days). A total of 2509 eggs were laid for *Chelonia mydas*. Of these eggs, 2035 (81.1%) hatchlings were able to reach the sea. A total of 2042 eggs were laid for *Caretta caretta*. Of these eggs, 1358 (66.5%) hatchlings were able to reach the sea.

Order: 369 **Abstract ID:** 1662 **Type:** Poster **Subject:** Population Biology and Monitoring

THE SPATIAL DISTRIBUTION OF LOGGERHEAD SEA TURTLE NESTS AND THEIR TEMPERATURE AND SEX RATIO VARIATIONS ON DALAMAN BEACH, TURKEY

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The nesting activities of loggerhead turtles were recorded on Dalaman Beach, one of the main nesting grounds in Turkey, during 2005. A total of 63 nests was recorded. Nest distribution, fate of the nests and hatching success were recorded and nest locations were marked on maps along with beach-back structures. The incubation periods varied between 40 and 65 days with a mean of 52 days. The sand and nest temperatures were recorded with electronic temperature recorders. The sand temperatures were found to be lower close to the sea and increased inland. Intra-nest temperature variations of 6 nests were recorded. Mean temperatures at each level were: 30.5°C at the bottom, 31.3°C in the middle and 31.6°C at the top levels. The mean temperatures during the middle third of the incubation period were 30.6, 31.3 and 31.8°C, respectively. The estimated sex ratios of females at these levels were 77% at the bottom, 86% at the middle and 91% at the top levels. The mean sex ratio for all levels was 84%. The spatial and temporal variations of nests and their sex ratios are discussed with the possible effects of beach-back structures on the nesting site preferences of adult females.

HATCHLING SEX RATIOS OF HAWAIIAN GREEN SEA TURTLES

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Green sea turtles in Hawaii represent an isolated population inhabiting the Hawaiian Archipelago. Green turtles possess temperature-dependent sex determination (TSD) which can result in a variety of hatchling sex ratios. Thus, hatchling sex ratios are of conservational and ecological interest. French Frigate Shoals (FFS), part of the Hawaiian Islands National Wildlife Refuge, is an atoll where approximately 90% of Hawaiian green nesting occurs. The study sites, East and Tern Islands, are two sandy islets that help comprise FFS. The purpose of this study was to predict hatchling sex ratios produced on East and Tern Islands based on both nest and beach temperature data from 1998-2004. Dataloggers were placed into nests and in beach locations at mid-nest depth (approximately 45 cm) to monitor temperatures. Sex ratio predictions were based on the average temperature during the middle third of incubation. Based on the nest temperature data, the results suggest an overall male-biased sex ratio. The sand dataloggers also recorded relatively cool temperatures and followed similar patterns. Additionally, a second technique was employed to verify the sex of hatchlings from the 2004 nesting season. Gonadal histology was used to identify the sex of hatchlings that were found dead in nests after all of the live hatchlings emerged. The kidneys and gonadal tissues were preserved and processed using standard paraffin histological procedures. Each gonad was then examined microscopically to determine if it was an ovary or a testis. Both male and female hatchlings were identified from FFS during 2004.

SEA TURTLE SURVEY IN PRAIA GRANDE, SÃO TOMÉ E PRÍNCIPE

Rogério Nuno Lopes Ferreira

ONG MARAPA - Mar Ambiente e Pesca Artesanal, São Tomé e Príncipe

The Democratic Republic of São Tomé e Príncipe (STP) is a volcanic origin archipelago situated in the Gulf of Guinea. The following proposal research will be conducted in Praia Grande, situated in the main Island of STP, from November 2005 to February 2006. The beach, of 1 km extension, is the largest of the island and is inserted in the Caué district on the southeast part of the Island. This location was chosen because of the following: inexistence of information on sea turtles for that particular area; existence of a plan for the development of an organic fish farm, a small scale eco-resort and a marine protected area; and local comments of nesting emergences. So the main objective of this research is to contribute with base scientific background data for the sustainable use of the area, this includes the characterization of the sea turtle nesting beach in relation to species, densities, distribution of nests, hatch success, physical parameters and natural and anthropogenic threats. The methods will consist mainly in night census and tagging, daytime track surveys, captures and inquiries as described in Eckert *et al* (1999). Logistical support will be given by the local NGO MARAPA.

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CONFIRMATION OF HAWKSBILL NESTING IN GABON

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The nesting sites for *Eretmochelys imbricata* on the western coast of Africa are not clearly known. Their tracks can be mistaken for those of *L. olivacea* from the Bijagos, and inadequate data for the Loos Islands (Guinea) fail to report the regularity of nesting in West Africa (Fretey *et al.*, 2000). In the Gulf of Guinea, *E. imbricata* nest regularly in the south of Bioko Island, as well as on the islands of Principe, Sao Tome and Rolas. Nesting in Cameroun has been reported by fishermen but remains to be confirmed. Sporadic tracks have been spotted on the beach of Nendyi, south of the continental part of Equatorial Guinea. The present strategy for the conservation of sea turtles in Gabon requires observing many areas along an 885 km coastline which can't be easily reached. Observing areas that have never been surveyed at night may lead to interesting discoveries. For example, teams patrolling the beach during the 2004-2005 and 2005-2006 seasons were able to observe, photograph and tag hawksbill females in the south of Pongara National Park (Pointe Ngombé) and around Gamba.

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AN UNUSUAL NEST ACTIVITY ALONG SOUTHERN SICILIAN COASTS: AN HOPE FOR SEA TURTLE SURVIVAL?

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Caretta caretta nesting is an unusual event along the Italian coasts, and confirmed sites are increasingly rare. In the last 25 years, WWF Italy has documented about 30 nests along the southern beaches. But during the summer of 2005, an unusual event occurred on Giallonardo Beach, Agrigento (south Sicily). Two nests and two nesting attempts were identified along a 300 m stretch of beach. Such an event had never been observed before in Sicily, or in all of Italy, especially during July and August when crowds (vehicles, people, fires, pubs, fishermen activities, etc.) discourages turtles. At the end of July, some fishers saw a nesting attempt and reported the event. WWF Italy and Sicilian Fund for Nature guarded and protected the area. The morning after, turtle tracks were found but no eggs were deposited. A few days later, a turtle nested and the surrounding area was constantly checked. At the end of September, few hatchlings were found on the same beach and their tracks made it possible to find another nest, the fourth record of nesting activity in 2 months! After the hatch, the nest was excavated and only 26 of the 66 eggs had hatched (25.8% success). The development of the first nest wasn't regular and staff at Torre Salsa WWF Oasi offices decided to use an incubator. Unfortunately, few eggs hatched due to the presence of mildew on all 100 eggs

(1% of survival). All samples were preserved for future analysis. Incubation temperatures were checked throughout incubation of this nest by WWF volunteers. In addition, volunteers distributed information to summer visitors to involve them in monitoring and protecting this site for the future.

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TWO DECADES OF STRANDING DATA FROM BERMUDA, AN ISLAND IN THE SARGASSO SEA

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The Bermuda Wildlife Rehabilitation Center, coordinated by the Bermuda Aquarium, Museum and Zoo and in collaboration with the Bermuda Turtle Project and the Sea Turtle Stranding and Salvage Network, archives data on sea turtles that strand within our coastal waters. Between July 1983 and December 2005, data have been collected on 308 stranded sea turtle events in Bermuda representing four species: 155 green turtles (*Chelonia mydas*), 85 hawksbill turtles (*Eretmochelys imbricata*), 62 loggerhead turtles (*Caretta caretta*), 3 leatherback turtles (*Dermochelys coriacea*) and 3 apparent hybrids. The size ranges for all sea turtles' stranding records document a presence of predominantly juvenile and sub-adult (immature) animals. The size ranges are: for green turtles (n=143) 18.8-97.7 cm straight carapace length (SCL), for hawksbills (n=82) 5.3-75.7 cm, for loggerheads (n=57) 6.26-74.5 cm and for leatherback turtles (n=3) 116.8-146.25 cm. In two of the four species represented (hawksbills and loggerheads), a significant number of the stranded animals fall within a size class less than 20 cm SCL. Thirty-eight percent of the green turtles are less than 30cm SCL. Thus it appears that there are small turtles in the pelagic environment around Bermuda and that some of these are approaching the size at which they switch over from a pelagic to a neritic life style. Trends in numbers of strandings by species over time and assessments of mortality factors are discussed using necropsy results and stranding data. These data can provide valuable support to conservation efforts to preserve sea turtles.

Order: 375 **Abstract ID:** 1502 **Type:** Poster **Subject:** Population Biology and Monitoring

NESTING SEA TURTLES ON THE AUSTRALIAN CONTINENTAL SHELF EDGE ISLANDS: ASHMORE REEF, CARTIER ISLAND AND SCOTT REEFS, EASTERN INDIAN OCEAN

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Surveys of the numbers of nesting sea turtles and the success of their nesting attempts on the islands of the western edge of the Australian continental shelf have taken place opportunistically since 1992. The locations visited included Sandy Island on Scott Reef Western Australia, three islands on Ashmore Reef, and the unvegetated sand cay of Cartier Island. All localities have now been protected under state and Commonwealth legislation. The

nesting on the islands is dominated by green turtles (*Chelonia mydas*) with occasional nesting by hawksbill turtles (*Eretmochelys imbricata*). Successful nesting by turtles is hindered by dry, loose sand for most of the year. On average over the years there are 6 tracks (range 1 to 18) for each successful nest. The moisture associated with the leaf litter of the strand plant, *Argusia argentea*, on West Island Ashmore Reef is thought to facilitate higher nesting success by both species compared to the unvegetated Sandy Island and Cartier Island. The islands, reefs and surrounding waters are either conservation zones or marine protected areas but they contain sites and fishing areas that remain significant to artisanal fishers from nearby Indonesia. The challenge for the respective managers of these areas is to balance the protection of the natural and cultural values, continue to facilitate visits by traditional fishers and investigate increasing evidence of regional impacts to the reefs and species from climate change and increasing water temperatures.

Order: 376 **Abstract ID:** 1451 **Type:** Poster **Subject:** Population Biology and Monitoring

AN ESTIMATION OF DEMOGRAPHIC PARAMETERS FOR THE LOGGERHEAD SEA TURTLE, *CARETTA CARETTA*, ON BALD HEAD ISLAND, NC USA

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Key life history parameters were estimated using 26 years of data on the loggerhead sea turtle (*Caretta caretta*) nesting population on Bald Head Island, NC, U.S.A. Bald Head Island is one of the most northern, high density nesting beaches for the northern subpopulation of loggerhead sea turtles on the east coast of the U.S.A. Data collected over the 26 years includes critical information on adult females, nests, and hatchling success. Three key life history parameters and associated variances were estimated from these data to better understand loggerhead population dynamics and for incorporation into population management models. Clutch size relative to female carapace measurements was estimated to determine a possible correlation. The relationship between clutch size and order of nests from an individual female within and between seasons was also explored. The third component analyzed was an estimation of female survival over time based on 15 years of tagging data. Preliminary analysis indicates a time independent survival rate of 0.814 (SE = 0.003) and a recapture rate of 0.086 (SE = 0.012). The demographic parameters calculated in this study were also compared with parameters in the current literature, providing information about the ecology of the northern subpopulation. These findings increase both our ecological understanding of the subpopulation as well as our ability to examine the likely effects of alternative management actions on the population through improved population models.

WHERE HAVE ALL THE RIDLEYS GONE: THE DECLINE OF THE ARRIBADA AT PLAYA NANCITE COSTA RICA

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The olive ridley arribada at Playa Nancite in Santa Rosa Park, Guanacaste, Costa Rica has been studied since the early 1980s. It was long known as one of the largest arribadas in the eastern Pacific with 100,000 nesting females in a year. Nearby Playa la Flor and Playa Chacocente in Nicaragua were smaller arribada beaches with at most a few hundred to a thousand turtles nesting there. Recently the olive ridley arribada at Nancite has apparently collapsed and the arribadas at the Nicaraguan beaches have increased in numbers to several thousands. In this presentation we review the historic data on numbers of nesting turtles at these beaches and discuss whether the decline at Nancite is due to anthropogenic or biological factors or is actually a migration to the Nicaraguan beaches or perhaps to Playa Ostional.

Acknowledgments: SH gratefully acknowledges travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service, provided through the Symposium Travel Committee.

MONITORING OF THE GREEN TURTLE POPULATION IN THE CAMPO-MA'AN AREA SOUTH CAMEROON, CENTRAL AFRICA REGION

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There has been no confirmed green turtle nesting along the Campo-Ma'an coastline. However, they are caught in fishing nets and their shells are sold to tourists or kept as decoration. For four years (1998-2001), the research team has identified turtles and taken morphometric measurements (curved carapace length (CCL)) along the Kribi-Campo road. The team also carried out surveys by interviewing coastal inhabitants on marine turtle issues. Incidentally caught turtles are tagged and released back into the sea. Among 170 green turtles that were identified and measured, 122 individuals were tagged in Campo-Ma'an. The mean CCL of green turtles in the Campo-Ma'an coastal area is 50.90 cm (CCL). The number of individuals increases within the class size of 30-40 cm and the modal value is within the class size 45-50 cm. After the modal value, the number of green turtles decreases up to the 70-75 cm class size, which represents the maximum curved carapace length observed. Eighteen of the 122 green turtles that were tagged and released have been recaptured within 3 km from the tagging point. The presence of juvenile green turtles in the Campo-Ma'an coastal area is quite diverse. Gatherings of green turtles from 2 to 10 years old (37-69 cm) are seen on the rocky shoreline and are caught in fishing nets. This increases the need for radio-tracking individuals to evaluate the migration routes of the green turtles.

NEST TEMPERATURES AND SEX RATIO VARIATIONS AMONG THE HATCHLINGS AND EMBRYOS OF LOGGERHEAD TURTLES ALONG THE MEDITERRANEAN COAST OF TURKEY

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Temperatures of loggerhead nests and sand temperatures were recorded on seven beaches (Dalyan, Dalaman, Fethiye, Patara, Cirali, Anamur and Kazanlı) for at least one season during the last five nesting seasons. The nesting season started towards the end of May and continued until mid-August on all beaches. The majority of the nests were recorded during June and July, which is peak nesting season. The sex ratios of dead hatchlings and embryos were determined by gonadal observation and sex ratios for the other hatchlings were estimated by measuring nest temperatures and by analyzing the incubation durations and the periods of emergence asynchrony. Sand and air temperatures were not directly related to nest temperatures. Air temperatures were warmer on the eastern beaches but nest temperatures did not change accordingly. The sand temperatures were much more variable in different areas of the beach (i.e. sandy, shady and stony areas). The sex ratio of hatchlings obtained from dead hatchlings showed remarkable differences between the zones of the beach perpendicular to the sea and the depths of the nests, having more females in the inland nests and at the top of the nests. The sex ratio of dead hatchlings collected from the first and last emergences of nests were also different, having a higher ratio of females in the first nightly emergence and higher ratio of males in the last nightly emergence.

A FIVE YEAR SUMMARY OF SEA TURTLE TAGGING DATA FROM AN IN-WATER STUDY IN THE MARYLAND PORTION OF THE CHESAPEAKE BAY: POSSIBLE EVIDENCE OF SITE FIDELITY

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The Chesapeake Bay has been identified as an important region to study sea turtle seasonal distribution, site fidelity, genetic origin, baseline health, and growth rates. In 2001, the Maryland Department of Natural Resources initiated a sea turtle tagging and health assessment study in the Maryland portion of the Chesapeake Bay. Through the cooperation of commercial watermen, data were obtained from sea turtles that were incidentally captured in pound nets, a type of passive, stationary fishing gear utilized in the Chesapeake Bay to catch finfish. Between 2001 and 2005, 70 individual sea turtles (39 loggerheads, 29 Kemp's ridleys and 2 greens) were examined as part of this study. The number of turtles ranged from 7 in 2001 to 23 in 2004, with an average of 14 sea turtles per year. The number of watermen participating in the study varied from year to year, which in part accounts for the variability in numbers over the five year period. The loggerheads ranged in size from 51.9 to 105 cm (curved carapace length (CCL), notch to tip), the Kemp's ridleys from 29.8 to 57.2 cm (CCL) and the greens measured 34.2 cm and 83.1 cm (CCL), with the majority of animals being juveniles. The occurrence of a large subadult green sea turtle is uncommon in sampled

nearshore waters along the East Coast of the United States. Reported captures occurred from May to October, with the majority in June and July. Two sea turtles were previously tagged by other studies; a juvenile loggerhead tagged at the St. Lucie Power Plant in Florida traveled to the Chesapeake Bay over a period of 4 months, and an adult female loggerhead migrated from a nesting beach along the Atlantic coast of Florida to the Chesapeake Bay, demonstrating that juveniles, and to a lesser extent, adults, utilize the Bay during the summer months. Of the 70 individual turtles encountered in this study, 9% were recaptured either within or between sampling seasons. Four loggerheads and one Kemp's ridley were recaptured once and a loggerhead was recaptured twice over a period of two months. Several recaptures recorded within a season suggest localized movements in the Bay during the summer months. Two loggerheads tagged in this study were re-encountered in subsequent years in the vicinity (less than 2.5 km) of their original capture sites. These recaptures demonstrate site fidelity to specific locations over both consecutive and non-consecutive years. Time at large for all recaptures ranged from 2 to 3,278 (~9 years) days and growth rates for four loggerheads recaptured after being at large for 11 months or more (allowing for measurable growth) ranged from 0.41 to 2.90 cm yr⁻¹ for straight-line length. The results of this study will be compared to those from similar pound net projects in North Carolina and Virginia. Future work includes analysis of tissue samples to determine the genetic origin of sea turtles visiting the Chesapeake Bay and using satellite telemetry to further identify habitat usage within the Chesapeake Bay and migratory routes upon leaving the Bay.

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PAPUA NEW GUINEA LEATHERBACKS: SETTING THE PACE

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The nesting trends of and conservation efforts for the leatherback turtle, *Dermochelys coriacea*, at the Kamiali Wildlife Management Area (KWMA), Papua New Guinea, are reported. Leatherback turtle populations have been in decline for years throughout the Western Pacific region. Concern was raised at the local and international level as to the viability of the remaining populations along the northern coast of Papua, New Guinea. The KWMA is about 60 km southeast of Lae City, Papua New Guinea, and hosts a significant population of leatherback turtles. Monitoring of leatherback nesting within the KWMA started in 1999 and has continued until present. The initial objectives were to determine the nesting population size and develop management strategies which would allow a sustainable egg harvest by the Kamiali community. The overall long-term goals of the program are to protect and increase the leatherback population size and raise local peoples' understanding and appreciation of the value of the species for present and future generations. During the 2005-2006 nesting season, the sampling area expanded to three km for better estimates of nesting activity. In addition, daily surveys were conducted starting in 2003-2004 to count the number of nesting crawls along the entire 10 km nesting beach. While nesting trends have gradually risen from 50 nests in 2000 to 197 in 2004-2005, much of this is due to spatial and temporal improvements of monitoring efforts.

MAXIMIZING POPULATION INFORMATION FROM VARIOUS BEACH CENSUS REGIMES

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Due to their complex ecology, widespread dispersal and migratory behavior, monitoring sea turtle populations is not simple and it is often logistically impossible to investigate all life stages. However, well-designed studies on reproductive females on nesting beaches can be important in determining long-term trends of abundance. Nesting populations are ideally monitored through intensive long-term studies throughout the entire nesting season. However this is often not feasible on beaches with long nesting seasons or if there are financial or logistical restrictions to the duration of the monitoring. Therefore much shorter or periodic intervals are required. This study investigated the use of different monitoring regimes to detect population trends of nesting sea turtles on beaches with long-seasons. We applied two modeling techniques to a full-time monitoring study of nesting green turtles at Sabah, Malaysia and a partial-season monitoring study of flatback sea turtles in the Northern Territory, Australia. Trends and seasonality were modeled using seasonal and trend decomposition using Loess; and a parametric seasonal curve fit. This presentation highlights the limitations and accuracy of each approach, along with their ability to be used between species and rookeries. This paper shows that periodic and shortened monitoring intervals are highly accurate in determining population numbers at some rookeries.

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SURVIVAL PROBABILITIES FOR IMMATURE HAWKBILL TURTLES, *ERETMOCHELYS IMBRICATA*, ALONG THE WEST COAST OF BARBADOS

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In recent years, survival probability estimates have been calculated for populations of immature green and loggerhead turtles. In this study we present the first survival probabilities for a population of immature hawksbill turtles. The capture-mark-recapture profiles for 687 juvenile and sub-adult hawksbills captured in Barbados from 1998-2005 were analyzed using the Cormack-Jolly-Seber (CJS) modeling approach. Turtles were all hand-caught using SCUBA diving techniques at depths ranging from 15m to 40m on the off shore reefs along the west coast of Barbados. Immature turtles were classified as large (>55cm) or small (<55cm) and their capture site was classified as a sponge site (high density) or non-sponge

site (low density). The best fit CJS model for small turtles at the non-sponge sites was a Brownie-Robson type model to account for different survival probabilities from 1st capture (0.512) to subsequent captures (0.818). These small turtles at non-sponge sites appear very transient while looking for suitable foraging habitat. All other size/site classes exhibited annual survival probabilities of 0.885. Recapture probabilities ranged from 0.243 to 0.567, with large animals at non-sponge sites having the lowest recapture probabilities as they apparently migrate out of the study area to either deeper water habitats or other localities. This study will allow for a greater understanding of hawksbill turtle population dynamics.

Order: 384 **Abstract ID:** 1690 **Type:** Poster **Subject:** Population Biology and Monitoring

SEASONAL FECUNDITY AND ITEROPARITY IN THE LOGGERHEAD (*CARETTA CARETTA*) DERIVED FROM A 43-YEAR TIMELINE OF REPLICATE SEASONAL SURVEYS (1964-2005), LITTLE CUMBERLAND ISLAND, GEORGIA, USA

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Fecundity and iteroparity are essential life history parameters for the study and management of loggerhead sea turtle populations. We present 43 years of seasonal data compiled from records on 2203 nesting loggerhead sea turtles (*Caretta caretta*) and 5000 clutches deposited by these turtles from 1964 to 2005 on Little Cumberland Island, Georgia, USA. Annual surveys have been replicated across all years. We use five years of nesting surveys using Little Cumberland sampling protocol on adjacent Cumberland Island to evaluate quantitatively our values for seasonal clutches per turtle derived from Little Cumberland data, with emphasis on error resulting from differences in spatial coverage between islands. We compare our results with accepted values for clutch size and clutches per season, both measured numbers and predicted estimates, and clutch size per year across our 43-year timeline. We test current understanding of clutch size correlated by turtle clutch number and Julian date. We revisit an apparent bimodality of clutches per season observed in earlier years and use our 43-year time line to search for continued presence and/or changes in this observation. In particular, seasonal iteroparity (clutches per turtle) has been dropping in recent years, concomitant with reduction in seasonal nesting turtles. Possible reasons for apparent change in this parameter, such as sampling error or a shift in population structure, are discussed.

Order: 385 **Abstract ID:** 1773 **Type:** Poster **Subject:** Population Biology and Monitoring

GENETIC STOCK COMPOSITION OF LOGGERHEADS (*CARETTA CARETTA*) ENCOUNTERED IN THE ATLANTIC NORTHEAST DISTANT (NED) LONGLINE FISHERY USING ADDITIONAL MTDNA ANALYSIS

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The U.S. Northeast Distant (NED) longline fishery operates in the North Atlantic and interacts with sea turtles that are caught incidentally, in particular loggerheads (*Caretta caretta*). In response to a growing concern for the recovery of sea turtle populations, the NED fishery was closed in 2001, and a 3-year experimental fishery,

implemented by NOAA Fisheries in cooperation with the Blue Water Fisherman's Association, was initiated to evaluate modifications to reduce bycatch and mortality (Watson, *et al.* 2005). Preliminary work (LaCasella *et al.* 2004) indicated that the majority of loggerhead bycatch belonged to the South Florida (SF) stock, although the U.S. Northeast (NE) stock was also detected. We expanded this study to include 368 biopsy samples collected by fisheries observers in 2000 and through the experimental NED fishery between 2001 and 2004. A 400 base pair fragment of the mtDNA control region was amplified and sequenced from each sample and compared to published loggerhead sequences from Atlantic and Mediterranean nesting populations (Bowen *et al.* 2004; Bolten *et al.* 1998; Encalada *et al.* 1998). Mixed stock analysis (BAYES, Pella and Masuda 2001) was used to estimate stock composition of the NED bycatch, using our data in combination with published data from eight potential source nesting stocks. Our results to date indicate that the majority of the NED loggerhead bycatch is composed of animals from the SF stock, with a relatively small proportion comprised of NE and Mexican stocks. Proportions of these stocks in the NED bycatch generally reflect the relative abundance of the SF stock when compared to the depleted NE stock. Work is ongoing to improve our ability to assess stock origin of loggerheads in the Atlantic, and these results should be interpreted with caution until more data from additional nesting populations are available. However, these results are useful for evaluating potential impacts of fisheries in the North Atlantic.

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Order: 386 **Abstract ID:** 1479 **Type:** Oral **Subject:** Population Biology and Monitoring

POTENTIAL SOURCE OF MALES IN LOGGERHEAD TURTLE (*CARETTA CARETTA*) POPULATION IN THE SOUTHERN COAST OF ISRAEL

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Existing knowledge of loggerhead populations around the world points to female domination. A recent study based on nest incubation duration differences of the loggerhead population along the Israeli coast suggests that female offspring should dominate the northern region, and male offspring should dominate the southern region. Studies in Greece suggest that the pivotal incubation duration for loggerhead nests is 56.6 days. Shorter durations produce females, whereas longer durations produce males. Our results showed the median incubation duration of loggerhead nests in the northern region of Israel to be shorter (51 days) than 56.6 days, and longer in the southern region (58 days). In light of the worldwide deficit of males to females, identifying a region with the increased potential of male to female production bears a special significance to the species conservation. However, it should be pointed out that the loggerhead population along the Israeli coast has dwindled severely in the past 80 years. The existing nesting population is estimated at 50:20 females and males, respectively. Without improved protection and rehabilitation of this population, the overall recruitment of males in this region would be extremely small. Moreover, if the population decline along the Israeli coast continues, the potential production of males in this part of the Mediterranean would be lost. Our results elucidate the significance of further research on incubation duration and increased male production along the Mediterranean southern coasts (e.g. Egypt, Libya).

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PASTA: THE PACIFIC-ATLANTIC SEA TURTLE ASSESSMENT PROJECT

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There are profound differences in the nest trends of leatherbacks and loggerheads in the Atlantic and Pacific, despite many similarities in the human stressors that occur in the two ocean basins. Through a large-scale, multi-disciplinary, comparative analysis, we hope to elucidate which stressors are the most important drivers of population growth for these species. Our working group is a team of biologists, modelers, fisheries scientists and oceanographers, many of whom have little experience working with sea turtle data. Our first meeting resulted in a plan for analysis that includes a spatially-explicit hazard assessment through GIS mapping of coastal and pelagic fisheries, relative risk assessment based on individual-based movement models, and life history assessment through age-structured modeling. Stressors that will be qualitatively assessed both spatially and temporally include mortality from fisheries bycatch, egg harvest, adult harvest, beach development, and climate change that affects the amount and distribution of forage in pelagic habitats. Our group is also working on new modeling tools that may allow for improved monitoring and status assessment. Our primary goals are to identify viable hypotheses for observed population change and to determine what primary data gaps are hindering assessment.

NORTHWEST ATLANTIC LOGGERHEADS: ADDRESSING DATA GAPS IN SUB-ADULT ABUNDANCE ESTIMATES

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Significant data gaps exist for the sub-adult life stage in Atlantic loggerhead population models. Virginia's Chesapeake Bay provides important seasonal foraging habitat for sub-adult loggerhead sea turtles. Between 150 and 530 stranding deaths occur within Virginia's waters annually. Recently, the number of annual strandings has been on the rise, due in part to an increase in human-induced mortalities or an increase in the sea turtle population over time. The Virginia Institute of Marine Science has maintained strandings and live mark-recapture datasets spanning 27+ years, and aerial abundance datasets spanning between 1982-1985, 1994, and 2001-2004. These are among the longest datasets for sub-adult loggerheads in the US. Aerial survey estimates indicate that maximum densities are observed in spring as turtles migrate into the Bay. Turtles are visible to aerial observers only when swimming within the top one to two meters of water column. A correction factor is applied to density estimates accounting for turtles below the observable surface. Historically, this correction was based on the percent time (5.3%; Byles 1988) foraging turtles spend at surface during the summer and fall, not in the spring when migrating into the Bay. Or, for every one turtle at the surface, there are 18.9 turtles at depth. Recent data suggest that there are seasonal differences in surfacing behavior. Loggerheads radio tracked in Virginia spend between 9.9% (+/- 2.9% SD) to 25.0% (+/-16.3% SD) of their time at the surface in the spring months. Changes in observed densities from spring to summer likely reflect changes in surfacing behavior as opposed to actual changes in turtle numbers. It cannot be assumed that sea turtle surfacing behavior is constant at all times of the year or in all geographic locations when analyzing aerial data. Large differences (1:18 vs. 1:10 or 1:4)

in seasonal surfacing behavior bias historic abundance estimates of sub-adult sea turtles in Virginia. Aerial surveys conducted in the 1980's overestimated springtime sea turtle abundances. Mean annual density estimates uncorrected for seasonal surfacing behavior ranged between 0.25 turtles/km² and 0.38 turtles/km² in the 1980's. From 2001 to 2004, mean density estimates ranged between 0.05 turtles/km² and 0.10 turtles/km². There were significant differences among years and among survey days. Historic and recent density estimates were recalculated using multiple covariate distance sampling with season-based behavioral corrections as covariates. Results indicate that historic sub-adult abundances were overestimated for springtime observations in Virginia by 20% to 50%, and mean annual abundance estimates are stable or declining. Over the past ten years, annual sea turtle mortalities in Virginia have increased 200% to 300%. Thus, recent increases in stranding mortality may be attributed to an increase in actual mortality and/or increased effort in stranding coverage/response. Limits for incidental takes allowed per fishery have yet to be established for Virginia's fisheries. It is critical that take limits reflect the number of turtles that may be safely removed from a population without contributing to that population's decline. Managers should exhibit caution when comparing density or abundance estimates across seasons or geographic regions.

Order: 389 **Abstract ID:** 1881 **Type:** Oral **Subject:** Population Biology and Monitoring

G.I.S. APPLIED IN SEA TURTLE CONSERVATION

Alvaro Manzano and Monica López Conlon

Endangered Wildlife Trust, Spain

Geographic Information System (GIS) provides important information for long-term monitoring of wildlife with great potential utilities. Three of the seven sea turtle species nest on this Caribbean beach: leatherbacks (*Dermochelys coriacea*), greens (*Chelonia mydas*) and hawksbills (*Eretmochelys imbricata*). The beach is situated in the Northern sector of the Caribbean coast of Costa Rica, located between the mouths of the Pacuare and the Matina Rivers (north limit 10° 13' 50"N, 83° 16' 72" W, south limit 10° 12' 50" N, 83° 13' 22" W). This dense nesting aggregation is considered the fourth largest population (Troëng *et al.* 2004). This beach has been monitored since 1994, following the procedures recommended by the IUCN expert group (Eckert *et al.* 2000). During the 2005 leatherback nesting season, GIS was used on the beach to plot nest locations, erosion and flood threats, and any other risks. It is also a useful tool to improve the management of the beach for future statistical studies. The beach was marked with a post every 25m along the 5671m beach. Nests could not be marked, only measured to be located again in the future, because the highest risk for eggs is human predation. Measurements of beach width, sand banks and cliffs were taken every four days. Nest locations and beach width data incorporated into the GIS could be visually analyzed, and the risks due to erosion or flooding could be located and minimized immediately. One thousand and four sea turtle activities were monitored. Sixty-two percent of these nests (435 nests) were marked with high precision and monitored using GIS. Throughout the project, GIS has proven to be an efficient management and conservation tool, since the nests that were under the risk of being lost to beach dynamics and erosion were relocated to safer areas, the hatching success rates were not significantly different from the other nests. This system aids in statistical analysis and it could also strengthen the information network between different projects. The data stored in this cartographic database should be accessible in a common database for all nesting sites that are shared by one population (i.e. the Caribbean sea turtle population in Central America). The applications of this low budget tool are quite diverse, which is important to encourage its use, not just on this beach, but on many other similar projects. Any project aiming for conservation and research of an endangered species and its habitat, locally and globally, would benefit from this tool.

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VARIATION IN CLUTCH SIZE AND EGG SIZE IN THE LOGGERHEAD TURTLE NESTING POPULATION AT MINABE, JAPAN

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Nesting populations of loggerhead sea turtles, *Caretta caretta*, in the north Pacific have consistently declined over the last half century. Even with appropriate conservation strategies, population analyses are indispensable. In this light, it is important to describe and understand reproductive parameters such as clutch size and egg size, as well as number of nests and hatching success. Clutch size and egg size of loggerhead turtles were examined from Minabe-Senri Beach, Wakayama, Japan for the last 14 years. Mean clutch size was 109.4 (SD=25.2; range=10-177 eggs; n=779 clutches), however, the data most likely includes some split clutches for which the other half was not recorded by our patrol team. At the population level, mean clutch size for nests laid during the last period of the nesting season (after August 1) was significantly smaller than for nests laid earlier. Mean egg diameter was 39.6 mm (SD=1.09 mm; range=37.2-43.3 mm; n=112 clutches). There was no seasonal trend in egg size. At the individual level, egg size was less variable than clutch size. Both clutch size and egg size were significantly correlated with carapace length of the nesting female.

SEA TURTLE NESTING IN FLORIDA, USA: ASSESSMENTS OF ABUNDANCE AND TRENDS FOR REGIONALLY SIGNIFICANT POPULATIONS OF CARETTA, CHELONIA, AND DERMOCHELYS

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Sea turtle nesting is routinely monitored on approximately 1,300 km of Florida's 1,900-km coastline. These beaches host significant nesting activity by loggerheads (*Caretta caretta*), green turtles (*Chelonia mydas*), and leatherbacks (*Dermochelys coriacea*). The number of loggerhead nests recorded annually in Florida in recent years (mean = 52,601, SD = 9,073, 2001-2005) is unrivaled in the Western Hemisphere. The highest annual number of loggerhead nests recorded in the state was 85,988 in 1998. The number of green turtle nests in Florida during the past five years (mean = 5,055, SD = 4133, 2001-2005) suggests that the state has the second-largest nesting population of green turtles in the wider Caribbean. Leatherback nesting, once rare in Florida, is now regionally significant (mean = 717, SD = 185, 2001-2005). This presentation is a synthesis of data from 27 years of broad-scale nest counts and 17 years of spatially detailed counts at index sites. Analyses of annual nesting trends in Florida show that loggerhead nesting has both risen and declined. Green turtle and leatherback nesting have increased. Nest counts at 345 representative east-coast index zones, receiving standardized survey effort over a 17-year period, provide data that were used to develop trend-analysis models that can take into account the influence of both spatial and temporal correlation on count variability. Spatio-temporal shifts in nesting effort span a period of increasing coastal development and cover an extent of beach that includes habitats ranging from urban high-rise

to undeveloped refuge. Nest survey data from Florida beaches are used by management to guide human activities on the nesting beach, such as coastal construction, beach renourishment and the use of artificial lighting. They also assist in identifying areas that need to be protected, and in facilitating efficient responses to catastrophic events such as oil spills.

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DISTRIBUTION AND RELATIVE ABUNDANCE OF SEA TURTLE NESTING IN THE UNITED ARAB EMIRATES

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The mainland coast and off-shore islands of the United Arab Emirates (southern Arabian Gulf) were surveyed five times between May and October, 1999 to 2001, using low flying helicopters, to determine the distribution and relative abundance of marine turtle nesting. Because the entire area was not examined during each survey, the composite data provide an overview of the distribution and abundance of marine turtle nesting. Presence of tracks indicated current nesting activity and remnant body pits identified places where turtles had nested, at least in some years. Species identification was based on the size and shape of tracks and remnant body pits. Recent tracks made by hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) turtles were observed during May and June; no indication of nesting by any other marine turtle species was found. Based on track counts from the most comprehensive survey (26-28 June 2000), 85 % of the nesting occurred on the eight off-shore islands; near-shore islands and the mainland along the Arabian Gulf coast and along the UAE part of the Indian Ocean coast supported minor nesting effort (15% of the total tracks). Among the off-shore islands, Zirku and Sir bu Nu'air Islands hosted 52.5% of the total tracks counted and the remaining six islands hosted 32.5 % of the nesting effort. Hawksbill turtles nested primarily on the off-shore islands (n= 82 of 97 tracks). Hawksbill nesting on the near-shore islands and along the 1,318 km of the Arabian Gulf mainland coast was sparse (n= 15) and widespread, occurring in the extreme eastern (n= 4) and western (n= 3) remote areas with the remainder on near-shore islands. No hawksbill nesting attempts were observed along the northern part of the Indian Ocean coast. Only a small number of green turtle nesting attempts was recorded. Among these, most occurred along the mainland coast (n= 8) compared to the off-shore island beaches (n=1). Green turtle nesting along the mainland coast was concentrated on the extreme eastern portion of the Arabian Gulf mainland coast (n= 6) and in the northern part of the Indian Ocean coast (n= 2). Although the areas covered and the numbers of tracks counted varied among the surveys, the pattern was consistent that Zirku and Sir bu Nu'air Islands hosted the greatest number of hawksbill tracks compared to the number recorded on other islands and along the mainland coast. No marine turtle nesting was recorded along the coast adjacent to developed areas.

LOGGERHEAD TURTLE, *CARETTA CARETTA*, IN ITALY: A REAPPRAISAL OF NESTING ACTIVITY WITHIN THE NATIONAL SCENARIO

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Until recently, loggerhead turtles in Italy were reported to be regularly breeding in the Pelagian Islands (despite the small numbers), and only sporadically elsewhere. A project to assess the magnitude of nesting activity along the Ionic coast of Calabria (the southernmost part of the Italian peninsula) was undertaken in Spring 2000. Turtle nests have occasionally been reported along this coastline (198 km in length) in the past. Ground surveys were mostly focused along a coastal sector of 52 km and, in particular, in a sub-sector of 16.5 km. Monitoring efforts (ME = prospected km units per season / potential km units per season) in the sub-sector increased regularly from 0.06 (2000) to 0.51 (2005), for a total of 1,343.5 km patrolled in 152 days during June-July. The relationship between ME and emergence track density was used to assess the survey adequacy. Over all, we recorded between 39 and 43 nests (in total 84 emergences) along the entire study area between 2000 and 2005 (average = 6.5 ± 1.69 SE nests/year; range = 3-13, maximum in 2005). However, most of them (n = 27, 69.2%) were concentrated in the sub-sector. Our intensive monitoring program revealed the existence of an unexpected regular breeding area along the Ionic coast of Calabria, which can be currently recognized as the main Italian nesting ground. Our experience suggests that sea turtle nesting in Italy is still underestimated due to inadequate monitoring protocols. Moreover, the whole national nesting activity can be conservatively estimated at 30-40 nests/year.

CANCELLED

PRELIMINARY SURVEY OF MARINE TURTLES OF THE EGYPTIAN MEDITERRANEAN COASTAL WATERS

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The main objective of the present study is to detect the occurrence and distribution of marine turtles along the northwestern and northeastern Egyptian Mediterranean coasts. Several field surveys were carried out during Spring 2003. We recorded the presence of three endangered marine turtle species: the loggerhead turtle (*Caretta caretta*), the green turtle (*Chelonia mydas*) and the leatherback turtle (*Dermochelys coriacea*) in Egyptian Mediterranean waters. These marine turtles migrate several hundreds of miles from their feeding habitats and mating areas to their nesting beaches. The distribution of marine turtles in the coastal areas of the Egyptian Mediterranean varies

significantly from place to place. Generally, the results of the survey showed that two major sites are considered the most probable sites to accommodate marine turtles: El-Arish in the east and El-Sallum in the west. The other sites of the study area are subjected to major threats to marine turtle habitats. These threats include habitat destruction, pollution, international trade and by-catch. Stemming from pressing conservation needs in Egypt, EEAA supported the European Community initiation for the purpose of “identifying and evaluating all resources of potential value for inclusion in the Protected Network of Egypt”. The three new protected areas proposed in the northwestern coast of Egypt (west of Marsa-Matrouh), however, reflect the importance of that area in relation to marine turtles, among other resources.

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NESTING ACTIVITY OF THE LOGGERHEAD SEA TURTLE *CARETTA CARETTA* ON THE POCKET BEACH OF LINOSA ISLAND (SOUTH OF ITALY): RECENT DATA (2004-2005)

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Loggerhead turtle (*Caretta Caretta*) nesting surveys were conducted on the beach of Linosa Island (Pelagie, South of Italy) during 2004-2005 within the EU-Life NAT/IT/00163 Project Del.Ta. Nesting activity was recorded, including individual (two in 2004 and one in 2005), crawl and clutch data. At night, we tagged and measured the nesting females. In 2004, two females nested within an hour of each other and at a distance of a few meters from each other. One of the two females had been already tagged (tag number B333) on the same beach in 1996 and, after an inter-nesting interval of 21 days, the same female came back to deposit a second clutch. Incubation period, number of eggs, hatching success and emergence percentage have been calculated for these three nests. Only one female nested in 2005, depositing a single clutch. A comparison of these four clutches is provided.

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TURTLE MONITORING IN SOUTH AFRICA: 42 YEARS WORTH OF DATA

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Conservation management and monitoring of marine turtles started in 1963 along the northeast coast of South Africa. At the time, two species of turtles, leatherbacks and loggerheads, were under great threat from local communities raiding nests and killing turtles. When authorities started the program, first priority was to protect

nests and second priority was to monitor turtle activity. The objective of the program was to track the numbers of turtles over time and if the populations were to recover beyond a specific target, harvesting of both species could be reconsidered. The goal of this presentation is to evaluate the data that was collected over the 42 years, and possibly re-evaluate the original objectives of the program since the nesting numbers of both nesting turtle species appears to have “recovered” beyond the target threshold set. However, there are two distinctly visible trends that make the interpretation of population size difficult. The number of nests of both species appears to have two distinct cycles confounding population trends. Firstly, a ~20 year cycle in the number of nests of both species are visible, but seems strongest for leatherbacks. Secondly, the large interannual variation, possibly coinciding with ENSO events, confuses overall population trends, leading to suppressed nesting in times of increased SST. Care should therefore be taken with interpreting population trends of data gathered in an inconsistent or discontinuous manner in other short-term programs.

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INTERESTING SEASON PRESENCE OF LEATHERBACK TURTLES IN NEAR-COASTAL WATERS OFF GABON

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Most studies of leatherback turtles have concentrated on nesting behavior and little data is currently available on the movements of turtles between seasonal nesting periods. This is particularly true for turtles nesting on the Atlantic coast of Central Africa, where satellite tracking studies are still in their infancy. It is estimated that up to 30,000 leatherback nests may be deposited on the 900 km coastline of Gabon per year, however, turtle research groups in Gabon are limited by funding/logistical constraints to confine their presence in nesting areas to the months of highest nesting and hatching (November to April). Therefore, an information gap exists regarding nest numbers and turtle distribution from April/May through October. Here we report on preliminary observations of leatherback turtle presence in Gabon (principally the Mayumba National Park) outside of the main nesting season, using a combination of beach patrols and boat missions. Leatherback nesting attempts have been noted throughout the entire year, and a recent campaign of boat missions has shown leatherbacks to be present at relatively high densities in near-coastal waters. We report these findings and discuss methodologies for future research.

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AN OVERVIEW OF THE STATUS OF GREEN TURTLES (*CHELONIA MYDAS*) IN KENYA

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The green turtle, *Chelonia mydas*, is the predominant species in Kenya, representing over 90% of all documented nestings and sightings. Although the full extent of the green turtle nesting population is unknown, estimates have indicated an annual range of 200 – 300 individuals. Whether the nesting population is in recovery or in decline as a result of ongoing conservation efforts is not well established. This presentation focuses on the status of the green turtle population in Kenya with special emphasis on trends in nesting, tagging and mortality obtained by KESCOM from 1999 to 2004 from 4 regularly monitored sections of the Kenyan coast. The results highlight the need for increased conservation efforts for the future of a species which could be facing undetermined threats from depletion in the Western Indian Ocean. Recommendations are made for the review and update of the National Sea Turtle Recovery Action Plan.

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A REVIEW OF FEEDING, BREEDING AND WINTERING SITES OF MARINE TURTLES IN TURKEY

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The first detailed study covering all marine turtle nesting sites in Turkey was carried out in 1988 (Baran and Kasperek, 1989) and the most important 17 marine turtle nesting sites for *Caretta caretta* and *Chelonia mydas* have been identified as Marine Turtle Nesting Sites. There are also several records of *Dermochelys coriacea* sightings in Turkish waters. There has been no nesting record on the Turkish coast for this species. Turkey has signed international conventions and has also developed its own national legislation for the conservation of marine turtles and their habitats. Some marine biological diversity and environmental impact assessment studies of areas in the Western and Eastern Mediterranean part of Turkey include related data on marine turtles. In 2003-2004, a marine biological diversity assessment of Datca-Bozburun (Mugla) Specially Protected Area (SPA) was carried out by a team from the İstanbul University Institute of Marine Sciences. *Caretta caretta* was observed in the SPA: in the Kadirga Cape, Karagelme Bay and Samucak Cape. Our results also show that the SPA is a mating area for *Caretta caretta*. During WWF Turkey's marine richness assessment of the Lycian coast (Antalya) in 2002, *Caretta caretta* and *Chelonia mydas* specimens were seen more around Kas-Kovan Island and Suluada. Reportedly, these two rare species were frequently observed at some locations within the research area. Local diving centers in Kas indicate Kovan Island and Suluada as hotspots for both of these species. Both species were also frequently seen and photographed around the coasts of Ucadalar and Tekirova. Both species are found in the study area although there are no major nesting sites except Patara Beach, which suggests that these regions are regularly visited for

feeding purposes. Fields of pen shell fields, especially the ones observed in Kas, as well as dense populations of *Strombus persicus* probably attract *Caretta caretta* to these regions. Another food item of the loggerhead, the seah slug *Pleurobranchus* species, is plentiful around the seagrass meadows of the Ucadalar. The region between Kovan Island and Suluada, as well as the shores of Ucadalar and Tekirova are rich in marine vegetation, containing the most important food resources for both species of marine turtles. Thus, legal measures must be taken to protect the marine fauna and flora of these regions, and human activities threatening the marine turtles should definitely be prevented (Yokes, 2003). Next, regulations aimed at protecting critical habitats at sea should be developed and implemented.

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THE QUÉBEC SEA TURTLE PROJECT: TOWARDS A CONSERVATION STRATEGY IN THE ESTUARY AND GULF OF ST. LAWRENCE, CANADA

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Leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), and green (*Chelonia mydas*) sea turtles are known to occur seasonally in temperate waters off Atlantic Canada, between June and November. The leatherback is the only sea turtle that has been identified in the Gulf of St. Lawrence in the province of Québec. Since the first documented sea turtle observation in 1981, little effort has been made to collect information in Québec. To alleviate this situation, an action plan was developed and implemented in 2003 to assess sea turtle abundance, distribution, and biology in the Estuary and Gulf of St. Lawrence. Bilingual (*English - French*) observation kits which include datasheets, species information, proper release techniques, contact information and cameras are being distributed to coastal fishing communities, local organizations, and schools to improve public awareness, create a sense of stewardship, and document sightings. A toll-free telephone number and a website (www.amphibia-nature.org) have recently been established to facilitate the assembly of information. In the past three years, dozens of anecdotal (incomplete sighting reports) and documented (GPS locations, pictures, captured or stranded turtles) records have been collected. Leatherback turtles are encountered in the Estuary and Gulf of St. Lawrence as far west as Île aux Coudres and east to Blanc-Sablon. This large area may provide important foraging habitat for this species. Other sea turtle species may also occur in the region based on anecdotal reports. It is not clear whether leatherbacks are more abundant in recent years due to increased public awareness or from other factors such as climate change. However, it will be essential to include Québec waters in the international efforts to recover sea turtles in the Atlantic Ocean.

AREAS OF FEEDING OF MARINE TURTLES IN THE NATIONAL PARK ARCHIPELAGO THE ROQUES, SOUTH CARIBBEAN, VENEZUELA

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The Archipelago Los Roques is a complex of 42 keys of coral origin that constitutes the most important reef formation of Venezuela and one of the best preserved in the continent, with large meadows of sea grass. The goal was to design an integral program of conservation and development for the recovery of sea turtle populations. Density estimations were calculated by means of multiple census using light diving equipment, and using transects of changeable and long fixed width of 500 meters on five stations. These stations were selected according to the type of substrate, where we identified species, height and sex, as well as collected data on behavior and feeding. One hundred and one individuals were observed during 24 surveys: five (4.95%) *Chelonia mydas* and 96 (95.05%) *Eretmochelys imbricata*. According to the turtles' association with the biotic component, we found that 80% of the *C. mydas* prefers the sea grass beds and 96.88% of *E. imbricata* prefers the corals. The densities of the resident aggregations for hawksbills were 50.61 individuals/hectare and 5 individuals/hectare on stations with coral substrate, and for green turtles we found 3.33 individuals/hectare and 5.08 individuals/hectare associated with sea grass substrate. The technology of this census allows for direct observation with limited resources and a preferential position for observations. The obtained information clearly defines where attention must be directed in the conservation of feeding areas.

LEATHERBACK TURTLE NESTING MONITORING IN LA PLAYONA, ACANDÍ, CHOCÓ, ATLANTIC NORTHWEST OF COLOMBIA

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Leatherback turtles are suffering from severe anthropogenic problems, such as egg exploitation and beach destruction, in their nesting areas. This scenario advises the protection of the most important nesting areas throughout the species' range of distribution. In the northwestern Atlantic coast of Colombia, there is an important nesting beach at La Playona (Acandí), which hosts the highest known nest density of this species in Colombia. Nesting on some beaches in this region is still unexplored. La Playona is a 12 km long, high-energy beach where leatherback turtle nesting occurs from March to June. Sampling efforts were concentrated on a 3km section where previous studies had found the highest nest density (personal observations; Rueda et.al., 1987). When the leatherback nesting season finishes, some sporadic hawksbill nesting may occur. In previous studies conducted on the same 3 km section of La Playona, it has been estimated through tagging records that approximately 100 females nest every year (Ross, 1982) with the possibility of global numbers reaching up to 200-250 females (USFWS, 1981. In: Eckert 2001). We have monitored the nesting population since 1998, capturing an average of 120 new nesting leatherback females every year and marking them with Monel tags. The percentage of marked females has varied from 6.6% in 1998 to 34.3% females in 2005. During the 2005 nesting season, 111 new females were

marked, and 58 were recaptured from previous nesting seasons. The average number of nests on the 3 km beach section from 1998 until 2005 (no data for 2000 and 2001) was 218 nests per year. Due to the high exploitation and predation rates of nests on this beach, together with the frequent inundation of nests located close to the shoreline, nests have been translocated into a controlled hatchery. An increasing number of nests have been translocated every year since 1998. Research is being conducted in order to improve the hatching success in natural and translocated nests. In order to improve turtle protection, education and sustainable development programs are being implemented in the area by local NGOs.

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AERIAL PHOTOGRAMMETRY OF LEATHERBACK TURTLES: A NOVEL METHOD FOR NON-INVASIVE MEASUREMENT

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Little is known about the distribution and size-class structure of leatherback turtles (*Dermochelys coriacea*) in the eastern Pacific. While aerial surveys have proven to be an effective method for detecting leatherbacks and determining their distribution, the only technique for measuring turtles has been through capture. Due to the highly endangered status of leatherback turtles, this approach may not be the most efficient. A technique that has been successfully used to measure other vertebrate species in the marine environment is aerial photogrammetry, the photographing and subsequent measurement of organisms. In this study, we used a modified aerial reconnaissance camera mounted in a photo port in the deck of a NOAA Twin Otter aircraft. An onboard data acquisition system recorded time, position, and altitude each time the camera fired. Altitudes were determined via output from a radar altimeter, which was calibrated by photographing targets of known size. Two films were tested (Kodak Aerochrome MS 2427 and Kodak Aerial Plus X 3404) at altitudes ranging from 152.4 to 243.8m. While black and white film provided higher resolution, color positive film allowed us to see the outline of the turtle underwater at greater depths. Two turtles were measured during this experiment, one male (155.6 cm straight carapace length [SCL], 85.8 cm straight carapace width [SCW]) and one probable female (149 cm SCL, 81.1 cm SCW). As the first application of the aerial photogrammetry technique for measuring sea turtles, we demonstrate that this is a viable method for measuring turtles in other areas, particularly where capture is logistically difficult, in areas of high water clarity, and in areas of high turtle density.

POPULATION LEVEL IMPACTS OF SMALL-SCALE FISHERIES BYCATCH ON HIGHLY-MIGRATORY MEGAVERTEBRATES: A CASE STUDY OF LOGGERHEAD TURTLE MORTALITY AT BAJA CALIFORNIA SUR, MEXICO

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Industrial-scale fisheries bycatch has been shown to drive declines in non-target megavertebrate populations including cetaceans, sea birds, sharks and sea turtles. However, the effects on megavertebrate populations of small-scale gillnet and longline fisheries are poorly understood. As a case study, we examined the demographic implications of small scale fisheries bycatch as a result of the overlap of loggerhead turtle foraging and intense fishing along the Pacific coast of Baja California Sur (BCS). We identified a juvenile loggerhead turtle foraging hotspot at the BCS coast based on satellite telemetry of 29 juvenile loggerheads from 1998-2005 and combined shoreline surveys for beachcast turtle carcasses, semi-structured interviews of fishermen and fisheries observations from 2003-2005 to estimate annual local bycatch. Daily bycatch rates per boat and per unit effort rivaled or far exceeded those published for industrial-scale fisheries. We extrapolated minimum annual bycatch rates for BCS small-scale fisheries, resulting in one of the highest documented sources of mortality for the critically endangered North Pacific loggerhead population. Incorporating these data into a simple demographic model, we conclude that bycatch mortality in BCS small-scale fisheries alone could preclude recovery of this population. Our case study suggests that small-scale fisheries bycatch can have population-level impacts on highly migratory megavertebrates. Because small-scale gillnet and longline fisheries like those of BCS are ubiquitous to the world's oceans, we conclude that assessing and addressing small-scale fisheries bycatch should be an international marine conservation priority.

TRIALS AND TRIBULATIONS OF TRACKING SEA TURTLES IN MOSQUITO LAGOON- TRENDS IN ABUNDANCE AND RESULTS FROM THE PASSIVE ACOUSTIC MONITORING NETWORK

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NASA has funded marine turtle research in Mosquito Lagoon since 1976. The ratio of green turtle (*Chelonia mydas*) and loggerhead turtle (*Caretta caretta*) captures changed markedly in the past 29 years. Green turtles, which composed 20% of the total captures in the 1970's, now represent 80% of captures. Sex ratios are highly biased towards females in this juvenile green turtle population. Capture and recapture rates of both species are low, with recaptures averaging only 10% over the last decade. Comparing Mosquito Lagoon capture data to other sites within the Indian River Lagoon (IRL) and other Florida estuaries shows similar population structure (dominated by juveniles) but indicates that Mosquito Lagoon supports a relatively small population in terms of numbers. Prior to 1980, fibropapillomatosis (FP) was not observed in marine turtles in Mosquito Lagoon. Since 1995, the disease

afflicts 50% of all green turtles with some variation each year but no particular trend in FP incidence. To improve our knowledge of site fidelity and short term movement patterns of healthy and FP turtles, we began using a passive acoustic tracking technique, on a sub-sample of turtles. In partnership with the Florida Program for Shark Research, we installed a network of passive acoustic receivers in 2004 in the lagoon and northern Indian River. To date, 17 juvenile turtles (45-66 cm SLCL) have been tagged and tracked with varying levels of success. We will discuss the spatial data collected and the challenges, pros, and cons of this technique for monitoring juvenile marine turtles in a shallow estuary.

Order: 407 **Abstract ID:** 1490 **Type:** Poster **Subject:** Population Biology and Monitoring

NEST COUNTS AND BEACH CHOICES FOR MARINE TURTLES (LEATHERBACK, *DERMOCHELYS CORIACEA*; GREEN, *CHELONIA MYDAS*; OLIVE RIDLEY, *LEPIDOCHELYS OLIVACEA*; AND HAWKSBILL, *ERETMOCHELYS IMBRICATA*) ON THE SOUTHERN BEACHES OF BOKO ISLAND (GULF OF GUINEA, AFRICA) ACROSS FIVE NESTING SEASONS (2000/2001 THROUGH 2004/2005)

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Bioko is the largest of the four Gulf of Guinea islands (2027 km²) and the nearest to mainland Africa, lying only 32 km offshore from Cameroon. Four species of marine turtles (leatherback, *Dermochelys coriacea*; green, *Chelonia mydas*; olive ridley, *Lepidochelys olivacea*; and hawksbill, *Eretmochelys imbricata*) are known to nest on the 19 km of black sand beaches along the southern shores of the Island's Gran Caldera and Southern Highlands Scientific Reserve. For the past five (2000/01 through 2004/05) nesting seasons (October through April), the Bioko Biodiversity Protection Program, a cooperative enterprise of Arcadia University and the Universidad Nacional de Guinea Ecuatorial, has employed local patrols to record turtle activity on these beaches. Leatherback nests were the most common, and showed the greatest year-to-year fluctuation (typically 2500-6000 nests), followed by green turtles nests (1000-2000), olive ridley nests (50-100) and hawksbill nests (fewer than 20). When combined with comparable results by other scientists for the 1996/97 and 1997/98 nesting seasons, long-term trends became evident and indicated relatively stable nest counts for green, olive ridley and hawksbill turtles. Leatherback nests increased to over 5,000 for three seasons, followed by a decline to approximately 3000 in the 2003/2004 season and 2000 in the 2004/2005 season, but these totals are considerably higher than those recorded in the 1990's (approximately 1000 per season).

Order: 408 **Abstract ID:** 1509 **Type:** Poster **Subject:** Population Biology and Monitoring

AMVRAKIKOS BAY: AN IMPORTANT FORAGING AREA FOR LOGGERHEAD TURTLES IN GREECE

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A radio and satellite telemetry study on turtles in Amvrakikos Bay was undertaken by ARCHELON in 2002-2003 (Rees & Margaritoulis in press). Subsequently, a long-term programme was started to obtain further data on the

turtle population, implemented within the context of the LIFE project: “Reduction of mortality of *Caretta caretta* in Greek seas”. The tagging programme comprised 10 and 18 days of fieldwork between May and September during 2004 and 2005, respectively. Each fieldtrip lasted approximately one week. Turtles were caught using a rodeo technique in the shallow waters of the north-eastern part of the Bay. Carapace (straight carapace length notch to tip [SCLn-t; Bolten, 1999]) and tail measurements (Dorsal tail length from the anterior part of the inter-supracaudal notch to the tail tip [TLC; Limpus & Limpus 2003]) were recorded with other biometric data. Turtles were double tagged with a plastic and a metal tag and photographed. Results provided evidence of an important, foraging population of large sub-adult to adult size loggerheads utilizing the bay, with 128 individuals identified in two years (mean SCLn-t=69.0cm, SD=7.7, range=47.1-91.5cm, N=127). Sex ratio, determined from tail length (adapted from Limpus & Limpus 2003), was biased towards males in adult-sized individuals (≥ 69 cm SCLn-t), accounting for 38 (61.3%) of the 62 adult-sized turtles. Only 4 (6.5%) individuals were confirmed as female, having previously been tagged after nesting during other ARCHELON projects. These previously tagged turtles link Amvrakikos Bay to Greece’s three major nesting areas. The final 20 turtles could not be positively sexed using external morphological features. Amvrakikos Bay hosts a large artisanal fishery which may impact the turtle population. Indeed, 3 turtles (2.3%) were entangled in, or had ingested, fishing line, 4 turtles (3.1%) were missing part or all of one flipper and 10 turtles (7.8%) exhibited significant impact-induced carapace damage. To promote the protection and rescue of injured turtles, ARCHELON has established a turtle First Aid Station at one of the key ports in the Bay.

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Order: 409 **Abstract ID:** 1486 **Type:** Poster **Subject:** Population Biology and Monitoring

IMPLEMENTATION OF GIS SYSTEMS IN *CHELONIA MYDAS* NESTING AREAS IN THE WESTERN REGION OF CUBA

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Geographic Information Systems (GIS) was used as a tool to characterize and compile biological information of the *Chelonia mydas* nesting population of the Guanahacabibes Peninsula in the western region of Cuba. A complete digitalization of all index beaches was made, which included the assignment of geographical coordinates

to characteristic elements of the coastline and vegetation as well as the located nests. Data corresponding to biological, temporal and abiotic variables (when present) were associated with each located nest in order to obtain thematic maps depending on the researcher's needs. As a result, patterns of spatial distribution and temporal variation were found. For instance, in all analyzed beaches, there were one or two specific areas where most nesting attempts occurred, mainly in association with the vegetation line. This density effect varies, and is more conspicuous during high nesting seasons. Elements of a female's nesting behavior, such as nest site fidelity, were also obtained through this application. Therefore, GIS can be considered an efficient tool in the monitoring of marine turtle nesting areas and the gathering of biological information with possible management implications.

Order: 410 **Abstract ID:** 1487 **Type:** Poster **Subject:** Population Biology and Monitoring

REPRODUCTIVE SUCCESS OF *CHELONIA MYDAS* IN NESTING AREAS OF GUANAHACABIBES PENINSULA, CUBA

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A study of the reproductive success of green turtles (*Chelonia mydas*) was carried out between the years 2000 and 2004 on the Peninsula of Guanahacabibes, located in the western region of Cuba. Spatial and temporal comparisons were performed on successful female emergences as well as hatching success. There were more successful nesting attempts during seasons with the highest nest numbers (2000, 2002 and 2004) ($F(4, 196)=3.04$, $p=0.018$). Hatching success was also higher in those years compared to the 2001 and 2003 nesting season, where no hatchings were observed due to the massive mortality caused by tropical storms. Spatial variation was analyzed on five beaches and differences were found not only among beaches (highest values were found in Antonio and Caleta de los Piojos ($F(4, 196)=6.58$, $p<0.05$) but also in relation to the distance from the high tide line, with a concentration of nests as well as hatching success occurring near the beginning of the vegetation zone. Differences in the number of nesting attempts per female were also found, varying among high and low nesting seasons with a maximum number of attempts during the early years. In general, there was a higher frequency of females (55%) with only one nesting attempt within a season, producing a low average number of nests per female (1.68 ± 1.26). Despite this low number, the relatively high hatching success (over 70 %) and successful nesting attempts (around 60 % during high nesting seasons) indicate that the green turtle nesting population of the Guanahacabibes Peninsula has a significant reproductive success.

Order: 411 **Abstract ID:** 1750 **Type:** Poster **Subject:** Population Biology and Monitoring

COMPARATIVE MODELING OF SEA TURTLE POPULATION DYNAMICS

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I compare two types of models of leatherback sea turtle population dynamics to evaluate how to focus and prioritize

research needs. Performing uncertainty and sensitivity analysis on different types of models (e.g. population projection matrix models vs. detailed simulation models or mechanistic models) can produce quite different rankings for a parameter's influence on model outcome. Conclusions from earlier models of sea turtle population dynamics have ranged from juvenile survival having the greatest impact on population growth rate, to parameters describing fertility having the greatest impact on long term population growth. Such different outcomes may be due in part to constraints imposed by the structures of the models. Deterministic population projection matrix models have been used in part because they are analytically tractable and relatively easy to interpret, but they can be unrealistic, especially in populations under fluctuating environmental or behavioral conditions. Since leatherbacks exhibit temporal and spatial variation in movement that may depend upon variable environmental conditions such as food availability, models that incorporate movement and behavior may be more realistic. Simulation models are one form that allow more direct incorporation of the kinds of information that is provided by many lines of research (including physiology, behavior, radio-tracking, growth, etc.), allowing direct comparison of the sensitivity and uncertainty of model output to parameters provided by each research program.

Order: 412 **Abstract ID:** 1824 **Type:** Poster **Subject:** Population Biology and Monitoring

SINGLE NUCLEOTIDE POLYMORPHISM (SNP) MARKER DISCOVERY IN *CHELONIA MYDAS*

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Chelonia mydas was used as a model to develop a series of nuclear SNP loci. SNPs are a recently developed type of genetic marker that have the potential to improve and simplify current genotyping methods and eliminate the variability of microsatellite genotypes due to technological and financial differences between labs. In addition, these markers can be used to build on previous studies that used mtDNA, RFLP and microsatellite markers in order to further our understanding of sea turtle population structure, evolution and molecular ecology. DNA extracts from 35 green turtles sampled in Caribbean, East Pacific, Central Pacific, and Indo-Pacific locations were used for two methods of SNP discovery. The first approach employed amplified fragment length polymorphism (AFLP) techniques to generate random fragments of DNA. The second technique utilized a microsatellite library to screen sequences of DNA segments not containing microsatellites. Site specific primers were designed for eight candidate clones from the microsatellite library and used to amplify identical regions, ranging in size from approximately 400-600 bp, across a set of individuals. The resulting homologous sequences were compared across green turtles and any nucleotide difference at a single point along the linear sequences was indicative of a SNP. Approximately 3300 bases were screened resulting in the discovery of 30 SNPs, or an average of one SNP every 110 bp. SNPs ranged in frequency from 0.02 to 0.5. One SNP will be chosen from each locus to generate a set of 8 independent SNP markers. These markers will be used to assess green turtle population structure in the Pacific and tested for utility for the other sea turtle species.

MARINE TURTLE NESTING SURVEY, SYRIA 2005

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The 183 km coast of Syria was briefly surveyed in 1991 and limited nesting (primarily loggerheads) was found on 2 beaches, at Lattakia and between Tartous and Lebanon. A collaborative project between ARCHELON, the Sea Turtle Protection Society of Greece and Tishreen University, Lattakia, Syria, recorded 100 green turtle nests and 6 loggerhead nests during the two-month survey (July and August 2004) on the 12.5 km beach south of Lattakia. This resulted in the development of a plan for continued conservation efforts, including: • Continuing beach surveys / tagging in Latakia and other areas of importance; • Strengthening lobbying to reduce threats to marine turtles; • Assessing marine turtle nesting levels along the Syrian coast; and • Producing a management plan for Syrian marine turtles. A four month (June-September) survey of the three beaches (south of Lattakia (13 km), north of Baniyas (2 km) and Wadi Kandil (3 km) was undertaken in 2005. This abstract presents a summary of the nesting, stranding and tagging results. Nest numbers were calculated in two ways: 1) from initial track assessments that did not include clutch identification; and 2) by summing the number of nests confirmed by the observation of eggs. Eggs were confirmed in one of four ways: a) nest excavation after hatching; b) clutch location after deposition; c) post-depredation activity; and d) direct observation at deposition. The accuracy of the number of nests obtained from track assessment only was checked by comparing nesting success. Nesting species was determined by the appearance of the track and by maximum width of the track, as well as during the excavation of hatched nests. The number of green turtle nests determined by track inspection was 29 (18 on Lattakia Beach, 7 on Baniyas Beach, and 4 on Wadi Kandil Beach). The number of nest determined through direct observation of eggs was 11; comprising 6 nests on Lattakia Beach (one loggerhead turtle and 5 green turtle nests); 4 nests on Baniyas Beach (2 loggerheads and 2 green turtle nests) and one green turtle nest on Wadi Kandil Beach. Comparing these results with last year's nest numbers, we found that nest numbers in 2005 represent approximately 11% of the nests recorded during 2004. This is a somewhat disappointing number but is seemingly part of a Mediterranean-wide trend for low nesting levels in 2005. Data from 26 incidentally captured loggerhead and green turtles were recorded. Both species of marine turtles that nest in Syria were captured from March to October 2005. Six loggerhead and 9 green turtles were tagged on Syrian beaches before being released, which will hopefully provide post-nesting migratory data. Turtle monitoring on Syrian beaches will be continued and developed during next few years.

CANCELLED

LOGGERHEAD TURTLE DENSITY AND ABUNDANCE ALONG THE PACIFIC COAST OF THE BAJA CALIFORNIA PENINSULA (MEXICO), DETERMINED THROUGH AERIAL SURVEYS: A PRELIMINARY ASSESSMENT

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Loggerhead turtles, *Caretta caretta*, are highly migratory and use a wide range of broadly separated localities and habitats during their lifetime. In the North Pacific, loggerheads carry out an extensive developmental migration, often traveling from nesting areas in Japan to distant developmental and foraging habitats in the eastern Pacific. Loggerhead turtles in the Pacific are adversely impacted by a variety of activities including incidental capture in commercial fisheries, boat strikes, debris ingestion, and intentional harvest. These impacts have prompted calls for increased research and protection of loggerheads in this region. To address this need, we carried out aerial surveys for loggerhead turtles along the Pacific Coast of the Baja California Peninsula, Mexico – an area long thought to be critical habitat for juveniles. The project was a US- Mexico binational effort with cooperating institutions from government, academic, and nongovernmental sectors. Surveys were carried out from September to October 2005 and encompassed nearly 7,000 km of track-line with offshore extents to 170 km. More than 400 turtles were sighted. Loggerheads were the most prevalent (77% of all sightings). Olive ridleys (12%), green turtles (7%), and leatherback turtles (<1 %) were also sighted. Approximately 4% of all turtle sightings were unidentified. We estimate 10's of thousands of loggerhead turtles were present in the spatial and temporal scope of these surveys. Combined with our ongoing water-based demographic studies and satellite telemetry efforts, this project has further demonstrated the value of Baja California's Pacific Coast for loggerhead turtles.

NESTING ACTIVITY OF *CHELONIA MYDAS* AND *CARETTA CARETTA* ON KARPAS PENINSULA, NORTH CYPRUS

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This paper provides detailed information regarding the spatial and temporal patterns of nesting green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles during seven nesting seasons (1999-2005) at key nesting sites on the Karpas Peninsula, north Cyprus. Additional importance is placed on these sites, due to the fact that they remain relatively undeveloped and therefore have experienced negligible anthropogenic impacts to date. This study includes 18 beaches and coves which were considered important (hosting more than 5 nests in any given season) during previous extensive monitoring surveys. Six of the study sites are on the southern coastline and the remaining twelve are on the northern coastline of the Karpas Peninsula. A total of 1,221 nests was recorded over the study

period. The relative distribution of nests between the two coastlines was 863 on the northern coastline (71%, annual range 32-245), with only 358 (29%, annual range 25-93) found on the southern coastline. In fact, 1,014 out of the 1,221 (83%) were *Chelonia mydas* nests recorded on Karpas beaches, indicating that these beaches are utilized primarily by green turtles. Also, 746 of the 1,014 (74%) *Chelonia mydas* nests were on North Karpas beaches. It is therefore extremely important that full legal protection be given to the north Karpaz and Agios Philon beaches, which are so important for the Mediterranean subpopulation of green turtles, and to have them formally designated as “Specially Protected Areas.”

Order: 417 **Abstract ID:** 1808 **Type:** Poster **Subject:** Population Biology and Monitoring

EVALUATION OF HATCHING LOGGERHEAD SEX RATIOS FROM THE SOUTHEASTERN U.S. USING GONADAL HISTOLOGY

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Loggerhead sea turtles possess temperature-dependent sex determination in which the incubation temperature determines the sex of the hatchling. Temperature-dependent sex determination (TSD) has the potential of producing biased sex ratios. Therefore, the sex ratios produced from TSD are of ecological and conservational interest. In the current study, gonadal histology was used to identify the sex of hatchling loggerheads from the southeastern U.S. which were found dead in nests after all of the live hatchlings emerged. Loggerheads nesting in the southeastern U.S. represent one of the largest loggerhead populations in the world. The current study examined sex ratios on four beaches spanning from North Carolina to south Florida. One to nine hatchlings per nest were collected from a total of 66 nests. Kidney/gonad tissue was preserved from each hatchling, and was then processed using standard paraffin histological procedures. Each gonad was examined microscopically to determine if it was an ovary or a testis. Males and females were identified on all four of the beaches examined, but females appeared to predominate.

Order: 418 **Abstract ID:** 1799 **Type:** Poster **Subject:** Population Biology and Monitoring

DEVELOPMENT AND VALIDATION OF A TECHNIQUE FOR USING SKELETAL GROWTH MARKS TO BACK-CALCULATE LENGTH IN LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)

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Growth rates within and among sea turtles are highly variable and gaining an understanding of this variability is difficult using traditional means, such as mark-recapture. Skeletochronology is becoming a standard technique for the assessment of individual growth rates in sea turtles. Here we present an analysis of the relationship between humerus dimension and somatic growth in loggerhead sea turtles, demonstrating that it is allometric, with a higher slope for small pelagic turtles and a lower slope for larger neritic turtles. The use of this relationship to accurately back-calculate carapace lengths from diameters of skeletal growth marks was validated with 12 loggerheads that

were captured, tagged, released, and subsequently recovered as dead strandings. We estimated the length at capture by back-calculating, using the diameter of the skeletal growth mark most representative of the time of capture as a predictor. The mean difference between the measured carapace length at capture and the estimated carapace length obtained through back-calculation was 0.8 cm \pm 0.3 S.E. For corresponding estimates of annual growth rate, the mean error was 0.3 cm/yr \pm 0.1 S.E. We suggest that, with proper application, back-calculation in combination with skeletochronology can be a powerful tool in studying the growth dynamics of individual sea turtles.

Order: 419 **Abstract ID:** 1802 **Type:** Oral **Subject:** Population Biology and Monitoring

APPLICATION OF THE DENNIS-HOLMES POPULATION VIABILITY ASSESSMENT MODEL TO MARINE TURTLE CONSERVATION

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The Dennis-Holmes model provides an analytical tool for evaluating quasi-extinction risk. The model relies on time series of abundance and calculates the probability of extinction over a set time period based on the size, exponential trend, and year-to-year variance of a population. The minimal data requirement makes this a potentially valuable tool for marine turtles although these abundance time series are for nests or nesting females, and adult females do not reproduce every year. Therefore, an appropriate multi-year running sum is needed to account for nesting remigration intervals which will provide a population size estimate closer to the number of adult females and reduce some of the variance in annual counts caused by variable nesting remigration intervals. To cope with uncertainty surrounding extinction probabilities, we propose a risk calculation based on the proportion of replicate “populations” that cross a threshold, where each replicate has a mean and variance drawn from the 95% confidence intervals for those estimated parameters. We evaluate the utility and robustness of our approach with simulations of age-structured populations and we demonstrate how this model can be applied to fisheries management and, potentially, as a new status assessment tool for IUCN listing criteria.

Order: 420 **Abstract ID:** 1775 **Type:** Poster **Subject:** Population Biology and Monitoring

INSIGHTS INTO THE NESTING POPULATION OF MARINE TURTLES IN THE CAYMAN ISLANDS

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The Cayman Islands has been previously described as the largest marine turtle rookery in the Caribbean. However, following considerable harvesting pressure, the population was presumed to be extinct. Established in 1998, the Cayman Islands Department of Environment’s Marine Turtle Beach Monitoring Programme was instituted to document the existing nesting population and to develop a management strategy to assist the recovery of this population, notwithstanding continued beach development and the presence of a legal fishery. Seven years of

intensive and systematic monitoring has determined that while the loggerhead (*Caretta caretta*) and the green turtle (*Chelonia mydas*) still nest on the islands, their numbers are critically low. These low nesting numbers coupled with low levels of fecundity/success question the viability and long-term recovery potential of these populations. The occurrence of hybridization in the 2002 nesting season and the reoccurrence of the same nesting female in concurrent years (2003 and 2004) may be related to low availability of suitable mating partners in reduced nesting populations. Data has been used to produce educational and nesting beach management materials for the public on threats facing the dwindling nesting population and means to remedy them. This data is also being used to support changes in legislation to prohibit the legal take of turtles. The introduction of a community sponsored satellite telemetry programme has illustrated the migratory patterns of nesting females and raised awareness that local populations are also shared international resources.

Order: 421 **Abstract ID:** 1456 **Type:** Poster **Subject:** Population Biology and Monitoring

OCCURRENCE OF LEATHERBACK SEA TURTLES OFF THE PACIFIC COAST OF CANADA

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Little is known of the distribution and foraging habitats of leatherback sea turtles off British Columbia. In an effort to acquire baseline data essential to directing future research and recovery efforts, Fisheries and Oceans Canada (DFO) is evaluating current and historical occurrence of leatherbacks in the region. There have been 127 leatherback sightings reported in BC since the first encounter in 1931. Sightings information has been collected through surveys, questionnaires, and an educational outreach campaign known as the Leatherback Turtle Awareness Program. In 2003, a questionnaire was mailed to over 2000 mariners and coastal aircraft pilots soliciting leatherback turtle sightings. Sighting effort for leatherbacks was maintained during ship-based and aerial surveys for cetaceans off the BC coast during 2002-2005, and the first dedicated leatherback aerial survey was performed in September 2005. This survey covered 1100 km of trackline along the west coast of the Queen Charlotte Islands extending out to the 180 metre isobath. Aerial survey effort has been funding-limited and has yet to yield sightings; however, a ship-based survey in August 2005 encountered an adult leatherback that was approximately 1.5 metres in length. Preliminary results suggest that leatherbacks are found off Canada's Pacific coast primarily between late summer and early fall, in waters with depths ranging from 30 to 180 metres. More detailed analyses of sightings and questionnaire results are underway to help direct future survey effort. However, given the difficulty in interpreting incidental and opportunistic sightings, the need for further aerial surveys is evermore important.

Order: 422 **Abstract ID:** 1558 **Type:** Poster **Subject:** Population Biology and Monitoring

SEA TURTLES OF PALMYRA ATOLL, LINE ISLANDS

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Palmyra is an uninhabited, remote atoll in the tropical Central Pacific. Despite the pressing need for adequate biological understanding of, and informed conservation measures for, marine chelonians globally, little is known about the turtles occurring in the Line Islands region. The present research is designed to characterize sea turtles in

this area, focusing on Palmyra. This isolated site provides a unique opportunity to study sea turtles in an ecosystem relatively free of human influence. Two species of sea turtles, the green (*Chelonia mydas*) and the hawksbill (*Eretmochelys imbricata*), were observed foraging near Palmyra. There was no evidence of nesting along the Atoll, although this may occur infrequently. The large number of turtle sightings during survey periods indicates this is a significant marine chelonian foraging area. No turtles were seen dead or carrying highly visible fibropapilloma tumors. Palmyra was classified as a mixed species and age-class foraging ground. A variety of behaviors was observed, ranging from apparent resting in sandy habitats, to active foraging in areas where algae occurred. Ecosystem function of marine chelonians was considered with respect to likely predator-prey relationships. Algae were surmised to be the main food sources for *Chelonia mydas*, and specimens co-occurring with green sea turtles were sampled for species identification. The research was instructive in identifying factors to be considered in restoration efforts at Palmyra, emphasizing benefits of a gradual, science-based, and adaptive approach.

Order: 423 **Abstract ID:** 1461 **Type:** Poster **Subject:** Population Biology and Monitoring

EGGS WELLDONE: NEST SUCCESS OF FLATBACK SEA TURTLES, BARE SAND ISLAND, NORTHERN TERRITORY, AUSTRALIA

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Incubation duration, hatching success and emergence success of over 150 natural flatback sea turtle (*Natator depressus*, Garman) nests were investigated on Bare Sand Island (50 km due west of Darwin, NT, Australia). The 1.8 km of beach was divided into eight unequal sectors where turtles could nest. Nest position on the beach was identified as one of three habitats from the high-water mark to the top of the dune. Clutches deposited during a 5-week period, from June 10 to July 17, 2005, were monitored throughout incubation to determine whether hatching and emergence success were affected by the nest location and habitat. During this period, sand temperature at nest depth (50 cm) ranged from 24.19°C to 35.68°C with a maximum daily variation of 0.37°C. Incubation duration (mean=50 days, ± 2.69 SD, n= 92) was affected by beach locality ($p=0.029$) but not by habitat. Examination of multiple clutches laid by 43 females in the 5 weeks revealed no difference in incubation duration regardless of changes in location and habitat. Overall hatching success and emergence success were similar to other beaches, with means of 82.5% and 78.9% respectively. Reported loss of eggs due to depredation amounted to 7%, with roots of the creeper *Ipomea pes-caprea* responsible for 65% of this loss.

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A QUANTITATIVE LOOK AT LONG-TERM SEA TURTLE NESTING CYCLES IN GUYANA; WHAT ROLE HAS CONSERVATION PLAYED?

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Previously, Pritchard summarized the qualitative changes that occurred over 35 years on marine turtle nesting beaches of all three Guianas, and in particular the ways in which change reflected the patterns of erosion and accretion of the beaches. Here we present for the first time a compilation of quantitative data for marine turtles in Guyana. The data incorporate some uncontrolled variables resulting directly from the changing nature of the coastline and the concomitant shifts of nesting turtles. Nonetheless, the resulting database is long-term, and the changes have been dramatic enough to be real, at least for the primary nesting species at the present time. Two decades of surveys have seen stability in hawksbill nesting and a dramatic decline in olive ridley nesting. Ridges have shifted eastward, now nesting east of Cayenne and increasing their nesting tenfold in Sergipe, Brazil. An upsurge in nesting by *Chelonia mydas* in 2004/2005 may be a result of turtle and egg protection in the mid-eighties. For *Dermochelys*, an early modest increase was followed by a corresponding decline; perhaps turtle and egg protection had not yet yielded new adults. In 2000, leatherback nesting in Guyana abruptly increased by an order of magnitude to well over 1200 nests, and records show that nesting reached a record high in either 2000 or 2001 in other western Atlantic colonies. Since then, Guyana leatherback nesting has oscillated around a much higher mean value (~580 nests/year) than was seen prior to 2000 (~118 nests/year). We believe this may be a positive response to our nest protection from 1985 onwards.

Acknowledgments: KS gratefully acknowledges travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service, provided through the Symposium Travel Committee.

ST. KITTS SEA TURTLE MONITORING NETWORK: IMPLEMENTATION OF A LONG-STANDING SEA TURTLE PROTECTION PROGRAM

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St. Kitts, West Indies, is an important nesting ground for leatherback and hawksbill sea turtles, and a critical foraging ground for hawksbills. The St. Kitts Sea Turtle Monitoring Network (SKSTMN) is a unified nonprofit organization, founded in January 2003, which monitors nesting populations and acts as an advocate for strengthening sea turtle protection laws in St. Kitts. SKSTMN works in conjunction with the St. Kitts Department of Fisheries, the St. Christopher Heritage Society, WIDECAS, Ross University and local citizens to develop a long term sea turtle monitoring and protection program. SKSTMN has been monitoring the two primary leatherback nesting beaches, Cayon to Keys and North Friars, for the past three years, and has recently expanded to incorporate hawksbill nesting beaches. In November 2004, an in-water hawksbill tagging program was implemented, followed

by the implementation of a nesting leatherback tagging program in April 2005. Leatherback nesting season on St. Kitts is from mid-March through the end of July, with hatchlings emerging through the beginning of October. Since the initiation of regular beach monitoring in 2003, leatherback crawls have been recorded, with 408, 154, and 228 crawls documented each year, respectively. Leatherback nesting is distributed primarily along the Atlantic coast of the island while hawksbills prefer the Caribbean side of the island for both foraging and nesting. Hawksbill nesting season is from July through February, with hatchlings emerging through April. Regular beach monitoring has resulted in a significant reduction in the annual number of poached nests. Monitoring has also allowed for the implementation of a more focused analysis of the poor hatch success observed in previous short-term field studies. A total of 14 leatherback nesting females have been tagged since implementation of our tagging program in April 2005, and a total of 25 foraging hawksbills have been tagged since November 2004 (D. Browne, pers. comm.). Now that a regular monitoring and tagging regime has been implemented, our program plans to move forward into the upcoming nesting seasons with a focus on permanent elimination of poaching and human harassment through daily and nightly monitoring and public education, implementation of more stringent protection measures on the major nesting beaches, elucidation of the cause of low hatching success, construction of a hatchery, and implementation of a population health assessment program.

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EVALUATION OF SPATIAL CHANGES AND CARDINAL BEACH DIRECTIONAL EFFECTS ON LOGGERHEAD SEA TURTLE NESTS ON BALD HEAD ISLAND, NORTH CAROLINA

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We analyzed data from Bald Head Island, North Carolina, USA to determine: 1) spatial changes in loggerhead sea turtle (*Caretta caretta*) nests and false crawls over time; and 2) annual fluctuations in nest clutch size, nest success and incubation times. Bald Head Island is a dynamic barrier island that has undergone multiple beach nourishment/restoration projects. Knowledge of preferred nesting sites will help to better manage the beaches of Bald Head Island for loggerhead sea turtles. The locations of nests and false crawls were recorded using Global Positioning System (GPS) points from years 1999-2005, excluding 2000. Clusters of nesting activity were evaluated with ArcGIS 9.0 and nest incubation time and nest success as functions of cardinal beach direction were analyzed by independent t-tests to determine possible correlations. For the years 2004 and 2005, the nests located on the southward facing beach were shown to have a significantly lower percentage of nest success (South Beach mean = 59.9%, SE \pm 5.72, East Beach mean = 81.1%, SE \pm 4.91, $t = 2.77$, $df = 52$, $p = 0.008$) and significantly shorter incubation times in days (South Beach mean = 55.1, SE \pm 0.74, East Beach mean = 58.9, SE \pm 1.61, $t = 2.31$, $df = 39$, $p = 0.027$) than the nests laid on the eastward facing beach. Overall, from 1980 to 2005, it was found that the mean number of eggs per clutch (mean = 117.0, SE \pm 0.55) had minimal variation over the 25 years. Only 10 nonconsecutive years of data were available to analyze incubation time and from these years, there is a significant decreasing trend in incubation times from 1982 (mean = 64.8, SE \pm 0.54) to 2005 (mean = 55.0, SE \pm 1.03, $t = 7.75$, $df = 134$, $p \leq 0.001$). The hatchling success rate over the 25 years is highly variable, ranging from 21.3% (SE \pm 4.84) in 1980 to 81.3% (SE \pm 3.37) in 1993. The variation in hatchling success is a function of multiple factors including flooding events, summertime beach restoration projects and the relocation of all nests to a hatchery in the 1980s. These results show an analysis of clutch size, nest success and incubation times over a long term period. In addition, the GIS analysis provides a better understanding of nesting habitat utilized by loggerhead sea turtles on Bald Head Island, and this information is useful for future management.

A REVIEW OF 2005 MARINE TURTLE NESTING SEASON ON FIVE BEACHES (DALYAN, FETHIYE, PATARA, BELEK, GOKSU DELTA) IN TURKEY

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Five beaches (west to east: Dalyan, Fethiye, Patara, Belek and Goksu Delta), designated as Specially Protected Areas (SPA), were monitored daily for sea turtle nesting activity from 1st June to 15th September, 2005. A total of 2,626 turtle crawls were recorded on five beaches: 35.6% of the crawls were on Belek Beach. A total of 952 nests [*Caretta caretta* (99.2%) and *Chelonia mydas* (0.8%)] were recorded. Of the 944 total loggerhead nests, 213 (22.56%) were recorded on Dalyan, 79 (8.37%) on Fethiye, 68 (7.2%) on Patara, 433 (45.87%) on Belek, and 151 (16%) on Göksu Delta. Of the 67,909 eggs laid in the nests, 36,276 (53.42%) eggs hatched, 11,183 (16.47%) eggs were destroyed by various predators and 33,134 (48.79%) hatchlings were able to reach the sea. Mean hatching success of five beaches was 59.64% [Belek (73.33%), Dalyan (66.06%), Fethiye (63.47%), Patara (50.78%), Göksu (14.78%)]. Mean emergence success of five beaches was 45.94% [(Dalyan (62.23%), Belek (53%), Patara (40.24%), Fethiye (37.13%), Göksu (9%)]. Nest densities ranged from 4.86 to 59.81 nests/km, with an average of 15.85 nests/km. The most important negative factors for each beach are also discussed.

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IMPLICATIONS OF HATCHING SUCCESS ANALYSIS ON THE REPRODUCTIVE SUCCESS OF THE LEATHERBACK TURTLES THAT NEST AT PARQUE NACIONAL MARINO LAS BAULAS, COSTA RICA

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Hatching success of leatherback turtles is generally lower than that of other sea turtle species and plays an important role in the reproductive success of individual female turtles. We marked over 200 nests on the beach during egg deposition for two complete nesting seasons to investigate variation of hatching success throughout the season for this population of leatherback turtles. Nests were excavated after hatching and hatching success was estimated for each nest. Hatching success varied seasonally, decreasing dramatically as the season progressed in 2004-05 from 52% for nests laid in October to 24% for nests laid in January. This variation affects the total hatchling production per female and indicates that turtles arriving early in the season (October-November) tend to produce more hatchlings than turtles arriving later in the season (December-January). The strong seasonality

of hatching success can also affect the sex ratio of hatchlings produced on the beach, because relatively fewer hatchlings are produced in the months during which female-producing nest temperatures occur. These results have important implications for the selection of seasonal timing of sea turtle nesting activity.

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GRUPO ECOLOGICO DE LA COSTA VERDE SAN FRANCISCO, NAYARIT - MEXICO 1994-2004: 10 YEARS OF CONSERVATION EFFORTS

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Grupo Ecologico de la Costa Verde

Five out of seven species of marine turtles nest on both coasts of Mexico. The state of Nayarit, located on the Pacific Ocean, hosts three of these species: Leatherback (*Dermochelys coriacea*), Eastern Pacific Green (*Chelonia mydas agassizii*) and the more common Olive Ridley (*Lepidochelys olivacea*). There are six nesting beaches located near the village of San Francisco (Nayarit state): Huachinango (2 km in front of the village), Questo to the south (2km) and four smaller ones to the North (Las Huntas 1 and 2, Las Bancas, and Las Chalolos). The main objective of the Grupo Ecologico de la Costa Verde is to monitor and protect those nesting beaches. It also raises awareness within the local population throughout workshops and environmental education. Nesting activity and hatching success were studied from 1994 to 2004. The most important issue faced, like in many other nesting sites in Mexico, is poaching. In 1992, 60.7 % of the nests were poached and 36 poachers were identified. After ten years, the number of poached nests has dropped to 8.6 % and 6 poachers remain. In order to prevent nest poaching, nest are collected, relocated to a hatchery, and incubated in styrofoam boxes. The peak of the season runs from the end of July to the beginning of October. More than 70% of the nests were collected at this time of the year between 1997 and 2004. The geographical distribution shows that more than half of the nests are found on Huachinango (up to 90 % in 2002).

Order: 430 **Abstract ID:** 1767 **Type:** Poster **Subject:** Population Biology and Monitoring

TRENDS AT THE MAJOR LOGGERHEAD ROOKERY IN THE EASTERN GULF OF MEXICO: 1980-2005, SARASOTA COUNTY, FLORIDA

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Sarasota County in southwest Florida supports the largest number and highest density of loggerhead turtle nests in

the Gulf of Mexico. Sea turtle nest inventories and monitoring for this rookery have been recorded systematically since 1980. All six barrier islands of Sarasota County (Longboat Key, Lido Beach, Siesta Key, Casey Key, Venice Beach, and Manasota Key) have some extent of development. Significant differences emerge among the islands characterized by high-rise hotels vs. those that mainly host single family dwellings. Manasota Key and Casey Key have the longest coastlines with the least amount of development, and the most recorded nests and the highest density of nesting. Average densities are 40-70 nests/km (Casey) and 80-160 nests/km (Manasota). Tagging studies indicate reproductive longevities of individual females of over 20 years. Ratios of nesting success (the percent of all emergences that results in nests) is declining as rapid coastal development proceeds. Causes for the decline in nesting success include beach nourishment projects, coastal armoring, and coastal lighting. In addition to raccoon predation, new predation pressures include nests taken by fire ants, armadillos, bobcats, and coyotes.

Order: 431 **Abstract ID:** 1371 **Type:** Oral **Subject:** Population Biology and Monitoring

PRELIMINARY RESULTS FOR THE POPULATION TRENDS OF TWO INDEX BEACHES, FETHIYE AND DALYAN, TURKEY

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Fethiye and Dalyan beaches are two of the most important nesting sites of loggerhead turtles in Turkey. Both beaches have been designated as Specially Protected Areas. A total of 1,421 nests were recorded over a 13 year period (1993-2005) with a mean of 109 nests/year on Fethiye Beach. There were strong annual fluctuations in the number of nests, ranging from 58 (2004) to 191 (1995), a 229% difference. This difference is very similar to the 224% documented by Margaritoulis and Rees (2001) between the minimum and maximum nest counts in Greece (Kyparissia Bay) over the course of 17 seasons. Broderick and Godley (1996), for example, recorded a 112% increase between the lowest and highest nest numbers in Northern Cyprus in three seasons, and even smaller fluctuations (ca. 54%) are known for loggerhead nests in Florida (Heppel *et al.* 2003). Based on nesting data over a 13-year period (1993-2005), nests on this beach have been declining at an average of 5% per year. The 95% confidence intervals on this decline are -1.5% to -8.6% per year. A total of 3,592 nests were recorded during 18 consecutive years with a mean of 200 nests/year on Dalyan beach. There were also strong annual fluctuations in the number of nests, ranging from 57 (1990) to 286 (2002), a 401% difference. There was no significant trend in nesting over this 18-year period (1987-2005). The 95% confidence intervals are -2.7% to +6.7% per year.

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LENGTH AND WEIGHT RELATIONSHIPS OF HATCHLING AND ADULT LOGGERHEAD TURTLES IN BELEK, TURKEY

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A total of 301 hatchlings and 18 mature loggerheads was measured during the 2005 nesting season in Belek, Turkey. We report data on the relationships between SCL-SCW and SCL-weight for both adults and hatchlings, and SCL-CCL, CCL-weight and CCL-CCW for adult sea turtles. Mean carapace length, carapace width and body weight of 301 measured hatchlings were 4.07 cm (3.1-4.5 cm, SD: 0.20), 3.1 cm (2.3-3.5 cm, SD: 0.19) and 15.76 g (11.83-20.50 g, SD: 1.73) respectively. The linear equation for length-width was computed as $y = 0.4059x + 1.4092$; $r^2 = 0.1919$ and the equation for length-weight was $y = 1.9552x + 1.4832$, $r^2 = 0.4515$. Adult means for SCL, SCW and weight were 69.3 cm (64.0- 73.4 cm, SD: 2.15), 52.7 cm (49.9-56.5 cm, SD: 1.99) and 42.4 kg (34.0-50.0 kg, SD: 5.53) respectively. The linear equation for length-width computed as $y = 0.6636x + 6.7282$; $r^2 = 0.5161$ and the equation for length-weight was $y = 0.00002x + 3.42765$; $r^2 = 0.60765$. Weight and length relationships of loggerhead sea turtles have been discussed in terms of allometric and isometric aspects.

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RESULTS OF SEA TURTLE NESTING ON AVES ISLAND, VENEZUELA: 2005 SEASON

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The goal of this project is to protect the gravid females and their nests on the most important nesting beach in Venezuela. Beach surveys were initiated in May 2005. Throughout the nesting season, the work included tagging females with a metal tag, taking morphological measurements (SCL and CW), recording general condition of the turtle and checking for the presence of tag scars. Some nests were transferred to safe sectors of the beach. Almost 400 females were tagged and several recaptures were observed and recorded. The number of nests was between 1000 and 1200. The team work included people from the Ministry of Environment and volunteers. We also discuss our conclusions and recommendations.

THREE YEARS OF MARINE TURTLE MONITORING IN THE GAMBA COMPLEX OF PROTECTED AREAS, GABON

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² Local NGO: Ibonga-ACPE

Gabon's coastline supports one of the largest leatherback (*Dermochelys coriacea*) populations in the world. However, this population is understudied and little is known about the population dynamics, their foraging behaviour, migration patterns and nest ecology. This study reports on three years of fieldwork (2002 – 2004) within the Gamba Complex of Protected Areas in the south-west of Gabon. A 5.75 km stretch of beach was intensively studied from November until March in each year. The leatherback nest numbers dropped from 576 in 2002/2003 to 207 and 128 respectively in the following two seasons (a decrease of approximately 77 % of laid nests). Yearly fluctuations in leatherback numbers are normal, however, only long-term monitoring will be able to confirm any trends. We found that several leatherbacks nesting in our research zone had been tagged in Mayumba (100 km south of Gamba) earlier in the season, suggesting that intra-nesting movements along the coastline exist. In 2004 a leatherback tagged in Gamba was found off the coast of Argentina. This is the first evidence of leatherback migrations from the Africa coast to South American waters, a straight-line distance of 7,000 km (Billes *et al.* in press). Nesting numbers of olive ridleys (*Lepidochelys olivacea*) were stable (around 50 each year). Green turtle (*Chelonia mydas*) numbers were much lower. One nest was seen in 2002, five in 2003, and two in 2004. One hawksbill (*Eretmochelys imbricata*) was seen in January 2004.

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HAS THE INCUBATION PERIOD OF LEATHERBACK NESTS ON ARUBA CHANGED?

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Turtugaruba, Aruba

All nests of *Dermochelys Coriacea* on the Eagle Beach of Aruba over the last six years have been documented. In 2001 the average incubation period was 65.9 days and we noticed that nests, which have been laid in April hatch after an average of 67.7 days and those in June hatch after an average of 63.6 days. During the 2005 nesting season the average incubation period of leatherback nests on Aruba decreased with 4 days (61.4 days) compared to several more in previous years (2001-2004: 65.5 days). In situ protection on a beach with artificial lighting problems requires a typical procedure to avoid loss of hatchlings on the inland side of the beach. The better the understanding of the factors that influence the incubation period the more adequate and well timed this final conservation procedure can be applied. Weather data from the Meteorological Service of Aruba are used to calculate the average ambient temperature during the specific incubation period of each individual nest. To evaluate a possible correlation between the variables temperature or nest date, female, clutch size, nest depth and the incubation period a multivariate analysis is performed using SPSS. At the deadline for editing this abstract the analysis is not yet completed. The conclusion will be presented on the poster and can be requested by email at Turtugaruba

PHOTO-RECOGNITION: A TECHNIQUE USED TO IDENTIFY INDIVIDUAL LOGGERHEAD TURTLES IN THE MARINE ENVIRONMENT

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Photo-recognition was used to identify individual loggerheads at sea during a study of their marine behaviour (2000-2005). Dorsal photographs were scrutinized for features that might allow turtles to be recognized during subsequent encounters. Turtles swimming at depth or resting on the seafloor were filmed from above; very close approaches were avoided. Bennett and Keuper-Bennett (2004) used facial profiles to identify green turtles in Hawaii. Specific scute patterns were based on existing identification keys (Dodd, 1988; Marquez, 1990; Pritchard and Mortimer, 1999; Wyneken, 2001). Technique: Dorsal head-scales of loggerheads were grouped into two sectors, each with an index number: 1) PF number (number of prefrontal scales), 2) FP number (number of scales that surround the large central frontoparietal scale). Further differentiation between individual turtles was achieved by subjectively allocating scales in each sector into small, medium and large size-classes based on photographic evidence. This was more simple than measuring the head-scales of a large turtle, particularly when researching underwater. The pattern of head-scales was slightly different (number, size and shape of scales) in all of the loggerheads observed; which Wyneken (2001) suggested might be the case. The number of prefrontal scales in loggerheads varied from 4-8; the FP number ranged from 9-15 (n=120 turtles). Carapace scutes were counted and anomalies noted (e.g. asymmetry, damage, or additional scutes). Scutes colonized by epibiota (e.g. barnacles) provided further data for identifying individual turtles. Kefalonia (2000-2004) Fourteen loggerheads were re-encountered on numerous occasions intra-annually during foraging ground surveys. However, only one loggerhead was re-encountered in more than one year: for 12 weeks in 2003 and 14 weeks in 2004 (White, in prep). Other loggerheads were present, but unfilmable (e.g. too far away). Suboptimal image quality (e.g. poor light or underwater visibility) could be a limiting factor, and also encounters with loggerheads at sea could be infrequent; perhaps due to their solitary lifestyle. Lampedusa (2005-2006) The technique was improved by photographing turtles (n=160) at the WWF-Centro Recupero, Lampedusa. Many of these turtles, which included different size-classes (CCL 23-87 cm), were fisheries' bycatch. Although these turtles have yet to be re-encountered at sea, the juveniles could potentially validate this recognition technique by linking current photographs (using flipper-tag numbers) to future images following their reproductive recruitment in decades to come.

Acknowledgements: Thanks to Daniela Freggi of WWF-Centro Recupero Tartarughe Marine, Lampedusa.

SEA TURTLES IN ALBANIA: RESULTS OF A RAPID ASSESSMENT OF POSSIBLE FORAGING AND OVER-WINTERING HABITATS (OCTOBER-NOVEMBER 2005)

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Tagging and morphometric data from turtles captured in 'stavnike' (fish-traps) over three years suggested that many loggerheads were present in Albanian sea areas. Under the Medasset Marine Turtle Conservation programme in the Mediterranean region, the entire coastline of Albania was rapidly assessed by boat over a three-week period to determine if sea turtles were using inshore waters. Data concerning sea turtles were collected in three ways: 1) interviews with fishermen 2) direct observations at sea 3) underwater habitat surveys (SCUBA). Findings were included in a GIS database. Fishermen, using different types of gear, provided details of their by-catch, sightings and most recent encounters with turtles. By-catch data showed a marked difference in the number of turtles captured annually between the north and south of Albania. Typical catches per fisher per year were 2-6 turtles south of Dürres, and 100-250 turtles in the north. Most were loggerheads, but occasionally green turtles were caught. Juveniles were mainly captured in shallow waters <10m (trawls, nets, long-lines, and stavnike) during April-May, which suggests that an important foraging habitat for juvenile loggerheads may exist in northern Albania. Adults (including animals with metal tags or Roto-tags) were mostly trawled in deeper waters >30m during the summer, with peak captures in October-November each year. The presence of tagged animals in the by-catch suggests that migrating turtles, perhaps post-nesting, may use local waters. Large turtles were also reported from the deep waters west of Karaburuni Peninsula, which again suggests a migratory route along the Albanian coast. At-sea observations, including underwater habitat surveys, focused upon areas where local fishermen encountered or captured the most turtles. GPS was used to record the location of mega-fauna encountered at sea. A new method was used for underwater research. A 100-metre transect line was deployed underwater, so that the number of turtles encountered during SCUBA dives could be used to provide a population estimate (Distance 6 software). Underwater visibility at some dive sites was zero, usually because of clay substratum or high levels of mud flowing from the rivers and lagoons. Only two transects had good visibility (one over sand, the other over seagrass on gravel), but no turtles were encountered. SSTs were 19-22°C; minimum water temperature was 18°C at a depth of 30m. An important new finding was that loggerheads were reported from shallow lagoons (e.g. Butrintit and Patok), which it seems they entered during the summer, probably to feed, but were then trapped inside when the sluice gates from the sea were closed. In each case turtles were encountered in channels attempting to leave the lagoons; following a decrease in water temperatures (i.e. involuntary over-wintering).

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THE REMOTE COCOS (KEELING) ISLANDS, INDIAN OCEAN: A HAVEN FOR RESIDENT SEA TURTLES AND A POSSIBLE INDICATOR SITE FOR THE HEALTH OF EAST INDIAN OCEAN HAWKSBILL AND GREEN TURTLE POPULATIONS

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The Cocos (Keeling) Islands, a territory of Australia, consist of two atolls, and are located over 3000 km from Perth, Australia and 1000 km from Java, Indonesia. The southern atoll consists of over twenty islands formed in a horseshoe shape that protect the inner lagoon from the southeast trade winds. The islands were settled in 1826 and several naturalists and visitors, including Charles Darwin, commented on the abundance of turtles in the waters. Since then, the islands have experienced varying degrees of harvest and trade. In the 1940s and 1950s, high harvest pressure was blamed for the scarcity of turtles. A seven year study has shown that today, immature and adult-sized green and hawksbill turtles are abundant in the waters of the southern atoll with numbers for both species estimated in the high thousands. Both species are found in habitats ranging from the protected lagoonal waters to the outer coral reef slope. Both species feed on the shallow seagrass and algal beds inside the lagoon. Individual growth rates for immature green turtles ranged from 3.8 to 9.3 cm/yr CCL while individual growth rates for hawksbill turtles ranged from 0.1 to 8.3 cm/yr CCL. New recruits into the population are recorded annually indicating that the waters are continually being restocked from unknown nesting beaches. Isolation from major human pressures and a low resident human population on these islands result in low human-related mortality. Only low numbers of green turtles nest annually on these islands. Genetic studies are still to be completed, but the remoteness of the islands to major nesting beaches of both species indicate that a mixed stock is likely. The fully protected nature of these islands and the remoteness to major nesting beaches may provide an independent measure of the health of the east Indian Ocean green and hawksbill turtle foraging populations. Once the genetic relationships between this foraging population and nesting populations are determined, the continued monitoring of recruitment and population numbers at this location may provide an advanced warning of any future declines in numbers of next generation nesting turtles.

REPRODUCTIVE HISTORIES OF REMIGRANT LOGGERHEAD TURTLES FROM WASSAW NATIONAL WILDLIFE REFUGE, GEORGIA, USA

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Several studies have quantified and reported the average reproductive parameters of individual sea turtles over the course of a nesting season based on clutch size and clutch frequency data. However, many studies were based on the reproductive parameters of a nesting population as a whole, and not based on data collected from individual turtles. The Caretta Research Project has been conducting a saturation-tagging project on Wassaw National Wildlife Refuge since 1973. This long-term database affords us the opportunity to look at the reproductive potential of individual turtles which have shown a high degree of site fidelity to Wassaw Island, GA, both within and among

multiple nesting seasons. In this study we examined the reproductive parameters of twelve individual turtles that have nested at least three times within a nesting season for at least three seasons on Wassaw Island, Georgia.

Order: 440 **Abstract ID:** 1470 **Type:** Poster **Subject:** Population Biology and Monitoring

A PRELIMINARY ASSESSMENT OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN PALM BEACH COUNTY WATERS

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This study represents the first effort to survey Palm Beach County coral reefs (Florida, USA) for hawksbill turtles (*Eretmochelys imbricata*). Individual turtles have been hand-captured at depth using SCUBA, retained on a vessel for the collection of morphometric data, tag placement, photographs, tissue sampling for DNA analysis, and blood sampling for gender determination. A reference library of local hawksbill photographs has been developed to document newly tagged individuals, and the effectiveness of photographic identification is being assessed. Divers aboard local dive charters report sightings when tagged turtles are encountered. To date, 54 hawksbills have been captured in 50 dive days, representing 55.7 hours on SCUBA. Only two encountered turtles escaped capture, indicating the approachability of these turtles underwater. This aggregation consists of primarily juveniles, ranging from 40.2 - 82.3 cm (mean 58.2) straight carapace length. Turtles have been captured within several miles of shore at depths ranging from 13.4–24.4 m (mean 18.8). Re-sightings have been confirmed for 13 tagged turtles, with a maximum of 5 sightings of one individual over a 250 day period. Preliminary data indicate strong site-fidelity and close association with both natural and artificial coral reef structures. Untagged turtles are still reported regularly within the survey area. Preliminary mtDNA sequence data suggest possible origins for this feeding ground aggregation.

Order: 441 **Abstract ID:** 1821 **Type:** Oral **Subject:** Population Biology and Monitoring

THE IMPORTANCE OF ANNUAL VARIATION IN UNDERSTANDING SEA TURTLE SEX RATIOS

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Perhaps the most intriguing result of our study of loggerhead sea turtle sex ratios is that there is sometimes wide variation in sex ratios within a beach or region across years. Comparing sex ratios at sites across years found that sometimes the differences were substantial. Interpreting those differences was difficult because of the varied methodologies used to determine sex. Examinations of young turtles using a single rigorous sampling method (laparoscopy with histological verification) allowed us to document and assess sex ratio variation among years. Here we present the results of three years of empirical sex ratio evaluation of *Caretta caretta*, along the eastern coastal United States from beaches ranging along 10 degrees of latitude. We document large differences in sex ratios (range: ~3-35%) across regions and years. We compared our results with those of previous empirical studies

and note that inter-annual variation in sex ratio is common. Additionally, sex ratios from hatchlings at beaches may not reflect the sex ratios of large juveniles about to enter their reproductive years. It is the integration of multiple years of sex ratios that contribute to the population's functional sex ratio. Thus, multiple year classes contribute to the operational sex ratio. We argue that it is dubious, at best, to characterize the sex ratio of a region based on just one or a few years of sex ratio data.

Order: 442 **Abstract ID:** 1817 **Type:** Poster **Subject:** Population Biology and Monitoring

NESTING BEACH MONITORING OF GREEN TURTLES IN THE GALAPAGOS ISLANDS: A 4-YEAR EVALUATION

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The Galapagos Islands have been recognized as one of the most important nesting areas for green turtles in the eastern Pacific Ocean, given an annual number of 1,500 nesting females by Hurtado in the 1980's. We present an evaluation for a four year period of systematic monitoring from December to May (2001 – 2005) on the beaches of Quinta Playa and Bahía Barahona (Isabela Island), Las Bachas (Santa Cruz Island) and Las Salinas (Seymour Island). These sites correspond to those from previous work for which baseline data exist. We measured, tagged, and recorded nesting parameters and threats in order to evaluate the current status of the green turtle nesting colony in the Galapagos Islands. There was considerable inter-annual variation in nesting activity with nesting abundance ranging from 2,756 green turtles in 2001 to 726 turtles in 2005. The predominant nesting remigration interval was three years. Threats on the nesting beaches included nest destruction by human presence and predation by introduced species on developing eggs. However, perhaps the greatest threat comes from the establishment of a longline artisanal fishery within the limits of the Galapagos Marine Reserve. These data will be provided to the Galapagos National Park Service and will be useful for further strengthening of management practices within the Park.

Order: 443 **Abstract ID:** 1863 **Type:** Poster **Subject:** Population Biology and Monitoring

FIRST RECORD OF FLY LARVA DEPREDATION ON GREEN TURTLE DEVELOPING EGGS AND HATCHLINGS IN THE GALAPAGOS ISLANDS

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Several predators impact nesting success of the east Pacific green turtle, *Chelonia mydas*, in the Galapagos Islands. These predators can be divided into two categories: natural and introduced. Previous studies have demonstrated that *Omorgus suberosus*, a native beetle, and feral pigs reduce green turtle nesting success in Galapagos. Here we report for the first time the effect of a fly larvae depredating live hatchling and residual egg contents of the Galapagos green turtle. The study was conducted between 2002 – 2005 on the beaches of Quinta Playa and Bahía Barahona (Isabela Island), Las Bachas (Santa Cruz Island) and Las Salinas (Seymour Island). Nests were excavated 70 days

after deposition, the contents of each nest were recorded, and insect larvae were taken in order to identify predators throughout incubation period and quantify their impacts. Several fly larvae species were identified and there was considerable inter-annual variation in fly impact on nests among beaches and seasons. Some fly larvae were introduced and others were endemic to Galapagos.

Order: 444 Abstract ID: 1523 Type: Poster Subject: Social Science Research

ORIGIN AND PROGRESS IN RESEARCH AND CONSERVATION OF MEDITERRANEAN MARINE TURTLES AT THE NAPLES “STAZIONE ZOOLOGICA”

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Our intention in this work is to trace the evolution of scientific thought in the field of the Marine Turtle during the last two centuries in one of the oldest and most prestigious Institutes engaged in marine sciences, built in Naples in 1872. This “Stazione Zoologica”, thanks to its Mediterranean Aquarium, was destined to show the path which would lead to modern Marine Biology. Many historical documents and references in the literature from the late eighteenth century to the early twentieth century clearly show that, at the time, researchers at the Stazione were not very interested in studying turtles, although there are occasional references of a *Caretta caretta* being exhibited in the “Great tank”. Since then, the situation has gradually improved. Today, the Institute has an active programme of research and protection of the Mediterranean turtle. Furthermore, in order to reduce the mortality rate of the Italian sea turtles, a Rescue Centre has been added to the normal Aquarium facilities. This facility is capable of holding 60 animals, and also has a separate Rehabilitation Centre where animals stay during a period of convalescence and observation before being returned to the sea. This gradual but notable improvement in the protection of the turtles is illustrated by the more significant results during the past twenty years which have already indicated the direction in which further research should continue.

Order: 445 Abstract ID: 1696 Type: Poster Reserve Subject: Social Science Research

INCIDENTAL CATCH OF SEA TURTLE IN ARTISANAL GEARS IN ANDALUSIA AND MURCIA (SE SPAIN): RESULTS FROM INTERVIEWS

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The marine waters of Andalusia and Murcia are considered priority areas for several marine turtle’s populations. Fishing activity in the region is very important and represents a social and economic traditional system. Incidental captures are risky not only to sea turtles but also to fishermen since it can result in economic loss in time and gear components as well as personal injuries during manipulation of the hooked or entangled turtles. It is therefore a matter of interest to both fishermen and conservationists to detect the fishing gears that interact significantly with sea turtles as well as the areas and times of the years when captures are more frequent. It is also necessary to take into account the practical proposals of fishermen as to how incidental capture may be mitigated, encourage them to take turtles to recovery centres and if that is not possible, to liberate the captured turtles with minimum damage. In the study area there are 31 fishing harbours, 16 in the Mediterranean sector and 15 in the Atlantic. Interviews

were carried out in 18 fishing selected harbours encompassing fleets using a range of fishing gears grouped into 9 categories: bottom longlines, coastal trawls, deep water trawls, driftnets, octopus pots, purse-seiners, surface longlines, trammel nets and others. A total of 223 interviews were carried out, a single interview per vessel. The objective of this document is to determine the principal fishing gear that interaction with marine turtles to elaborate recommendations and proposals to reduce the turtle captures. Our data confirm longlining as a strongly interacting fishery but we sampled only one drift-netting vessel. It is important to research the factors involved in incidental capture as well as on the development of new methods to minimize it such as changing the fishing depth, use of alternative hooks and baits. During the interviews we asked the fisherman for proposals to reduce the turtle captures. Regarding proposals to minimize turtles capture in surface long-line fishery 10 fishermen agreed a type of long-lining gear called “roller” would be the best system to avoid it, 2 said the best would be to reduce the number of attracting lights and 2 more suggested that greater enforcement of the current Spanish regulations regarding the number of hooks and the total gear length would help. Since 2003 we observed the introduction of the roller that implied a reduction in the number of hooks and an increase of the main line length and the depth of fishing. This modified surface longline increases the distance between hooks and the length of the gear reducing to 1,000 the total hooks with respect to the traditional surface longline (>2,500 hooks as mean), and the time needed to board the gear (6-7 hours) supposes a 2-3 hours reduction with respect to the traditional longline. Recent study indicate that the use of roller reduce total accidental catch but may increase loggerhead direct mortality.

Order: 446 **Abstract ID:** 1410 **Type:** Oral **Subject:** Social Science Research

ENGAGING WITH INDIGENOUS TRADITIONAL OWNERS IN THE PLANNING AND MANAGEMENT OF DUGONG AND MARINE TURTLE TOURISM IN AUSTRALIA

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There is increasing recognition amongst wildlife managers and tourism operators that local Indigenous communities have an important role to play in the design and management of wildlife tours based on their land or in their sea country. Dugong and marine turtle tourism, wherever it occurs around the Australian coast, will almost inevitably involve the land and/or sea country of one or more Indigenous groups because of the cultural significance of marine turtles and dugongs to Australian Aboriginals and Torres Strait Islanders. Best practice management of such tourism must include recognition of the fundamental relationship between Indigenous people and their land/sea country. Best Practice Guidelines were developed to assist tourism operators' and managers' engagement with Indigenous Traditional Owners in the planning and management of dugong and marine turtle tourism in Australia. The primary goal of the project was to minimize negative impacts of tourism activities on dugong and marine turtles by trialing specific Codes of Conduct. Key issues relating to the protection of biological and cultural values associated with dugongs and marine turtles were identified, including the significance of these species to Indigenous Australians' broader cultural and economic relationship with their country. Draft Codes of Conduct and broader management recommendations were evaluated in field trials at several locations around Australia using Key Informant and Visitor Surveys. The resulting Code of Practice contains a section detailing “Best Practice Guidelines for Engaging with Indigenous Traditional Owners in the Planning and Management of Dugong and Marine Turtle Tourism”. The Best Practice Guidelines are based on a document ‘Overarching Principles for Dugong/Turtle Tourism in Sea Country,’ developed by Indigenous and other participants at the

Dugong and Turtle Tourism Planning Workshop in 2004. The Guidelines were revised on the basis of surveys and interviews conducted with a sample of Key Informants, including some Traditional Owners, tourism operators, Government managers and other stakeholders at four key dugong and turtle tourism sites around Australia. These Guidelines have been designed to help Traditional Owners, tourism operators and Government management agencies work together to develop culturally appropriate tourism involving dugongs and marine turtles, and to facilitate greater involvement of Traditional Owners in the development and management of tourism operations in their sea country. The Guidelines have three sections containing: 1. actions for all parties involved in the process of planning and management of dugong and marine turtle tourism; 2. specific actions for government management agencies; and 3. specific actions for tourism operators and proponents. Each section lists recommendations, the intended outcome of each recommendation, and additional comments to highlight issues which may require clarification, and/or to draw attention to linkages between recommendations. The Guidelines cover aspects such as:

- providing opportunities for consultation processes to occur and protocols to be developing during permit application stages;
- resourcing of Indigenous communities to provide comments throughout application processes including the incorporation of land/sea country plans where such plans exist;
- encouraging on-ground involvement of Indigenous communities where acceptable; and
- developing incentives to encourage ‘cultural accreditation’ of tourism operations.

Order: 447 **Abstract ID:** 1411 **Type:** Poster **Subject:** Social Science Research

TOWARDS SUSTAINABLE MANAGEMENT OF VESSEL AND IN-WATER TURTLE TOURISM IN AUSTRALIA

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The increasing desire of tourists to have experiences with iconic wildlife species, especially threatened species, means there is a need to ensure that informative and rewarding experiences are coupled with adequate safeguards for the environmental and cultural values associated with the species being viewed. This project aimed to minimize negative impacts of tourism activities on marine turtles through trialing Codes of Conduct for vessel-based and in-water (swimming/snorkel/scuba) tourism activities. The project identified key issues relating to the protection of biological and cultural values associated with marine turtles in Australia. Recommendations were also made for protected area and wildlife managers, Indigenous Traditional Owners, researchers, tour proponents and other stakeholders, covering: •Permitting of tour operations in key habitat areas; •Speed limits in key habitat areas; •Appropriate vessel design; •Research and monitoring priorities for sustainable management; •Education and interpretation needs; and •Introduction of a ‘Marine Animal Interaction Flag’. In 2005, the Draft Code of Conduct for the Sustainable Management of Vessel and In-Water Marine Turtle Tourism was trialed on board

four dive vessels operating in the Cairns and Far Northern Management Areas of the Great Barrier Reef Marine Park. A Visitor Survey of live-aboard dive boat passengers (n=239), along with a Key Informant Survey (n=12) involving some Indigenous Traditional Owners, management agency staff, tour operators and non-governmental environmental organizations, was used to ascertain the suitability of the Draft Code and broader management recommendations. An Online Workshop was trialed to allow a mechanism for the collective experience and knowledge of c.180 Project Participants involved through the study to assist with guiding the process and development of these Draft Codes. It was intended that this would help to build stakeholder involvement in, and hence ownership of, the resulting Code. There was a high level of support overall for the in-water management provisions, however the support for a specific minimum in-water approach distance to turtles was somewhat lower. Visitors' explanations for some provisions highlighted issues, which were subsequently addressed in the revised Codes of Conduct. For example: •There was some opposition to introducing an in-water approach distance to turtles on dive sites, particularly where resident turtles are approached closely on a regular basis. Only a small number of changes to the Code were required, however specific comments provided by Visitor Survey respondents identified a need to rephrase the wording of some provisions to help explain them more clearly and provide reasons for their use, for example: •“Turtles will often sleep inside a coral crevice and they may flee this enclosed space if startled – there may be a risk of injury to the turtle or diver as well as coral damage from sudden fleeing.” Feedback from the Online Workshop, and results from the Key Informant Surveys and Visitor Surveys were used in the revisions to the overall structure of the Code as well as specific provisions. Refinements were made, which became part of a new “Code of Practice for the Sustainable Management of Dugong and Marine Turtle Tourism in Australia”.

Order: 448 **Abstract ID:** 1796 **Type:** Poster **Subject:** Social Science Research

MARINE TURTLE CONSERVATION AND LIVELIHOODS OF COASTAL COMMUNITIES - TOWARD A CONCEPT AND INDICATORS TO UNDERSTAND AND ENHANCE OUR SOCIOECONOMIC IMPACT

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Coastal communities in developing countries are at the heart of many interventions toward marine turtle conservation. For five of the seven species of marine turtle, 78%-91% of countries where they occur have developing economies. Two thirds of countries with developing economies have marine turtles, one third have three or more species. Projects have focused traditionally on immediate mitigation of overexploitation. More recently, some projects seek to link marine turtle conservation with the generation of additional cash revenue to local communities. Improved livelihoods for the custodians and users of the natural resource at stake are accepted as necessary for the long-term sustainability of best practices. However, the impact of species conservation on local livelihoods is only partly understood, because various socio-economic dimensions have not been adequately monitored. We propose the adoption of an integral livelihood concept and corresponding indicators to design community-based marine turtle conservation projects. Marine turtle conservation can affect various socio-economic variables, such as political power, social relationships, infrastructure, human resources, culture and economic income. Indicators for the impact of the project on such socio-economic aspects are typically absent, however. Despite cases where some effects may have been negative, anecdotal evidence suggests that marine turtle conservation has the potential to improve these community assets. This potential can only be fully unfolded, if projects include activities toward strategically enhancing these livelihood dimensions and measure their impact in relation to carefully chosen controls. This approach is necessary, if we are to understand the impact of marine turtle conservation on poverty alleviation.

TURTLES AND TOURISTS: VALUING CARIBBEAN BEACHES FOR INTEGRATED COASTAL MANAGEMENT

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The reliance of endangered sea turtles on beach habitats for reproduction makes alteration and loss of beaches through intensive coastal development and environmental change of significant concern. Aside from providing vital ecological and recreational services, there is widespread recognition that protection of beaches is critical to the sustainability of tourism in the Caribbean region. There is, therefore, considerable incentive to preserve beaches in the Caribbean, and to this end many nations are developing and implementing integrated coastal management plans, which aim to incorporate the needs of beach users whilst maintaining the beach in an ecologically functional way. In this study we examined the overlap and potential conflicts between the beach preferences of tourists and those of turtles, and the value of beaches to tourists in Barbados. Surveys were used to determine patterns of beach use and the importance of different beach characteristics to tourists which were then compared to the nesting requirements of sea turtles on the island. We also used discrete choice models to evaluate tourist attitudes towards, and willingness to support, beach management options that can help protect beaches. There was considerable overlap between tourists and nesting turtles in the beaches they prefer to use. However, stated preferences for specific beach characteristics indicated that tourists are relatively indifferent to some features, such as beach lighting, which offers the potential to mitigate some of the negative impacts of tourism-related development.

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THE ENIGMA OF THE LEATHERBACKS IN PAINTINGS OF RENÉ MAGRITTE

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The enigma of the Leatherbacks in paintings of Magritte Many works of the great Belgian surrealist painter René Magritte are real puzzles. None of the numerous comments made about the paintings of this real-false painter seems to be able to explain the mysterious presence of a Leatherback in two of the major paintings of his “Lugubrious Period”. There seems to be no satisfying interpretation by any of the numerous commentators of the works of this ‘vrai-faux’ painter, of the mysterious appearance of a Leatherback Turtle in two of his major paintings. Why the hell a turtle? Did he copy it after a book print, or something seen in a museum? René François Ghislain Magritte was born on 21 November 1898 in Belgium to a lower middle class family. In 1912, while still a teenager, he was traumatised by his mother drowning. Her body was found with her head draped in the white cloth of her nightgown. The biographers of the painter would later interpret his portraits of veiled characters as being the obsession of a missing mother with an invisible face. Affiliated to the surrealist move, he would later be considered

as only a mediocre painter, but all would consider him as a genius artist and poet. Writer Louis Scutenaire, friend of Magritte, wrote that the world was a turtle and that the surrealists were trying to make it something altogether different from a turtle, but that all they managed to do was painting its shell over. There are two paintings: “The Secret Player” and “The Garment of Adventure” where a Leatherback Turtle is mysteriously represented, a link to his brother gamer, so as to illustrate his metaphors ? The painting named “The Garment of Adventure” dated 1926, belongs to the collections of Kawamura Museum of Art in Japan. It measures 0.80 m by 1 m. A woman can be seen floating on the water, naked and wrapped in a shroud. Her eyes are closed. Is she asleep or is she dead? Is it to recall the suicide of the painter’s mother who drowned herself in her nightdress, which was a real trauma for him in his teenage years ? This woman stretches out her arms towards the sky. The misshapen head of the turtle comes above the woman’s feet. The rear flippers are wide, which corresponds to reality but they seem to come out from the front of the shell. Another painting named “The Secret Player” painted in 1927 measures 1.52 m by 1.95 m. It shows two men dressed in white holding a bat with cup-and-ball like trees in the background. A gagged woman appears in a box. A Leatherback with no head seems to be swimming in this strange scenery. According to one of his biographers, Magritte would have painted the Leatherback from an encyclopedia.

Order: 451 **Abstract ID:** 1539 **Type:** Poster **Subject:** Social Science Research

THE AEGINETAN STATERS OR CHELONOMORPHS ON THE FIRST COINS OF HUMANITY

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The quality of the soil on the Greek island of Aegina was not good for agriculture, so its inhabitants traded beyond their borders. Therefore, on this island we find the first silver coins from the 6th century B.C. with a turtle symbol on them. These “Chelones Aeginetianos” or “Aeginetan stater” were used and circulated throughout the Mediterranean, making them the first and the most important currency for trade in Europe. In 457 B.C., Athens stripped Aegina of its maritime power. According to historians, the loss of this power was marked by the replacement of the marine turtle on the coins by a tortoise. However, with silver ore on the island of Siphnos becoming inaccessible and with the Mediterranean trade being dominated by Athens, the production of these coins with turtle symbols decreased. They were replaced by the coins of the Athenian neighbors, which carried the engraving of an owl. The morphological detail of the various models of marine, terrestrial, and sometimes freshwater turtles is remarkable; the many variations observed are undoubtedly due to the quality of work of different foundries and craftsmen and their symbolic interpretation of the turtle depending on whether they had observed the animal or not. The ones with a marine turtle symbolized the maritime power of the Aeginetans. Between 265 B.C. and 242 B.C., a Roman coin depicting a marine turtle was also minted. Today, several countries (Brazil, Cape Verde, Cayman Islands, Cyprus, Sao Tome and Principe) have marine turtles on their currency.

COMMUNITY-BASED CONSERVATION STRATEGIES: AN ANALYSIS OF EFFORTS EMPLOYED IN BAJA CALIFORNIA (MEXICO) AND NICARAGUA

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Community-based conservation seeks methods to designate local communities as the beneficiaries and custodians of conservation efforts. Thousands of indigenous and ethnic cultures living in coastal regions depend on local sea turtle fisheries for income and as a source of protein. The Caribbean waters off the coast of Nicaragua are home to the largest remaining green sea turtle population in the Atlantic Ocean. Yet there is not a clear understanding of the impact Nicaragua's turtle fishery has on total population size of the species. The Wildlife Conservation Society has been present along Nicaragua's Caribbean coast for over 10 years; observing, working, teaching, and learning about the cultural history and the traditional sea turtle fishery. The Pacific coast of Mexico (Baja California) was once the most important feeding ground for several species of sea turtles. Grupo Tortuguero and various other support organizations have implemented various conservation programs based on community involvement in this region. Yet, despite efforts to conserve these endangered species, estimates of their population size continued to decline. The goal of my proposed Ph.D. research is to explore the drivers behind the strategy of community-based conservation initiatives, and to analyze the results observed, in both Baja California (Mexico) and Nicaragua. This research analysis will involve determining what factors of community-based conservation initiatives contribute to project goals. Local dynamics that affect community-based conservation strategies and their execution include: government involvement, historic sea turtle use, opportunistic vs. directive fishery presence, community buy-in, and other related issues.

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COGNITIVE STRUCTURE OF TRADITIONAL FISHERMAN AND COMMERCIAL FISHERMAN WAYUU: AN ETHNOGRAPHIC STUDY

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The cognitive structure is the systematic union of thoughts that determine the conduct of the individual including values, cultural norms of life and patterns. The indigenous cognitive structure is characterized for being hermetic and impenetrable through time, so that the changes that settle down in this environment are in extreme conditions. From ancestral times the native Wayuu co-exists with the marine turtles, his traditions and beliefs are the product of

the presence of the animal. Nevertheless from the process of culture mixing, for some years this thought has been undergoing modifications in cognitive structure and the marine turtles have gotten to become economic sustenance for the region. The present study had as a general mission to clarify the cognitive interpretation that the inhabitants of the ethnic group Wayuu attribute to the marine turtle, as much in the cultural scope as from the economic point of view. It was necessary to know that elements have changed through time which is advisable to emphasize in the process of environmental education, so we constructed a theoretical scheme that faithfully responds to the most possible to the perceptions, actions and norms of judgment of that social unit. The investigation was made in the Venezuelan Peninsula Guajira following a qualitative methodology under an ethnographic approach; method of investigation derived from the anthropology where the way of life of this concrete social unit is learned, persecuting the description or analytical reconstruction of interpretative character of the culture, form of life and cognitive structure of the investigated group. Two types of masculine informants were used: Fishermen Wayuu of 60 years of age that have experienced the culture mixing process, and fishermen Wayuu between 30 and 35 years of age that marine turtles commercialize at the moment. For the data collection we used the direct interview of open answers being recorded and based on faithfully recovering the interpretation of the informant and establishing with a this verbal contract of confidentiality and privacy; we also used validity of every kind for a construction of general meaning being used of previous experiences that could respond to the necessity and noticeable difference of thought between men and women of the zone and when these women were not used like main informants. Through the results we could conclude that the native Wayuu grants the past great importance as a source of wisdom, its cognitive structure is inherited through ancestors, therefore only aged people of the population have the power to change the thought of the present generations. As a result of this it recommends to emphasize the campaigns of ecological awareness to the aged people of the ethnic group, that are excluded due to their hermetic social behavior. Only this group of people will have the influence necessary in the rest of the community to create a deeper change of behavior.

Order: 454 **Abstract ID:** 1569 **Type:** Oral **Subject:** Social Science Research

USING SOCIOECONOMIC SURVEYS TO DESIGN COMMUNITY INCENTIVES FOR CONSERVATION

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Understanding the social and economic context in which conservation projects are implemented is important for achieving success. Collecting socioeconomic data can provide insight into the costs and benefits of conservation and help design appropriate incentives. Household surveys are also useful for monitoring socioeconomic conditions and how they change with conservation activities. Any conservation intervention -whether encouraging volunteers, hiring monitors or patrollers, or paying communities directly for conservation - will have an impact on the recipient community. Household surveys were conducted in September 2005 in Saubeba, Papua, in conjunction with the WWF-Indonesia Jamursba Medi leatherback turtle project. The goal is to increase project effectiveness and sustainability by addressing community concerns about lack of benefits from conservation. To illustrate the importance of understanding communities, we explore the impacts of paying villagers to patrol leatherback beaches. Approximately 40% of households receive income from patrolling. We find significant differences between households with and without patrollers. For example, patrolling households own significantly more assets than non-patrolling households. Expenditures on durable goods over the past year are nearly three times greater in the average patrolling household compared to non-patrolling households. Patrolling households are much more likely to have better-quality housing. For example, while most households prefer an iron roof, only 29% of non-patrolling households have one, compared to 64% of patrolling households. Moreover, the average patrolling household received logging compensation payments nearly 20 times greater than that of non-patrolling

households. It is not clear why, but there may be something very different about these households that should be considered when designing conservation interventions. Though there are significant differences between these two sets of households, further data analysis is required to determine whether the patrolling income produced these differences or whether they already existed before the conservation project. We know that patrollers were chosen by the village leader and the position required literacy (approximately 59% of the adult population is literate). As education is generally associated with higher socioeconomic status, it is likely that the individuals chosen as patrollers were already relatively better-off (though still extremely poor). If so, it is likely that patrolling income is increasing inequality within the community. We considered the possibility of a trickle-down effect: households with patrolling income may be making transfers to poorer households. However, most transfers flowed to or from persons outside of the village (e.g. relatives in another village or city) and of those transfers within the village, the majority were from one patrolling household to another or one non-patrolling household to another. Previous community consultations revealed tensions among villagers and with the conservation program because of a disparity in conservation benefits. Investing in services that provide broad community benefits as a part of a community conservation agreement could address this issue. Surveys revealed that education is the top priority for nearly every household and subsidizing education would add little to current project costs. An agreement to provide such benefits contingent upon the community's continued provision of leatherback conservation might broaden community support for conservation, thus improving project sustainability.

Order: 455 **Abstract ID:** 1759 **Type:** Poster **Subject:** Social Science Research

MARINE TURTLE CULTURE IN THE BRITISH VIRGIN ISLANDS

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Over time, an obvious decline in sea turtle populations has influenced a progressive paradigm shift in cultural attitudes in the British Virgin Islands (BVI). The introduction of restrictions on sizes, moratoriums and seasons has been a great accomplishment in conservation terms, but there is concern of losing the “tradition” and “culture” of the indigenous peoples of the BVI. The mysticism behind “trunking” and the celebrations that accompanied a turtle harvest are all but a few of the cultural legacies that will be lost. This poster explores the past traditions and how the shift in cultural attitudes will impact many of the BVI Islanders.

Acknowledgments: We gratefully acknowledge travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service through the Symposium Travel Committee.

COMMUNITY-BASED CATCH-MONITORING OF A TRADITIONAL FISHERY FOR MARINE TURTLES IN THE KAIWALAGAL TRADITIONAL SEA COUNTRY OF TORRES STRAIT

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The Torres Strait and northern Queensland have the largest population of green turtles in the world. This population supplies a large, internationally-based green turtle harvest, which is currently not managed. In Queensland, successful management will need the involvement of the Indigenous Torres Strait Islanders who use green turtles for cultural, social and economic purposes. This project developed community-based strategies for green turtle catch-monitoring upon which communities could base management plans. I engaged two Torres Strait Island communities in a step-wise process: (1) I obtained support from the Torres Strait Regional Authority; (2) This support enabled me to engage Traditional Owners and Community Councils in each community; and (3) I involved turtle hunters through participatory workshops/meetings. Community members helped me design a datasheet to collect data about hunting behavior needed for co-management. Hunters completed the datasheet after each hunting trip. I assessed the project's success by evaluating the proportion of hunters in the community that participated and the quality of the information they provided. We have one year of data from two communities that actively participate in hunting. Ninety-two and 25% of hunters who signed up from Hammond and Thursday Islands, respectively, handed in datasheets consistently. On Thursday Island, a larger community with a broad social structure, it was more difficult to involve community members in catch-monitoring than on Hammond Island, where there is strong community support for the project. In this paper I discuss culturally appropriate aspects of hunting behavior and catch-monitoring statistics from these two communities.

Acknowledgments: Acknowledging project support from: CRC Torres Strait, James Cook University, Department of Environment and Heritage, Ocean Parks Conservation Foundation, Hammond Island Council, TRAWQ Community Council, Kaurareg Traditional Aboriginal Elders Corporation, WNM Community Fisher Group and Prince of Wales Community Fisher Group; Acknowledging travel award support from: Sea Turtle Symposium, Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service.

PRELIMINARY RESULTS OF VILLAGE-LEVEL TURTLE CONSERVATION FROM MAINLAND TANZANIA, EAST AFRICA

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Five species of endangered marine turtles occur in Tanzanian waters, of which two, greens and hawksbills, nest. The major threats are fisheries by-catch, exploitation for meat and eggs, disturbance of nesting and foraging habitats from unregulated coastal development and destructive fishing practices, limited conservation capacity and poor enforcement of existing laws. In July 2004, Sea Sense (formerly the Tanzania Turtle & Dugong Conservation Programme) began village-level turtle conservation activities along 65 km of coastline in the Temeke District, south of the city of Dar es Salaam. This district has a rural population of approximately 50,000 who rely directly

on coastal and marine natural resources for their survival. Their daily activities are thus implicitly linked with the continued survival of turtles in the area. The project aims to monitor and protect nesting sites, determine annual nesting populations and distribution, quantify the threats, raise awareness and develop an appropriate turtle conservation management strategy. Nineteen Conservation Officers monitor turtle nesting activity along 26.9km of available nesting beach. In 2005, 68 green turtle nests were recorded at eight sites, giving a density of 2.5 nests per km. This is low when compared to two key sites on the offshore island of Mafia where densities in 2005 were 42 and 58.5 nests per km. Lack of historical quantitative data for Temeke prohibits interpretation of nesting population trends. However, monitoring is on-going. Stranding data indicate that inshore fisheries may be having a significant impact on foraging and breeding populations. In 2005, 177 turtle strandings were recorded in Temeke. Mean curved carapace length was 61.5cm (25-114 cm, n=173) and mean curved carapace width was 56.5cm (15-109cm, n=173). The size data for stranded turtles indicates that Temeke's coastal waters are frequented by juvenile and mature turtles, highlighting the importance of the area as both a nesting and foraging ground. Results of questionnaire interviews with 62 fishers from six villages underline the threat posed by incidental net captures, particularly gillnets. Seventy-one percent of respondents cited fisheries bycatch as the major hazard. Human egg predation was also reported to be a problem (34% of respondents). However, during 2005, only 3 (4%) nests were poached implying that conservation activities, including modest financial incentives, are having a positive impact. The main use of turtles is for meat (55% of respondents) and to a lesser extent for decoration (shells) and oil (13% and 3% respectively). Although the fishers perceived no obvious positive or negative turtle population trend, 87% said that turtles should be conserved for future generations. While raised awareness, daily monitoring, nest incentive payments and turtle tourism have proved successful in reducing the threats to turtles in Temeke, this initiative is still in its infancy. Recommendations include: further promoting turtle tourism; continuing education efforts targeting fishers and school children; training relevant government authorities; and advocating mechanisms for the reduction of turtle by-catch at national level.

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JUST SAY NO! AN ASSESSMENT OF THE ESTABLISHMENT, IMPLEMENTATION AND UTILITY OF THE 25-YEAR MORATORIUM ON TURTLE EXPLOITATION ON THE ISLAND OF ANGUILLA, BWI

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A local turtle fishery in Anguilla harvested thousands of green and hundreds of hawksbill turtles annually until 1995 when a five-year moratorium on consumptive exploitation was introduced. The ban was extended for a further 5 years in 2000 and an additional 15 years in 2005. On each occasion the decision to extend the moratorium was taken primarily by government officials. This study, conducted during 2003-4, involved structured interviews, largely with Anguillian fishers, but also members of the public and decisionmakers, to gain insight into their perceptions of the establishment, implementation and utility of this moratorium. While there appears to be a widespread commitment to turtle conservation in Anguilla where some now perceive the turtle fishery to have been socially and/or economically

insignificant, this study revealed that some perceived the aims of the temporary legislation to include not only the facilitation of turtle population recovery, but also population monitoring by the authorities and, if appropriate, a resumption of harvest at some point in the future. To date, a lack of necessary resources has made it impossible to conduct the necessary research to provide any scientific justification for the compromises fishers have been asked to make in light of the legislation. There is in fact a general perception among fishers and members of the public that foraging green and hawksbill turtles appear to be on the increase. In addition, fishers themselves have identified a host of threats to nesting and foraging turtles imposed by the growing human population and the rapid growth of tourism which suggest that the regulation of use alone is unlikely to serve the sustainable management of these turtle populations. Yet, despite minimal enforcement capacity, this study suggests that Anguillian fishers have been largely compliant with the moratorium, apart from occasional illegal take for personal use. This study raises questions about conservation priorities and examines issues of stakeholder participation in the process of decision-making.

References:

Godley BJ, Broderick AC, Campbell LM, Ranger S, Richardson PB. 2004. An Assessment of the Status and Exploitation of Marine Turtles in the UK Overseas Territories in the Wider Caribbean. Final Project Report to the Department of Environment, Food and Rural Affairs and the Foreign and Commonwealth Office. 253pp.

Order: 459 **Abstract ID:** 1829 **Type:** Poster **Subject:** Social Science Research

OHUIRA WAS SILENCIO JOROBADO

Fernando Enciso Saracho

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The denominated ethnic group Mayo, inhabiting the North region of Sinaloa and the south of Sonora, Mexico, has maintained a permanent relationship with the marine turtles, although at the moment they have limited the clandestine use of the marine turtle due to the actual prohibition of 1990. In an effort to describe the aspects of this historical relation between Mayos and marine turtles, data has been extracted from the work “Utopia del Sudoeste” of Robertson B. T. A. (1943), where events of the foundation and development of Topolobampo Sinaloa Mexico are narrated. Topolo lambo Sinaloa was considered the first socialist city in America, a process in which Mayos played an important role, because they were used like labourers in the constructions that were required. The author of this adventure, Alberto Owen, in a denominated writing “El Sueño” (1889), makes several references to the use of these quelonios at that time by this ethnic group. The nostalgia of those times, makes poetically and literary an echo and in the writing of Guadalupe Estrada (1979).

Order: 460 **Abstract ID:** 1422 **Type:** Poster **Subject:** Social Science Research

THE SEA TURTLES ON THE GUINEAN COASTLINE

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Five of six species of West Africa's sea turtles can be found in the Guinean coastline waters. The five species are: *Lepidochelys olivacea* (Olive ridley turtle), *Eretmochelys imbricata* (hawksbill turtle), *Dermochelys*

coriacea(leatherback turtle), *Caretta caretta* (loggerhead turtle) and *Chelonia mydas* (green turtle). All of these species are either seriously threatened or threatened with extinction (red list of the IUCN). Human exploitation and predation are the main threats for these species. The poor urbanization of the coastline and the under-utilization of coastal beach sand has allowed these sites to remain in a condition that favors reproduction of these species. Guinea has ratified conventions on biodiversity, in particular the memorandum of Abidjan on the conservation of the sea turtles. Since 1999, the sea turtle conservation program has been listed as one of the activities of the CNSHB. Informational sessions were conducted at the piers in or around the capital Conakry, as well as at selected sites along the coastline. We have documented the release of 77 turtles caught accidentally since 2000. Our investigations have also revealed “ethnozoological information” regarding utilisation of products derived from these sea turtles comprising a traditional pharmacopoeia. Three spawning sites have been noted along the coastline: Blanche Island (White island), Cape Verga and Tristao Island. A survey obtained on Katract Island (Tristao) allowed identification of the common species at this site and a local community-based conservation program of sea turtles and their nesting sites has been initiated. Turtle tracks, nocturnal movements and nesting sites have been quantified with the involvement of the local population.

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COMMUNITY PARTICIPATION IN THE CONSERVATION AND MANAGEMENT OF SEA TURTLES IN KENYA

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A PRA process was implemented between November 2003 and December 2004 to enhance local community’s participation in the conservation and management of turtles and their habitats in Kenya. The project, carried out among 23 communities along the 600km Kenyan Coastline, sought to collect information on the status of marine resources, to identify major problems to conservation, and to draw a roadmap for community based conservation. The process was employed as it enabled local people to take control of their resources using local knowledge capacities and priorities. Data collection included transect walks, observation, resource mapping, seasonal calendars, and creating timelines and trendlines. Socioeconomic information and data relating to major conservation issues was collected. Data was analyzed through ranking, scoring and descriptive statistics. The exercise resulted in a community action plan (CAP) for the conservation and management of sea turtles and their habitats in Kenya. The CAP was based on contributions and analysis by various social factors. Marine fisheries were cited as the primary basis of livelihoods but also the most immediate threat to sea turtles in Kenya. Sea turtle populations were shown to have declined in six sites by 25-75% due to habitat degradation, destructive fishing methods, demand for trade and consumption of marine turtle products, as well as growth of coastal population and tourism. Recommendations include provision of quality environmental leadership, enhanced institutional capacity, establishment of more community-based conservation groups and facilitation to encourage alternative means of livelihood.

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Turtles and Climate Change

Order: 462 Abstract ID: 1805 Type: Poster Subject: Turtles and Climate Change

THE IMPACT OF CLIMATE CHANGE ON HAWKSBILL TURTLES – A WAY FORWARD TOWARD ADAPTATION STRATEGIES

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Climate change effects on marine turtles can include: 1) loss of nesting and feeding habitats due to a rise in sea level; 2) increased sand temperatures, which can lead to changes in sex ratios or, in severe cases, nest mortality; 3) increased ocean temperatures, which can lead to coral bleaching and other damage to turtle feeding habitats; 4) changes in ocean currents, which can modify migration paths and feeding patterns; and 5) extreme rainfall events, which can increase the potentially lethal transfer of sediment to coral reefs and raise water tables, thereby flooding nests. WWF's Latin America & Caribbean Programme and the Climate Change Programme are constructing a project to quantify the impacts that climate change will have on hawksbills, to provide a model for assessing future climate change impacts to other marine turtle species, and to begin to shape how we develop conservation strategies to protect hawksbill turtles in the face of climate change. The first stage of this project targets the Caribbean. This study will identify the location and susceptibility of known hawksbill nesting areas to climate change and will provide clear management prescriptions so that conservationists can reduce the vulnerability of hawksbill turtles and increase their resilience to climate change. When completed, WWF will provide tools, such as a map highlighting current nesting areas, key habitats and migration paths that are potentially threatened by sea level and temperature rise, so that managers and conservationists can prioritize their efforts. WWF is currently looking for partners to embark in this program of work.

Order: 463 Abstract ID: 1417 Type: Poster Subject: Turtles and Climate Change

BEACH TEMPERATURES AND THE POTENTIAL IMPACT OF GLOBAL WARMING ON MARINE TURTLE NESTING IN THE UNITED ARAB EMIRATES

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The off-shore islands of the United Arab Emirates in the southern Arabian Gulf are utilized primarily by hawksbill turtles (*Eretmochelys imbricata*) for nesting. Between August 2000 and January 2005, two sets of dataloggers (TibBit, Onset Computer Corp.) recorded temperatures at hourly intervals at 15 and 45 cm below the beach surface in artificial nests located in active turtle nesting areas on Zirku and Sir bin Nu'air Islands. Throughout the study period, daily and annual temperature variation was greater at 15 cm below the beach surface compared to variation at 45 cm. Temperatures during the summer exceeded the upper embryonic thermal tolerance limit of 34°C for mean

periods of 91 ± 14.9 days at 15 cm and 69.3 ± 11.8 days at 45 cm in the summer. In the winter, the lower embryonic thermal tolerance limit of 24°C was exceeded for mean periods of 61.7 ± 13.1 days at 15 cm and 73.5 ± 15.3 days at 45 cm depth. Nesting occurs in the mid spring and extends into early summer when temperatures are within the embryonic thermal tolerance limits. As summer temperatures rise with global warming, we suggest that critical nest incubation temperatures will increase, forcing the turtles to nest earlier in the year. The population will require time to adjust its sex determining pivotal temperature, but the time required is not known. Because the utilized beaches are small and constrained by raised rocky areas, the predicted increase in water level and storms will put further stress on the nesting population through sub-sand flooding of eggs and beach erosion.

Order: 464 **Abstract ID:** 1607 **Type:** Poster **Subject:** Turtles and Climate Change

TEMPORAL SHIFTS IN HAWKSBILL NESTING: MECHANISMS AND CONSEQUENCES

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The Jumby Bay Hawksbill Project has monitored hawksbill nesting at Jumby Bay, Antigua for 19 consecutive years, using intensive methods that yield an unusually high recapture probability (see Richardson *et al.* 1999). Using median nest dates we examine the seasonal timing of nesting at individual and sub-population (neophyte and remigrant) levels and assess how these contribute to population level trends. Possible causes for temporal shifts are discussed, including local and regional regulations (such as open and closed fishing seasons), and sea surface warming. Additionally, we address possible effects that such shifts may have on the ecology of the population.

Order: 465 **Abstract ID:** 1840 **Type:** Poster Reserve **Subject:** Turtles and Climate Change

THE IMPACTS CAUSED BY CLIMATIC GLOBAL CHANGES ADD TO THE THREATS OF THE BREEDING POPULATION (*DERMOCHELYS CORIACEA*) IN THE MARGARITA ISLAND, SOUTH CARIBBEAN, VENEZUELA

Pedro P. Vernet and Angela Arias-Ortiz

Grupo de Trabajo en Tortugas Marinas del Estado Nueva Esparta, Fundación Científica Los Roques. Provita. Isla de Margarita, Estado Nueva Esparta, Venezuela

Sea turtles face many pressures of anthropogenic origin, including the sudden climatic changes and natural disasters caused by the progressive overheating of our planet. Hurricanes, storms and storm tides have affected nesting habitats, and therefore clutch development. During the last 5 years, we have recorded an increase in tide height, dune loss (14 meters of beach lost in four years) and sand temperatures. In 2004, increased sand temperatures diminished the hatching success from 69.02% to 48.97% and resulted in the loss of 52.50% of relocated nests, lowering the success from 42.85% to 20.26%. In 2005, the increased sand temperatures at 60 cm rose to an average of 35.7°C , 5.2°C higher than the average from previous years (30.5°C). This resulted in the loss of 72.60% of the *in situ* nests, and 83.67% of moved nests. By the end of the 2004 season, due to the surge and rain from Hurricane Ivan, 37 *in situ* nests (13.40%) and 35 relocated nests (43.75%) were washed away. Hurricanes approach the northern coasts of South America due to the fact that previous thermal barriers are disappearing.

THE EFFECT OF DECREASING RAINFALL AS CLIMATIC CHANGE ON SUBSTRATE CONDUCTIVITY, EMBRYO MORTALITY AND FUNGAL INVASION OF SEA TURTLE NESTS

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The ubiquitous soil fungi *Fusarium oxysporum*, *Fusarium solani* and *Pseudallescheria boydii* are frequently isolated from failed eggs in nests of flatback, green, hawksbill and loggerhead turtles at rookeries in eastern Australia. Within the nest, fungi first appears on an egg that has failed from natural causes. Using this nutrient source, hyphae then expand to adjacent, viable eggs and result in embryo mortality due to inhibition of the respiratory surface area or possibly to calcium deprivation. Since egg failure is the event that allows fungal colonisation of the egg mass, environmental factors resulting in embryo mortality are of paramount importance. Substrate conductivity appears to be the most important factor affecting hatch success. High substrate conductivity imposes osmotic stress on eggs and results in higher mortality and the increased availability of failed eggs to act as a nutrient foci. Changing climatic conditions and long term rainfall patterns are therefore of great importance. Over time, an increasing occurrence of fungi on failed eggs seems to correspond with decreasing summer rainfall. Since rain leaches salts from the nest substrate, changing climate entailing reduced precipitation will result in an increasing substrate conductivity and higher embryo mortality from unfavourable nest conditions, allowing multiple foci for fungal invasion of the turtle nest and subsequent infection of viable eggs. This phenomenon has important consequences for the endangered loggerhead turtles nesting at the major rookery in eastern Australia - Mon Repos.

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ENSO DETERMINES THE REPRODUCTIVE FREQUENCY OF EASTERN PACIFIC LEATHERBACKS

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We developed a remigration probability model to test the effect of climatic variability, as governed by the El Niño Southern Oscillation (ENSO), on the remigration probabilities of nesting leatherbacks at Playa Grande, Costa Rica from 1995 to 2004. A total of 1,615 nesting females were tagged with PIT tags at Playa Grande from 1993 to 2003 and remigration intervals typically ranged from 2 to 7 years. We used equatorial Pacific sea surface temperature (SST) anomaly data from a moored buoy array and remote satellite sensors as indicators of ENSO. We used a linear logistic model to incorporate the effect of SST on a female's remigration probability. A binomial

probability model estimated parameters (through maximum likelihood) based on the empirical tagging data and each buoy's SST data set 1 year, 2 years, and 3 years prior to each nesting season. Our results suggest that inter-annual climate variability, as governed by ENSO, highly influenced the probability of leatherbacks remigrating to nest at Playa Grande, Costa Rica. Cool SST anomalies corresponded to a higher remigration probability and the opposite for warm SST anomalies. Cool periods of SST that corresponded to high remigration probabilities were indicative of highly productive La Niña events when the thermocline of the central and eastern Pacific was elevated resulting in an increased upwelling magnitude of cold, nutrient rich water. Warmer episodes were less productive El Niño events when the thermocline was depressed, thus decreasing the upwelling magnitude. A -2° C anomaly change increased the mean remigration probability over 500%. Specific areas of the equatorial Pacific served as better signals of ENSO for remigration probabilities than others. The northeastern equatorial Pacific produced the best remigration estimates. The ENSO signals at these areas were in synchrony with SST transitions at potential leatherback foraging areas in the sub-tropical, southeastern Pacific. The pattern of ENSO signal strength for remigration probabilities was similar to the physical dynamics of ENSO in the equatorial Pacific indicated by a principal component analysis of SST anomaly variation. The exact relationship between increased primary productivity from La Niña and leatherback prey availability (gelatinous zooplankton) in the equatorial and southeastern Pacific is unknown; however, our results show that there is a positive correlation between the two. We suggest that the increased rates of primary production and subsequent increase of secondary production lead to an increase in the abundance, distribution, and size of the gelatinous zooplankton that the turtles feed on throughout the water column. There are, however, other factors in addition to food availability that regulate the size and density of gelatinous zooplankton populations, particularly for medusae. Our low estimates of annual survival suggest that anthropogenic mortality needs to be reduced. Eastern Pacific leatherbacks are highly susceptible to any form of anthropogenic mortality due to the stochastic nature of mature female foraging areas rendering annual egg production variable. Our results suggest that this declining nesting population is highly sensitive to large-scale climatic variation rendering its recovery rates extremely susceptible to further anthropogenic mortality.

Order: 468 **Abstract ID:** 1572 **Type:** Oral **Subject:** Turtles and Climate Change

ENSO GOVERNED PRODUCTIVITY TRANSITIONS AT POTENTIAL LEATHERBACK FORAGING AREAS IN THE EQUATORIAL AND SOUTHEASTERN PACIFIC

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The remigration intervals of eastern Pacific leatherbacks nesting at Playa Grande, Costa Rica are extremely sensitive to the El Niño Southern Oscillation (ENSO). Satellite tracking studies of post-nesting females at Playa Grande during the mid-1990's and past few years suggest that the turtles follow a southwestern migration corridor along the Cocos Ridge towards the Galapagos Islands followed by an open migration through the eastern equatorial Pacific, the Chile-Peru Humboldt Current System, and the far off-shore waters of Peru and Chile, all of which are subject to environmental variation via ENSO. Leatherbacks are foraging specialists relying on gelatinous zooplankton such as medusae, siphonophores, and salps. The high intrinsic growth rates of gelatinous organisms coupled with their extreme sensitivity to the marine environment, renders their abundance and distribution sporadic. Given the low caloric content of gelatinous organisms, mature female leatherbacks most likely seek large aggregations of prey or areas that favor large prey items to build their energy reserves required for nesting. If the marine environment of the equatorial and southeastern Pacific is highly governed by ENSO, favorable leatherback foraging areas are most likely stochastic both spatially and temporally. Our approach was to use primary productivity as a proxy for gelatinous zooplankton biomass through bottom-up forcing. We calculated values and principal components (PCs) of primary productivity (PP) using 9 km, level 3 SeaWiFS chlorophyll-a

and PAR data, and Pathfinder SST data between 10°N to 40°S and the west coast of South America to 125°W. We found that PC1, PC2, and PC3 accounted for 17.6% of the total PP variation from 1997 to 2004. Using Pearson's Product-Moment Correlation (r), we found that the eigenvectors were either in a positive or negative phase with the Multivariate ENSO Index (MEI) (PC1, $r = -0.43$; PC2, $r = 0.49$; PC3, $r = -0.38$). Areas south of 20°S had PP values that were in a positive phase with ENSO although their low r values suggest a seasonal cycle opposed to inter-annual. Mean PP for the entire potential foraging area from September of 1997 to October of 2005 was 410.78 mg C /m²/month and a maximum of 480.50 mg C/m²/month. During the 1997-98 El Niño, mean PP was 300 mg C /m²/month over the entire area and then recovered to the mean PP after the 1998-99 La Niña. Coastal and equatorial areas had the highest PP during the 1998-99 La Niña. South of 20°S, PP at potential foraging areas were higher than areas north of 20°S during the 1997-98 El Niño. We suggest that the nesting females utilize foraging areas closer to the equator during La Niña but forage in the southern areas south of 20°S during El Niño. Our results can aid in the development of fishery management plans that aim to decrease leatherback by-catch among regulated fisheries. The use of ENSO indices may help fisheries determine where leatherbacks may be foraging to avoid interaction.

Order: 469 **Abstract ID:** 1747 **Type:** Oral **Subject:** Turtles and Climate Change

NESTING PHENOLOGY OF LOGGERHEADS IN SOUTHWEST FLORIDA: IS AN EARLIER NESTING SEASON TIED TO SST OR SIMPLY A REFLECTION OF SURVEY EFFORT?

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Previous studies at Atlantic loggerhead rookeries noted an earlier nesting phenology in recent decades which was attributed to global warming. We investigated whether similar phenomena operated on the opposite side of the Florida peninsula in the Gulf of Mexico. Nesting phenology data for the largest rookery of loggerheads in the Gulf of Mexico were compiled from 1980-2005. We also evaluated SST from data buoys in the region of the Gulf Loop Current. The loggerhead nesting in southwest Florida does show an apparent trend of earlier nesting over the recent period. However, we question whether this truly reflects a link to rises in sea surface temperature (SST) or merely reflects an effect of increasing survey effort in the state as spatial and temporal efforts were not standardized prior to 1991.

Order: 470 **Abstract ID:** 1761 **Type:** Oral **Subject:** Turtles and Climate Change

LEATHERBACK TURTLES, JELLYFISH AND CLIMATE CHANGE IN THE NORTHWEST ATLANTIC: CURRENT SITUATION AND POSSIBLE FUTURE SCENARIOS

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The current unprecedented rate of climate change is an accepted global phenomenon. The consequences of such change are likely to impact all marine systems, including those involving leatherbacks. We conducted a detailed spatio-temporal analysis of over 50 years of leatherback sightings on the European continental shelf. As expected

for an endothermic species, when we compare sightings with archival sea surface temperatures, we demonstrate how accessible foraging habitats are temperature delimited and related to body size differences within the species. To further contextualize the predator among its prey, we compare sightings and published satellite tracking data across the North Atlantic with a unique, integrative gelatinous seascape gathered through long-term zooplankton monitoring by the Continuous Plankton Recorder Survey. We highlight key areas of productivity known to be frequented by leatherbacks, those accessible but as yet uninvestigated, and those which are currently thermally constrained. Within the context of climate change, we investigate the possible effects of past and future climatic changes on the phenology and range of the species and highlight the further potential for additional anthropogenic disturbances.

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Video

Order: 471 Abstract ID: 1444 Type: Video Subject: Video

ANCIENT NAVIGATORS

Milagros López-Mendilaharsu¹, Virginia Boix², Horacio Gomez², Lorenzo Paradell², Andrés Estrades¹, and Alejandro Fallabrino¹

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² Contraviento

Documentary Film: Synopsis La Coronilla, Rocha, Southeast of Uruguay. This area of the Atlantic Ocean constitutes the habitat chosen by a great diversity of species (resident and migratory) as propitious shelter for their development, feeding and reproduction. A prehistoric navigator that has been sighted by a few privileged people sails and disembarks mysteriously on this region. Four of the seven species of turtles come to feed to our shores. They are all in danger of extinction and Belén is one of them.

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SEA TURTLES SEEN FROM THE SKY

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This 13 minute DVD presents the Sea Turtle Aerial Survey Program developed on Reunion Island in 1996. It explains how this program reports information on sea turtle biology, feeding behavior and spatial localization on Reunion Island. This program is integrated in the awareness program of the Sea Turtle Survey and Discovery Center.

GLORIEUSES... GENETIC

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In May 2004, 12 scientists, 3 film makers and 8 crew members landed on the Gloriosa islands, a completely protected French archipelago in northern Madagascar. This film illustrates the research done by Jérôme Bourjea on the vast, white sandy beaches and in the CIRAD laboratory. He used the pattern of mitochondrial DNA variation to analyze the genetic structure of the southwest Indian Ocean population of green turtles (*Chelonia mydas*). This program, developed by IFREMER (French Research Institute for Exploitation of the Sea) and the CEDTM (Sea Turtles Survey and Discovery Center) in 2003, reports interesting results: it is the first time that an Atlantic genetic variant is recorded among any Indo-Pacific nesting populations, and contrary to what was previously known about the green turtle, the Cape of Good Hope provides a recent matrilineal genetic link from the Atlantic to the Indian Ocean green turtle populations. It also found compelling genetic evidence that green turtles nesting at the rookeries south of the Mozambique Channel and those that nest north of the Mozambique Channel belong to separate stocks.

SEA TURTLE: WAYUU TREASURE

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Our presentation is a documentary, product of our grade thesis from college. It covers all the cultural activities related to sea turtles in the Venezuelan Guajira as well as the scientific studies carried out for seven years by local biologists, the natives' mythological beliefs, the traditional hunting techniques and the illegal hunting and turtle meat traffic. During the production of this documentary, we witnessed as spectators the brotherhood between the scientific group and the local inhabitants, the Wayuu people. Even though their jobs were so different, they both seem to be working for the same goal; on one side we had the biologists working to protect the sea turtle and educate the natives, on the other side we had the locals, who seem to have developed a sense of extinction and now they worry about their future as sea turtle hunters. The final goal of this work is to show all these activities from the anthropological point of view, making the human being the main figure in the film, thanks to its interaction with sea turtles. This is the whole point in the science we are practicing in this work, which is called visual anthropology and it consists of learning about the human being by participating observation, which means that we were involved in all their activities for the duration of the time that we were in the Venezuelan Guajira. Also, there are testimonies from the Guajira inhabitants on traditional rites. This is a work done by filmmaking students, at their own initiative, with help from biologists and the Guajira inhabitants (Wayúu Tribe), self-financed, so it has no compromise with any

public or private entity, this serving as a guarantee for its objectivity. It has been made with highly professional equipment, so is of great quality. Also, this documentary was selected to represent Venezuela in the first Latino Film Festival to take place in Sidney, Australia. The documentary was shot entirely on location at the Venezuelan Guajira in the month of September. We believe that this first bilingual work about the cultural practices regarding sea turtles in the Venezuelan guajira is very important because it portraits the extension of the problem, which is one, and also that it concerns everyone with a bit of interest for the common whole.

Order: 475 **Abstract ID:** 1600 **Type:** Video **Subject:** Video

“UNA ENTRE MIL” (ONE IN A THOUSAND), A LOOK AT THE SEA TURTLES OF MEXICO - ENVIRONMENTAL EDUCATION PROGRAM IN LOS CABOS, BAJA CALIFORNIA SUR, MEXICO

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Una Entre Mil, is an impressive 18-minute film about the sea turtles of Mexico. This film introduces all the sea turtles of the world, as all but one of the seven species spends part of their life in Mexico. This film uses a variety of themes that illustrates the different characteristics of each species, biological cycle, as well as global and local problems and implications, which are leading to the potential extinction of these species. This film is designed to be used in conjunction with other environmental education workshops, as it provides an important set of tools for discussion and activities. Some of the activities can further explore the different themes presented in the film. Each activity establishes a relationship, which helps the students construct concepts and ideas that are directly related to where they live and the sea turtles that live in their area. Many of the activities also present the opportunity for discussion concerning conservation and the human impacts on natural resources. These activities are interdisciplinary encompassing Spanish, mathematics, physics, history, as well as science. The activities are also very versatile as they can be implemented either before or after viewing the film. Although the activities are designed for students in grades 2 through 6, they can be adapted for any level. The combination of the film and associated activities provides essential tools to teach children, as well as adults, about sea turtles and the role they can play in protecting them. After the students have attended the workshops, we inform them of possible dates for sea turtle hatchling releases, allowing for the formation of a strong bond between each student and his or her hatchling, which serves to reinforce conservation ethics and practices, and protection of sea turtle species. Due to growing interest in the program, from 2002 to 2004 there were two thirds more participants, increasing from 293 to 495 students. For the year 2005, the amount of participants in the program multiplied five (5) times from the 2002 figure, confirming that its success was due to the greater demand of workshops on the part of the schools. A total of 2,710 students participated in the program from 2002 to 2005. Another result that indicates the existence of changing attitudes is that students have followed the possibilities and devised their own conservation proposals after one workshop, using skills learned in the workshop. These skills are then seen applied from their homes. This is confirmed by parents, who become interested in participating and wish to adopt the newly introduced strategies within the family circle, and subsequently contact our office. Existing testimonies from people who participate in the workshops and sea turtle releases comment that they have stopped consuming sea turtles, and voluntarily and actively support the sea turtle protection programs.

Acknowledgments: GTP gratefully acknowledges travel support from Disney Animal Kingdom, Western Pacific Regional Fisheries Management Council, US National Marine Fisheries Service, and US Fish and Wildlife Service, provided through the Symposium Travel Committee.

PICCOLO

Michael White

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This 12-minute film from the Ionian Sea shows a juvenile loggerhead (CCL 25cm) swimming underwater following its release from the WWF-Centro Recupero Tartarughe Marine at Lampedusa, Italy (2005). A steep-sided cove Cala Pisana was used for the release and two habitats are included: *Posidonia oceanica* seagrass and a rocky shelf. Underwater visibility was good (25 metres), respiratory surface intervals were filmed from below, and several close-ups were possible before the turtle headed out to the open sea.

AUTHOR'S INDEX

Author	Abstract Order
Abazinge, Michael	52
Abdallah, Omari	457
Abe, Osamu	95
Abella, Elena	1, 34, 110
Abreu-Grobois, Alberto	37, 77, 91, 200, 201
Accorsi, Pier Attilio	53
Acevedo, Exain	37
Acevedo, Javier	278
Acevedo-Ruiz, E.	275
Adulyanukosol, Kanjana	114
Affronte, Marco	248
Aguilar, Alex	97, 207, 208, 210, 236, 318
Aguilar, Héctor Rafael Contreras	177, 322
Aguilar, Juan	8
Aguirre, A. Alonso	2
Akcinar, S. Can	111, 427
Akoa, Amougou	249, 378
Akpagana, Koffi	238
Aksissou, Mustapha	112, 204
Al-Amri, Issa	32
Al-Bahry, Saif N.	32, 54
Al-Hanai, Fatma M.	202
Al-Kindi, Abdulaziz Y.	32, 44, 54, 202
Al-Rawahy, Salim H.	54
Al-Shamsi, Hafsa	202
Al-Siyabi, Sultan	32, 54, 202
Al-Zadjali, Shoaib A.	202
Aland, Rachel C.	27
Alansari, Aliya S.	202
Alegre, Ferran	48, 49, 208, 268, 279
Alexander-Garner, Jeanne	367
Algumezi, Mohamed A.	138
Ali, Abdellatif	413
Ali, Lamri	382
Allman, Phil	335
Almansori, M.	44
Almeida, Antonio P.	61
Alsharif, Mohamed E.	138
Alshwihedi, Mohamed A.	138
Altamirano, Ali J.	316

Author	Abstract Order
Altinkaya, Habib	145
Álvarez, Carla	268
Álvarez, Susana	234
Ambio, Levi	381
Ambrose, E.E.	324
Anchante, Helbert A.	316
Andraka, Sandra	448
Anfuso, E.	105
Angoni, Hyacinthe	249
Angulo, Ramón Enrique Morán	211, 212
Aniebona, F.	324
Antonio-P., Marco	167, 226
Aoyama, Jun	245
Apra, Aida	290
Arai, Nobuaki	95
Arana, Luis Eduardo Girón	113
Araña, Javier	39
Arencibia, Alberto	25, 26
Arendt, Mike	11
Argano, Roberto	287
Arias-Ortiz, Angela	3, 4, 333, 402, 465
Arlettaz, Raphaël	247
Arnold, Peter	447
Arthur, Karen E.	5, 6
Aureggi, Monica	114, 207, 210, 357, 379
Austin, Timothy J.	58, 420
Avens, Larisa	11, 22, 23, 418
Averbeck, Michelle	358
Avilés, Noldan Avilés	168
Awong-Taylor, Judy	14
Ayissi, Isidore	249
Aymak, Cemil	7, 17, 368
Azanza-Ricardo, Julia	237
Aznar, F.J.	46
Bache, Sali Jayne	115
Badillo, Francisco J.	46, 330
Baez, Jose C.	174, 320
Bagley, Dean	91
Bahry, Saif N. Al	44
Bailey, Lisa M.	263

Author	Abstract Order
Balazs, George H.	5, 370
Baldacchino, Alfred E.	264
Bali, James Anak	366
Ball, B.	217
Ballamu, Ferdiel	71
Baltodano, Luis Corea	168
Bando, Takeharu	390
Baptistotte, Cecília	61
Barboza, Pablo	474
Barcelo, Anna	208
Barker, Francesca	139
Baronio, Mateus A.	203
Barragán, Ana R.	173
Barraza, Angélica Maria González	175
Barrios-Garrido, Hector	8, 153, 360, 453, 474
Bartolí, Alex	268
Baskale, Eyup	379
Bass, Crystal	14
Bass, Zoe	430
Bañagas-Ojeda, M.	274
Becerra-Delgado, Marcos	118, 132
Becerril-Toral, Adrián	77
Becker, J.H.	232
Beggs, Jennifer	201, 383
Belalidis, Thanos N.	116
Bell, Rebecca	363, 384
Bellido, Juan Jesús	56, 63, 208
Bello, Antonio Di	9
Belskis, Lisa	326, 327
Benhamou, Simon	72
Benhardouze, Wafae	112, 204
Benson, Scott R.	140, 205, 220, 381
Bentivegna, Flegra	78, 208, 209, 236, 240, 444
Benvenuti, Silvano	82, 105
Beqiraj, Sajmir	437
Bergmann, Charles	327
Berkson, Dr. Jim	376
Berna, Howard	430
Bianchi, Gabriella	192
Bianchi, L.	105

Author	Abstract Order
Bicho, Rita	10
Billes, Alexis	57, 372
Birtles, Alastair	446, 447
Bjorkland, Rhema	281
Bjorndal, Karen A.	91, 98, 193, 198, 235, 282
Blanco, Rubén	160
Blanvillain, Gaëlle J.	43, 347
Block, Barbara	102
Blumenthal, Janice	58, 420
Boggs, Christofer	174, 320
Boix, Virginia	471
Bolten, Alan B.	91, 98, 193, 198, 235, 282
Bouain, Abderrahmen	294, 304
Bourjea, Jérôme	59
Bowden, Rachel M.	336, 343
Bowessidjaou, Joseph Esso	238
Boyle, Michelle M.	6, 206
Bradai, Mohamed Nejmeddine	294, 304
Bradsby, Jennifer	407
Branco, Paulo	68
Braun-McNeill, Joanne	11, 22, 23, 29
Bravo, Camelia Manrique	244, 283, 321
Bravo, Italo E.	443
Bresette, Michael	217, 361
Bride, Ian	337
Brill, Richard	296
Briseño-Dueñas, Raquel	117, 228, 229, 275
Broderick, Annette C.	58, 60, 70, 76, 286, 420, 470
Brost, Beth	391
Bruford, Michael	70
Brush, Julianna R.	380
Bugoni, Leandro	313
Buiten, Ricardo Sagarminaga van	216
Buras, Esam M.	138
Burchfield, Patrick M.	167, 226
Burgoín-Marron, S.	275
Burney, Curtis	233

Author	Abstract Order
Bursic, Moira	224
Bález, José C.	62, 284, 285, 445
Caballero, Edgar	260
Caballero-Aspe, Edgar	405
Cabrera, Rosendo Arturo Velásquez	77
Cahoon, Sigita S.	109, 442
Calabuig, Pascual	42, 92
Calderon-Campuzano, F.	180
Calderwood, Natasha	265
Cambié, G.	393
Camiñas, Juan A.	62, 91, 174, 284, 285, 320, 445
Campbell, Cathi	452
Campbell, Cathi L.	67
Campbell, Lisa M.	286, 458
Cardona, Luis	97, 207, 208, 210, 236, 318
Carlson, Brianna K. R.	11
Caros, Christina	252
Carrasco, Yeleine Ruisanchez	410
Carreras, Carlos	63, 92, 207, 208, 209, 210, 236
Carrion, Carlos T.	362
Carthy, Raymond R.	41, 154, 217, 452
Cartwright, Ian	317
Casal, Ana Belén	26, 42
Casale, Paolo	125, 287
Case, Michael	462
Castellanos, César Y. Luis	409, 410
Castellanos, Rodrigo	35, 118, 119, 132
Castillo, Carlos del	279
Castillo, Inocencio	151
Castillo, Juan José	56, 63, 210, 236
Castillo-Leggs, V.	275
Castleberry, Steven B.	323
Castleton, Michael	102
Castro, Jessica H.	362
Catellacci, Alima C.	64
Catsadorakis, Giorgos	143
Cattarino, Lorenzo	287
Ceriani, Simona	12
Chacón, Didiher	120
Chaloupka, Milani	197, 382, 383

Author	Abstract Order
Changawa, Kahindi	331
Chaverri, Didiher Chacón	168
Chaves, Gerardo	230
Cheng, I-Jiunn	13
Chevalier, Johan	291
Christopher, Steven J.	43, 347
Chryssomalis, Christos	122
Ciampa, Mariapia	18, 36
Ciccione, Stéphane	59, 72, 250, 472
Ciofi, Claudio	70
Clark, P.	217
Clark, Paula	430
Clerveaux, Wesley	70
Clune, Patricia	65
Cluse, Wendy M.	29, 251
Coleman, Manuel	277
Collins, Tim	398
Colucci, Antonio	9
Condran, Sarah	217, 430
Conlon, Monica López	266, 389
Connell, Des	24
Contato, María C. D.	109, 442, 443
Contina, Andrea	288
Contreras, Samuel	26
Cooper, Robert W.	66
Cordi, Victoria A.	67
Cornejo, Ingmar Sosa	123, 175, 176, 211, 212, 322
Corriero, Aldo	290
Costa, Alice	124
Costa, Margarida Neves da	15
Coulter, Jocelyn A.	363, 384
Cox, Tara	281, 289
Coyne, Michael S.	60, 76, 319
Craven, Kathryn S.	14
Crispino, F.	393
Croll, Donald A.	108
Cross, Helen	357
Crowder, Larry B.	281, 289, 340, 441
Cruz, Amado	332
Cruz-Morelos, A.	274
Cuenca, Rafaela	48, 49
Curnock, Matt	446, 447
Côté, Isabelle M.	449

Author	Abstract Order
d'Angelo, Stefania	373
Dam, Robert P. van	74, 242, 243
Darwish, Akram	413
David, Donald	252
Day, Russell D.	29, 43, 347
DeSalle, R.	232
Decastro, Natalia	151
Deflorio, Michele	290
Delcroix, Eric	291
Delgado, Cláudia	15, 364
Delgado, Stephen G.	2
Deliyannis, Alexander T.	116
Dellinger, Thomas	15, 68, 89, 364
Demir, Mehmet	145
Dick, Gerald	125
Dickerson, Dena D.	178, 365
Dickerson, Virginia L.	178, 365
Diez, Carlos E.	242, 243, 362
Dimopoulos, Dimitrios I.	126
Dimopoulos, Panayotis	100
Diogou, Niki	16
Diong, Cheong-Hoong	366
Diéguez-Uribeondo, Javier	34
Dobbs, Kirstin	446, 447
Dodd, Mark G.	29, 323
Dodge, Kara L.	213
Domingo, Andres	312
Dominici, Alberto	93, 314, 396
Donadi, Rodrigo	260
Donoso, Miguel	292
Dossou-Bodjrenou, Josea S.	253
Downie, J. Roger	310
Drews, Carlos	293, 448, 462
Driscoll, Cindy P.	380
Dung, Pham Hong	329
Dunn, Daniel	216, 281
Dunstan, Andy	447
Dutton, Peter H.	86, 109, 140, 181, 196, 199, 200, 205, 213, 214, 215, 292, 308, 358, 367, 381, 385, 404, 412, 415, 442, 443
D'apollo, Marielvy	474

Author	Abstract Order
Díaz-Fernández, Rogelio	237
Ebanks-Petrie, Gina	58, 420
Echwikhi, Khaled	294
Eckert, Karen L.	216
Eckert, Scott A.	84, 102, 104, 174, 216, 320
Eguchi, Tomo	381
Eguchi, Tomoharu	86, 367, 415, 419
Ehrhart, Llewellyn	91, 217
Ekmekci, Irfan	127
Elghmati, Hisham	138
Ellis, Erin K. M.	66, 69
Elshafie, Abdelkadir E.	32, 44, 54
Enciso-Padilla, Idelfonso	132
Engstrom, Tag N.	348
Epperly, Sheryan P.	99, 219, 295, 326, 327, 385, 441
Ergene, Serap	7, 17, 368
Erzin, Tarik	369
Espinosa-López, Georgina	91, 237
Estes, Jennifer	217, 254, 370
Estima, Sergio	313
Estrades, Andrés	31, 471
Evans, David A.	467
Fagan, Meredith A.	296
Fahy, Christina C.	128
Fajardo, Eneida	218
Fallabrino, Alejandro	31, 129, 471
Farfán, M.A.	56
Farmer, Andrew	265
Fellhofer, Christine	130
Fernández, Gloria	97, 208, 210
Fernández, Rogelio Díaz	409, 410
Ferrando, Virginia	19
Ferreira, Rogério Nuno Lopes	98, 131, 282, 371
Ferreira, Telma	68
Figg, Leslie	256
Fioravanti, M. L.	46, 270
Fiorentini, Laura	40
Fish, Marianne R.	449
Fisher, Tatum	286
FitzSimmons, Nancy N.	239
Flanagan, Joseph P.	101
Flegra, Bentivegna	18, 36

Author	Abstract Order
Flodin, Eric	65
Flores, Egle	108, 260
Flores-Millán, Eloy	118, 119, 132
Florio, Daniela	40
Floyd-Cutler, Sherrie A.	69
Fonseca, Ernesto Águila	409
Foote, Jerris	430
Ford, John K. B.	421
Formia, Angela	70, 200, 201
Forney, Karin A.	205, 415
Fortin, Christian	401
Fossette, Sabrina	21, 57
Fraga, Iliana	234
Francia, Gabriel	133
Frazer, Nat B.	158
Frazier, J.	194
Freggi, Daniela	9, 53, 287, 373
Freitas, Romeo de	424
Fretey, Jacques	57, 238, 249, 372, 378, 450, 451
Frett, Gaverson	455
Frey, Amy	213
Frick, Michael G.	73, 297, 439
Fulford-Gardiner, Michelle	255
Fuller, Wayne J.	60
Fulvio, Maffucci	18
Funes, L.	105
Funk, Stephan M.	242, 243
Fuxjager, Matthew	334
Gace, Arian	437
Gagliardi, Fiorella	19
Galia, Francesco	373
Galindo, José	234
Galois, Patrick	401
Gamberoni, Matteo	53
Ganong, James	102
García, Arturo	278
García, Débora	173
García, Luisa	268
García-García, D.	275
García-Monroy, Y.	274
García-Rojas, S.	274
Gardner, Beth	219
Gardner, Susan C.	2, 47, 53

Author	Abstract Order
Garland, Katy	452
Garner, Steven A.	367
Gasith, Avital	207, 210, 386
Gass, Jordan	298
Gastellum, Fredi	119
Gaulejac, Béatrice de	460
Gaus, Caroline	24
Gazo, Manel	268
Gearhart, Jeff	299
Gearheart, Geoffrey	71
George, Robert H.	20
Georges, Jean-Yves	21, 57
Gianluca, Treglia	36
Gibudi, Alain	372
Gidis, Muge	338, 341, 379
Gil, Magaly Andreina Castellano	453
Gilpatrick, Jim	404
Girard, Charlotte	72
Gjertsen, Heidi	140, 454
Glen, Fiona	60
Godfrey, Matthew H.	22, 23, 29, 76, 112, 251
Godley, Brendan J.	58, 60, 70, 76, 286, 420, 458, 470
Godínez-Orta, Lucio	136
Goitom, Mahta	134
Gomez, Horacio	471
Gomez-Quiroga, A.	180
Gonzalez, Elizabeth	135
González-Díaz, Óscar M.	39
González-Pumariega, Maribel	237
Gonçalves, João	98, 282
Goodman, April	22, 23
Gore, Shannon	70, 286, 455
Goshe, Lisa	22, 23
Goto, Kiyoshi	390
Gozalbes, Patricia	330
Gracan, Romana	224
Graham, Tanya	220
Gray, Jennifer	374
Grayson, Jillian E.	137, 456
Greig, Thomas W.	311
Griffin, DuBose B.	73

Author	Abstract Order
Griffiths, Laura M.	14
Grimes, Jim	217, 430
Grizel, Henri	59
Groves, Theodore	315
Gruppetta, Anthony	264
Guada, Hedelvy J.	156, 218
Guadagnin, Demetrio L.	203
Guclu, Ozgur	111, 427
Guffoni, Bruno	328
Guinea, Michael L.	375, 382, 423
Gumbs, James	70, 458
Gustinelli, Andrea	40, 46
Guzmán, Juan R.	135
Gómez-Muñoz, Victor M.	136
Haas, Heather L.	299
Hadoud, Daw A.	138
Hagerty, Bridgette E.	339
Halager, Kristine	256
Hall, Martin A.	319
Halley, John	183
Halpin, Patrick N.	281, 319
Hamann, Mark	137, 456
Hamed, Wahid	138
Hamza, Abdulmaula A.	138
Handy, Scott	139, 155
Hansen, Lara	462
Haralabous, John	306
Harfush, Martha	37, 77
Harms, Craig A.	22, 23, 29
Haro, Andrea de	257, 318
Harrison, Emma	74, 257, 276
Hart, Kristen M.	340
Harvey, Jim	220
Harwell, Mark	52
Hatase, Hideo	75, 245
Hataway, Dominy	326, 327
Hawkes, Lucy A.	76
Haxhiu, Idriz	300, 437
Hays, Alli	430
Hays, Graeme C.	78, 100
Hayward, Brett	299
Hazlewood, Ruth	119, 132
Hearn, Gail	407
Hedges, Melissa E.	376, 426

Author	Abstract Order
Heppell, Scott S.	89
Heppell, Selina S.	89, 301, 309, 352, 387, 419, 441
Hermanussen, Siobhan	24
Hernandez, Cesar	51
Hernandez, Jim	218
Hernández-Olazo, Alberto Ángel	77
Herrera, Henri W.	443
Hidalgo, M. Rosario	25, 26
Higgins, Benjamin M.	101, 327, 334
Hino, Akinori	28
Hirama, Shigetomo	246
Hitipeuw, Creusa	140, 147, 190, 273, 302, 454
Hochscheid, Sandra	78
Hodge, Karim V.D.	286, 458
Hohn, Aleta A.	22, 23, 418
Holloway-Adkins, Karen G.	221, 406
Honarvar, Shaya	377
Hopkins-Murphy, Sally R.	73
Horrocks, Julia A.	200, 201, 449
Huang, Tsung-Shun	13
Hughes, George R.	82
Hutchinson, Brian J.	263
Hyacinthe, Angoni	378
Hyams, William	446
Hykle, Douglas	141
Hyman, Mark	79
Ibarra-Martín, María Elena	237
Ibrahim, Mahmoud	44
Ikonomopoulou, Maria P.	27
Ilgaz, Mustafa	145
Ilgaz, Saban	145
Ili, Pinar	379
Innis, Charles	38
Insacco, Gianni	288
Isasi, Carlota	25
Ishihara, Takashi	28
Ítaatli, Hidayet	145
Iwamoto, Futoshi	28
Jackson, Chris D. J.	258
Jacobo, Javier	119
Jaime, J.J. Martín	56

Author	Abstract Order
James, Audley	424
Janzen, Fredric J.	336
Jeffers, John	70, 286
Jiménez-Márquez, Francisco	118
Joaquim, Natércia	10
John, Freya St	457
Johnson, Chris	99, 104, 217
Jones, Andrew P.	449
Jones, Meghann	417
Jones, Todd T.	223
Jribi, Imed	294, 304
Juan, E. Garcia	475
Jurado, Luis F. Lopez	227
Kama, Dean	274
Kamarruddin, Ibrahim	27
Kamel, Stephanie J.	142, 222
Kamezaki, Naoki	28, 80
Kapantagakis, Argyris	303, 306
Karaa, Sami	304
Karadaki, Olga	305
Karavellas, Demetres	143
Kardakari, Niki	144
Kaska, Arzu	379
Kaska, Yakup	7, 338, 341, 369, 379
Kasperek, Max	187, 351, 357
Katara, Isidora	81, 306
Katic, Jelena	224
Katilmis, Yusuf	379
Katselidis, Kostas A.	100
Katz, Wilma	430
Kavvadia, Alexandra	81, 306
Keane, Ellen	299
Keller, Jennifer M.	11, 29
Kellett, Ian	272
Kelly, Terra R.	22, 23
Kethan, Shanna L.	101
Khalil, Mona	207, 210, 357
Khan, Tabisam	44
Kikilaitety, Daniel Utra	147
Kilham, Susan	199
Kimmel, Tricia L.	380
Kindi, Abdulaziz Al	10
King, Tim L.	340
Kirac, Akin	369

Author	Abstract Order
Kiremit, Ferhat	349, 427
Kisokau, Karol M.	381
Kiyumi, Ali Al	10
Ko, Pou-Chung	13
Koch, Andrea U.	375, 382
Koch, Volker	135
Kouroutos, Vassilis	437
Koutsodendris, Andreas	144, 166
Koyluoglu, Husamettin	145
Kremezi-Margaritouli, Anna	259
Kritseli, Lito	16
Krueger, Barry H.	201, 383
Kubilis, Paul S.	391
Kucklick, John R.	11, 29
Kusetogullari, Hasibe	416
Kusmierski, Patricia	363, 384
Kutle, Bayram	145
Kuzuturk, Emine	145
LaCasella, Erin L.	205, 385
Lagueux, Cynthia J.	67, 452
Lambardi, Paolo	82, 105
Landry, Andre M., Jr.	101
Laporta, Martin	129, 312
Largiadèr, Carlo	247
Laudino, Johath	260
Lavin, Santiago	48, 49
Lawalata, Julius	147
Lawson, Richard	223
Lazar, Bojan	224, 301, 307
Lazo, R.	153
Lazou, Angela P.	225
LeBlanc, Anne M.	226
LeRoux, Robin A.	200, 213, 308, 358
Lee, A. Michelle	29
Leippert, Fabio	247
Leonard, Kenya	430
Leoncio, Villarías	475
Lettosome, Bertrand	455
Levy, Yaniv	207, 210, 386
Lewis, Kemit-Amon	30, 261
Lewison, Rebecca	281, 289, 309
Lezama, Cecilia	31, 312
Lima, E.H.S.M.	232

Author	Abstract Order
Limpus, Colin J.	2, 5, 6, 24, 206, 382, 446, 447
Linde, Andreas	51
Lioudakis, Lambros	303
Lira-R., Diana J.	167, 226
Livingstone, Suzanne R.	148, 310
Lohmann, Kenneth J.	334, 353
Lopez, Gustave G.	88
Lorne, Jacquelyn K.	83
Loshuertos, Alvaro G. de los Ríos y	84
Loughland, Ron	392, 463
Lowers, Russell	406
Loza, Ana Liria	227
Lucia, Alessandra De	93, 314, 396
Luigi, Ferretti	36
Luschi, Paolo	78, 82, 85, 105
Lutcavage, Molly E.	89, 309, 354, 387
Lutjeharms, Johann	82
Lutz, Peter	52
Luxon, James	255
Lynn, Morgan	404
Lyon, Boyd	86
López-Castro, Melania C.	228, 229
López-Jurado, Luis F.	1, 34, 92, 110
López-Mendilaharsu, Milagros	31, 195, 471
López-Reyes, Elpidio Marcelino	37
Macrae, Ismail	438
Madrid-Vera, Juan	117
Maes, Jean-Michel	51
Maffucci, Fulvio	208, 209
Magaya, Hans Gwladis	434
Magyar, Thomas	87
Mahenge, Jairos	149
Mahmoud, Ibrahim Y.	10, 32, 54, 202
Maison, Kimberly	150
Maldonado, David	260, 405
Malichi, Yariv	386
Mangel, Jeffrey	332
Mangott, Arnold	447
Mansfield, Katherine L.	388
Mantovani, Dario	230
Mantziou, Georgia	342

Author	Abstract Order
Manzano, Alvaro	389
Marco, Adolfo	1, 33, 34, 63, 92, 110, 208, 209, 210, 236, 403
Marco, Ignasi	48, 49
Marcon-Domenico, Enrico	35
Marcovaldi, Maria A.	88, 232
Marcovich, Dragoslov	52
Margaritoulis, Dimitris	81, 96, 144, 166, 183, 207, 210, 247, 305, 306, 408, 451
Margaritoulis, Jason D.	262
Marquez-Almanza, P.	275
Marsh, Helene	137, 446, 447, 456
Marsh, Jesse C.	2
Martin, Corrine S.	286, 470
Martin, E.R.	217
Martinez, Rolando	51
Martinez-O., Hector J.	167, 226
Martinez-Zamora, Christian	37
Martino, Giovanni De	236, 240
Martins, Helen R.	98, 282
Martín, Juan Jesús	63, 209
Martín, María Elena Ibarra	409, 410
Martín, María P.	34
Martínez-Tovar, Cecilia	118
Mason, Peri A.	464
Massie, Elaine	223
Mast, Roderic B.	263
Matheson, Kelly	272
Mathias, Dave	252
Matsinos, Yiannis	231
Matsuzawa, Yoshimasa	80, 390
Maye, Edward De	361
Maynard, Sarah	277
Mazaris, Antonios D.	231
Mazzarella, Kristen T.	311
Mba, Miguel Angel Ela	407
McAlister, Justin	334
McCarthy, Abigail L.	89, 309, 387
McClellan, Catherine M.	90
McDanel, Marc R.	425
McGowan, Andy	70, 286
McIvor, Carole C.	340

Author	Abstract Order
McLellan, L.	190, 317
McMillan, W. Owen	242, 243
Melly, Paola	332
Mencacci, Resi	82, 105
Mendonça, Vanda	10
Mengstu, Tekle	134
Merigo, Connie	38, 66
Metrio, Gregorio De	290
Meylan, Anne B.	151, 374, 391
Meylan, Peter A.	151, 200
Micò, N.	393
Mifsud, Carmen R.	264
Mihnovets, A. Nicole	22, 23
Miller, Dean	447
Miller, Jeff	392, 463
Miller, Philip	312
Milliken, Henry	299
Mingozzi, T.	393
Minotou, Charikleia	143, 152
Miranda, Pascual Calabuig	227
Miro, Aida T.	242, 243
Miyazaki, Nobuyuki	94
Mizuno, Kojiro	80
Moga, Frans	140
Monagas, Patricia	26, 39, 42
Moncada, Félix	91, 160
Monroy-García, Yazmín	136, 275
Mons, José Luis	56, 63, 209
Montagnant, Serge	472, 473
Montague, Jenny	38
Montanari, S.	105
Montaño, Bertha	260
Monteiro, Danielle	313
Montiel-Villalobos, Ma. Gabriela	8, 153, 360, 474
Montilla, Alfredo	156, 433
Monzón-Argüello, Catalina	92
Moreira, Luciana M.P.	61
Morin, Phillip A.	412
Morra, Wayne	407
Morreale, Stephen J.	219
Mostafa, Hesham M.	395
Mota, Mario J	154, 406, 430
Motta, Helena	124

Author	Abstract Order
Mrosovsky, N.	142, 222
Muasa, John K.	162, 461
Muccio, Colum	139, 155
Muhlia-Melo, Arturo	91
Muir, Catharine	457
Munguia, Jose	51
Murphy, Sally R.	66, 311
Murphy, Thomas M.	73
Murray, Wendy	438
Muscarella, Mario	14
Musick, John A.	296, 388, 467, 468
Mustakas, Ashley	83
Mustofa, Imam	302
Muurmans, Mechteld	265
Myers, Alyssa G.	254
Mylonas, Moysis	342
Médicci, María de los Angeles Rondón	156
Nannarelli, Stefano	93, 314, 396
Nantsou, Theodota	143
Narazaki, Tomoko	94
Nardini, Giordano	40
Naro-Maciel, Eugenia	232, 422
Naru, Colin	381
Nash, Patricia	401
Nasser, A.H.	395
Nel, Ronel	397
Nester, Lindsay	158
Newton, Kelly	108
Ngouessono, Solange	398
Nichols, Wallace J.	2, 108, 147, 159, 267, 281, 289, 405, 415, 452
Nickerson, Max A.	344
Nickson, Amanda	317
Niemann, Marilyn	254
Nodarse, Gonzalo	91, 160
Norem, April D.	41
Norton, Terry	29
Novak, Peter	180
Nunny, Rob	139, 155
Nzuki, Simmons K.	161, 162, 461
O'Hara, Jeffrey	315
Obando, Enrique	257

Author	Abstract Order
Ochoa, Ruth	260
Okemwa, Gladys M.	399
Okuyama, Junichi	95
Olvera, Enrique Ocampo	415
Olynik, Jeremy	58
Omuta, Kazuyoshi	75, 245
Opurum, S.C.	324
Ordoñez, Cristina	151
Ormeño, Milagros	316
Ortega, Marco Antonio Barraza	123, 175, 322
Oruc, Ayse	400
Orós, Jorge	25, 26, 39, 42
Osborn, Julie G.	266
Oshika, Tatsuya	80
Ouellet, Martin	401
Ouellette, Stefanie	233
Ouerghi, Atef	138, 163
Outerbridge, B.	374
Owens, David W.	43, 347
Pacali, Ersin	338
Pacheco, Marcos Bucio	123, 175, 211, 212, 322
Paepke, Olaf	24
Paitz, Ryan T.	343
Pajuelo, Mariela	332
Paladino, Frank V.	65, 102, 428, 467
Palmer, Jennifer L.	267
Panagopoulou, Aliko	164, 186, 305
Pankratz, Scott B.	266
Pantis, John D.	100, 126, 165, 182, 183
Papadopoulou, Stavroula	144, 166
Paradell, Lorenzo	471
Parga, Maria Luz	48, 49, 268, 279
Park, Amber	167
Parmenter, C. John	466
Parnell, Richard	398
Pascual, Marta	207, 208, 210, 236
Pastorino, Victoria	19
Patel, Keval	417
Patel, Tejas	417
Patiño-Martínez, Juan	33, 403
Patman, Daniel	119

Author	Abstract Order
Pauly, Daniel	198
Paz, Nelly de	316
Pease, Victoria L.	215, 404
Peckham, S. Hoyt	108, 260, 405, 415
Peden-Adams, Margie	29
Pelegrín, Elda	234
Pena-V., Jaime	167, 226
Penrose, Rod	470
Pereira, Wagner M. Quirós	168
Perriere, Patrice De La	451
Perryman, Wayne	404
Peterson, James T.	178
Philip, M.	190
Phillott, Andrea D.	169, 466
Pickering, Arlington	70, 455
Pilcher, Nicolas J.	317, 381, 382
Pinal, Rene	135
Piovano, Susanna	396
Pita, J.	190
Pitman, Robert L.	196
Pitt, Amber L.	344
Plotkin, Pamela	377
Plytas, Adonis	437
Pons, Emmanuel	473
Pont, Sara	208, 268, 279
Portafaix, Thierry	472, 473
Poulakakis, Nikos	342
Prince, Eric	295
Pritchard, Peter C.H.	424
Prodocimi, Laura	129
Provancha, Jane A.	406
Pubill, Eva	318
Páez, Vivian	403
Pérez, Rogelio Sosa	211, 212
Quaglio, Francesco	40
Quaresma, Isabel	15
Quattro, Joseph M.	311
Queiroz, Kevin de	342
Quesada, Claudio	120
Quevedo, Irene Álvarez de	318
Quirós, Anny Chaves-	184
Quiñones, Liliana	33, 403
Rader, Heidi A.	407
Raga, Juan Antonio	46, 208, 210, 330

Author	Abstract Order
Ramos, Willy D.	242, 243
Rangel, Rodrigo	415
Ranger, Sue	70, 286
Ranger, Susan	458
Rashid, S. M. A.	170
Ratnawati, Nilam	147
Rawahy, Salim H. Al	44
Read, Andrew J.	90, 281
Read, Andy	289
Real, Raimundo	56, 284, 285
Reece, Joshua	202
Reed, Nick J.	425
Rees, Alan F.	81, 96, 207, 210, 225, 306, 408
Rei, Vagi	381
Reich, Kimberly J.	235
Reina, Richard D.	428, 467
Restrepo, Adriana	403
Revelles, Mónica	97, 236
Revuelta, Ohiana	156
Reyes, Julio C.	316
Reyes, Rolando Parra	168
Reyier, Eric	406
Rhodin, Anders G.J.	355
Ricardo, Julia Azanza	409, 410
Rice, Marc R.	64
Rice, Richard	171
Richards, Paul M.	411
Richardson, James I.	363, 384, 464
Richardson, Peter B.	70, 286, 458
Richardson, Thelma H.	363, 384
Rico, Ciro	63, 92, 208, 209, 210, 236
Riede, Klaus	87
Rieth, Denise	61
Riewald, Brian	98
Rincon, Maria	8
Rios, Mariana	312
Rios-Olmeda, Daniel	117
Rivero, Carlos	295
Rivero, Miguel A.	25, 26
Rivero, Rosanna	391
Rizk, Charbel	357
Roberts, Jason J.	319

Author	Abstract Order
Rocco, Massimiliano	287
Rocha-Olivares, Axayácatl	228, 229
Roden, Suzanne E.	412
Rodriguez-Clark, K.	153
Rodríguez, Daynier	257
Rolph, Jill R.	269
Romero, Marcela	173
Ron, Tamar	172
Roos, David	72
Roques, Severine	63, 208, 209, 210, 236
Rosa, Elizabeth Arista De la	77
Rossi, Natalia	260, 405
Rostal, David C.	185
Roumillat, William A.	43
Royer, Francois	89
Rubini, S.	105
Rubio, Paul	265
Rueda, Lucia	174, 320
Ruiz, Argelis	151
Ruiz, Marina	173
Ruiz-Urquiola, Ariel	237
Rumano, Merita	300
Saad, Adib	413
Saba, Vincent S.	467, 468
Sacks, Ben	168
Safina, Carl	281, 289
Sagarminaga, Ricardo J.	62, 174, 284, 285, 320, 445
Sagbo, Patrice	253
Sahin, İbrahim	145
Sahin, Mehmet	145
Saldaña, Aline Mejia	123, 176
Sales, Gilberto	129, 328
Salmerón, Susana	119
Salmon, Michael	83, 103
Samper, Betwel	71
SanFelix, Manuel	208, 210
Sanchez, Dalia	474
Santamaria, Nicoletta	290
Santidrian-Tomillo, Pilar	428, 467
Santillan, Luis	45
Santos, Marco R.	98, 282
Saoud, Younes	204

Author	Abstract Order
Sara, Shaleyra Kelez	244, 283, 321, 332
Saracho, Fernando Enciso	123, 175, 176, 177, 211, 212, 322, 459
Sarti, Adriana L.	135
Sarti, Laura	173
Sarti-Martinez, Adriana Laura	415
Sasso, Carlos	286, 458
Sasso, Christopher R.	99, 295
Sato, Katsufumi	94
Scalfoni, Juarez T.	61
Scarabino, Fabrizio	31
Scaravelli, Dino	46, 248, 270
Scarpino, Russell A.	217
Schaffer, Chuck	271, 345, 346
Schaffer, Rick	271, 345
Scheidt, Doug	406
Schmid, J.	217
Schofield, Gail	100, 143, 152
Schroeder, Barbara	91, 167, 226
Schweitzer, Sara H.	178
Schwenter, Jeffrey A.	43, 347
Scott, Colin R.	258
Scott, Jason A.	323
Segars, Al L.	11, 29, 311
Segniagbeto, Gabriel Hoinsoude	238
Seitz, Alfred	239
Seminoff, Jeffrey A.	86, 109, 196, 199, 223, 404, 415, 442, 443
Seney, Erin E.	101
Senol, Asaf	416
Serrano, Xaymara	242, 243
Shalouf, Usama M.	138
Shaver, Donna	215, 358
Shaw, Glen R.	5
Shigueto, Joanna Alfaro	45, 332
Shillinger, George	102
Shima, Tatsuya	80
Shimizu, Tomohito	95
Shulman, David	417
Silman, Roxana	257
Silver, Jennifer	286
Sims, Michelle	281

Author	Abstract Order
Sinclair, Billy	169
Singewald, Dave	361
Siyabi, Sultan Al	44
Slater, Marina Ruiz	278
Smith, David	272
Smith, Frank D.	429
Smith, Michel B.	236
Smith, Morgan M.	103
Smyth, Dermot	446, 447
Snover, Melissa L.	418, 419
Soares, Luciano S.	88, 200
Soede, Lida Pet	302
Sola, Murad S.	138
Solarin, B.B.	324
Soler, Rolando	362
Solomon, Joni L.	58, 420
Sore, Ysidro	474
Soulantika, Kostandina	164
Soumah, M'mah	460
Southwood, Amanda	325
Spaven, Lisa D.	421
Spotila, James R.	65, 102, 199, 377, 428, 467, 468
Stachowitsch, Michael	130
Stamper, M. Andrew	22
Standora, Edward A.	439
Sterling, Eleanor	422
Stevens, April	423
Stevens, Darrin T.	264
Stewart, Kelly	99, 104, 424
Stewart, Kimberly M.	425
Stokes, Lesley	326, 327
Streeter, Kathy	38
Sudre, Joël	72
Sullam, Karen E.	426
Sullivan, Patrick J.	219
Sundin, Gary W.	178
Suárez, Ana	403
Swimmer, Yonat	309, 325, 328
Swingle, W. Mark	20
Swinkels, Jeroen L.	179
Symington, Keith	329
Tamayo, Duniesky Ríos	409, 410
Tanaka, Koki	80

Author	Abstract Order
Tapilatu, Ricardo F.	140, 273
Taskavak, Ertan	111, 348, 350, 427, 432
Tatge, George	430
Teas, Wendy	299
Teclenariam, Yohannes	134
Tellería, María T.	34
Tenorio-Rodriguez, Paola	47
Theissingner, Kathrin	239
Theriot, Craig T.	178
Thomas, Amber	286
Thome, Joao C.	61, 88, 328
Thorn, Robert	438
Thorvalson, Kelly	29
Tiburcio-Pintos, Graciela	136, 180, 274, 275, 475
Tisen, Oswald Braken	366
Tiwari, Manjula	57, 112, 140, 181, 273
Toba, Victor de la	405
Toba, Vladimir De la	260
Togridou, Anatoli	182, 183
Tomillo, Pilar Santidrian	428
Tomás, Jesús	46, 208, 210, 330
Torreblanca, Davinia	62
Tracy, C. Richard	339
Travaglini, Andrea	240
Treglia, Gianluca	240
Trejo-Robles, Jose A.	117
Trentini, M.	46, 270
Tripathy, Basudev	241
Trott, Steve	331
Troëng, Sebastian	151, 197, 257, 272, 448
Tsaros, Paul C.	429
Tsukamoto, Katsumi	75, 245
Tucker, Tony	217, 430, 469
Tuncay, Dogan	427
Turkozan, Oguz	111, 207, 210, 349, 350, 427, 431
Tuttle, Allison	29
Tuttle, Jacob A.	185
Tvrtkovic, Nikola	224, 307
Türkecan, Onur	427, 432

Author	Abstract Order
Ucar, Askin H.	17
Udy, James W.	5
Urhan, Rasit	379
Urquiola, Ariel Ruiz	410
Urso, S.	393
Uçar, Askin H.	368
Valastro, Carmela	9
Valavanis, Vasilis D.	81, 306
Valeiras, X.	285
Valente, Ana Luisa	48, 49
Valentine, Peter	446, 447
Valerga, Maria	186
Vallini, Carola	78, 105
Valqui, Michael	332
Valvo, Mario lo	373
Vasconcelos, Javier	278
Vaso, Andrian	437
Vasquez, Carlos Mario Orrego	50
Vaughan, Mario	51
Vaughan-Rojas, Walter	51
Vaughn, J.	217
Vega-M., Lila	167, 226
Velez-Zuazo, Ximena	242, 243, 244, 283, 321
Velásquez-Magaña, Salvador	132
Venizelos, Lily	187, 351, 357
Vera, Vicente	433
Verhage, Sebastiaan B.	148, 372, 434
Vernet, Pedro P.	3, 4, 333, 402, 465
Vicente, Oscar Ocaña	84
Viera, José del Carmen Espericueta	211
Vinh, Dr. Chu Tien	329
Vissenberg, Dominique	74, 276
Vázquez, José M.	25
Vélez-Zuazo, Ximena	200
Waayers, David A.	188
Wabnitz, Colette	198
Wal, Edith S. van der	189, 435
Wal, Richard W. van der	189, 435
Wallace, Bryan P.	102, 196, 199, 281, 289, 309, 428
Wallace, Nichols J	260

Author	Abstract Order
Walli, Andreas	405
Wamukota, Andrew W.	399, 461
Wang, John H.	334
Wang, Yamin	106, 191
Watanabe, Kunihiro K.	245
Watkinson, Andrew R.	449
Watson, John	327
Watson, Kennard	79
Weber, Scott	38, 66
Webster, Rebecca	16
Weldeyohannes, Simon	134
Wheatley, Damon	70
White, Aaron	52
White, Jim	70
White, Michael	107, 436, 437, 476
Whiting, Scott D.	375, 382, 423, 438
Whittier, Joan M.	27
Wibbels, Thane	167, 217, 226, 254, 356, 370, 417
Williams, Cassandra	65
Williams, Kristina L.	73, 439
Wilson, Lisette	190
Wingfield, Dana K.	108
Witherington, Blair E.	246, 391
Witt, Matthew J.	58, 470
Wolters, Monica S.	178
Wood, Lawrence D.	256, 440
Wooddell, Alexandra K.	64
Wyneken, Jeanette	12, 217, 417, 441
Wyss, J. Micheal	254
Xenopoulou, Katerina	277
Yahuaca, Jose Luis Alvarado	123
Yalcin-Ozdilek, Sukran	127
Yamashita, Suguru	28
Yerli, Sedat V.	432
Yilmaz, Can	350, 427
Yoseda, Kenzo	95
Yörükoglu, Ramazan	145
Zabini, S.	105
Zaccaroni, Annalisa	53
Zamora, Maria Angeles	48, 49
Zanre, Richard	331
Zárate, Patricia M.	109, 196, 442, 443
Zavodnik, Dusan	224

Author	Abstract Order
Zbinden, Judith A.	247
Zenteno-Savin, Tania	47
Ziza, Valter	307
Zucchini, Marina	53
Zurita, Julio	91
Zydelis, Ramunas	281, 289, 309

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